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Investigating the Psychological Factors that Influence Cyclone Mitigation Behaviour

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Statement of Sources

Every reasonable effort has been made to gain permission and acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

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Statement of the Contribution of Others

This thesis was written by Mitchell Scovell under the supervision of Connar McShane, Anne Swinbourne and Daniel Smith. All supervisors assisted with editing and provided academic advice.

The results chapters of this thesis are written as individual journal articles. Three of the four papers have been published/accepted for publication. Scovell wrote the papers and McShane, Swinbourne and Smith assisted with the research design and editing.

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Abstract

Tropical Cyclones can cause significant damage to houses located in high-risk areas. In Australia, cities and towns situated on the north coast of Queensland are considered some of the most cyclone-prone communities in the country. Cyclone related property damage can, however, be reduced if the citizens of these communities perform appropriate protective behaviours. People can, for example, install structural upgrades on their houses, which improves the house's ability to withstand cyclonic winds. There is also a range of short-term preparedness behaviours that have been shown to effectively mitigate cyclone related property damage. Though, to date, the proportion of people that perform these mitigation behaviours has been relatively low. The overall aim of this research project was to explore why some people do, and others do not, perform cyclone mitigation behaviours.

Past research has shown that Expectancy Value (EV) theories help to explain whether people perform mitigation behaviours for natural hazards. However, an EV based theory has yet to be applied to explain cyclone related structural mitigation behaviour. This research project addressed this research gap by testing the extent to which an adapted EV theory helps to explain people's intention to install cyclone shutters. An initial study showed that psychological factors within the adapted EV theory were significant predictors of mitigation behaviour. The results also indicated that an adapted EV theory can be used differentiate between different types of people and their levels of intention to install cyclone shutters. A follow up study showed that that *hazard intrusiveness, perceived benefits* and *perceived cost* were the only significant predictors of shutter installation status when controlling for other psychological, demographic and experience factors. The results indicate that when *perceived benefits* (i.e., the secondary benefits of a structural upgrade) and *perceived efficacy* (i.e., the perceived ability of the structural upgrade to mitigate harm) are considered separate constructs, only *perceived benefits* is a significant predictor of structural mitigation

behaviour. The findings suggest that people are more likely to invest in shutters if they believe that the secondary benefits of shutters outweigh the cost.

Although most EV theories suggest that *risk perception* influences protective behaviour, empirical research has shown that *risk perception* is not always a significant predictor of mitigation behaviour. This research project also tested a new method of assessing *risk perception* to determine if it was significant predictor of short-term cyclone preparedness behaviour. The results indicate that when controlling for objective risk and *protective action perceptions*, the *predicted damage* and *anticipated negative emotions* associated with that damage were both significant predictors of preparedness intention. The results suggest that it is possible to identify a relatively strong link between *risk perception* and mitigation intention when it is considered a dual-process phenomenon and objective risk is controlled for in the analysis.

Research investigating mitigation behaviour for natural hazards also tends to show that people with experience perceive more risk and are more prepared for future events. However, the link between experience, *risk perception* and mitigation behaviour seems to be dependent on the type of experience. One type of experience that has not been studied empirically is that of *fringe experience.* The final study addressed this research gap by exploring how people who had experienced the fringe effects of a severe cyclone (i.e., experienced lesser wind speeds compared to those near the eye of storm) predicted future damage from similar cyclone event. It was found that the more people overestimated the severity of the cyclone they experienced, the less damage they predicted they would experience from a future severe cyclone. The results highlight the importance of specifying the type of experience being assessed in empirical research and that *fringe experience* is one type of experience can lower *risk perception*.

The findings from this research project have several implications. The results show that different psychological factors are important for explaining different types of mitigation behaviour. It is, therefore, important for future research applying EV theories to adapt them in accordance with the type of behaviour they are attempting to explain. The findings also suggest that the link between *experience, risk perception* and cyclone mitigation behaviour is dependent on the way in which these variables are conceptualised and operationalised. Overall, this research project shows that how people think about cyclones and mitigation behaviours helps to explain the extent to which they prepare for cyclones.

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Introduction

Natural hazards can cause devastating consequences to the communities they effect. Natural hazards often cause widespread property damage, monetary loss and negative physical and mental health outcomes (National Centers for Environmental Information, 2021; Noji, 2000). Population growth in hazard-prone areas also means that impacts from future natural hazards may be more severe (Cutter & Finch, 2008). Mitigating these negative effects is, therefore, a primary focus for many countries (Department of Home Affairs, 2018a; United Nations Office for Disaster Risk Reduction, 2015). As outlined in Disaster Risk Reduction (DRR) strategies like the Sendai Framework and the Australian Disaster Preparedness Framework, reducing the impact from future natural hazards requires adequate preparedness responses from governments, communities and individuals.

Tropical cyclones are one type of natural hazard that cause negative consequences for many at-risk populations. In Australia, people that live in coastal regions north of the Tropic of Capricorn are particularly vulnerable to cyclone-related impacts. In these regions, and other cyclone-prone regions around the world, widespread damage to residential housing is a common consequence of a cyclone event (Holmes, 2015; Stewart, 2003). Such damage can lead to negative physical and mental health outcomes for affected individuals (Shultz, Russell, & Espinel, 2005). Making residential housing more structurally resilient is, therefore, an essential component of reducing the overall impact from cyclones.

Mitigating damage to housing often requires protective behaviour at the household level (Smith, Henderson, & Ginger, 2015). It is, therefore, important to understand what facilitates or impedes an individual's efforts to perform such behaviours. While there are a range of factors that can influence behaviour (Darnton, 2008), researchers have consistently identified that people's thoughts about hazards and their estimates of their own ability to mitigate harm are reliable predictors of behaviour (Floyd, Prentice-Dunn, & Rogers, 2000;

Milne, Sheeran, & Orbell, 2000; Weinstein, 1993). Many studies have also found that such thoughts predict mitigation behaviour or intention in response to a range of different natural hazards such as floods and earthquakes (Bubeck, Botzen, & Aerts, 2012; Lindell & Perry, 2000). There has, however, been minimal research investigating what drives mitigation behaviour aimed specifically at reducing cyclone-related property damage.

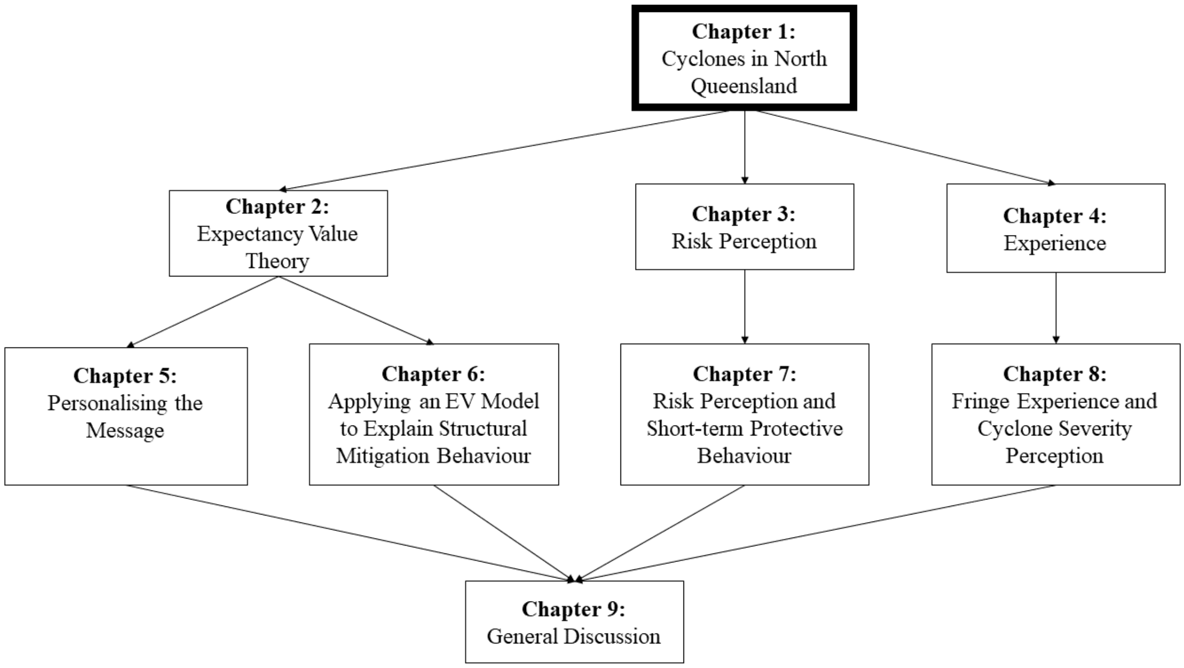
Adequately mitigating cyclone-related property damage requires a unique set of behavioural responses. As such, it is difficult to extrapolate the findings from past research and suggest that the same psychological factors that influence other types of preparedness behaviour (e.g., evacuation or general preparedness) also support the performance of behaviours aimed at reducing cyclone-related property damage. While several studies have investigated the psychological factors that influence different types of natural hazard preparedness (see Bubeck, Botzen, & Aerts, 2012; Lindell & Perry, 2000 for reviews), fewer studies have focused on property damage-reducing behaviours, especially structural mitigation behaviours, in a cyclone context. Studies that have considered damage mitigating behaviours, do not tend to treat such behaviours as a distinct form of preparedness (e.g., Duval & Mulilis, 1999; Lindell & Whitney, 2000; Paton et al., 2005). However, damage mitigation behaviours, and particularly structural mitigation behaviours, are different from other types of preparedness behaviour as they are usually more costly or require skills/effort to perform. This thesis aims to address this research gap by exploring whether commonly applied psychological theories can explain cyclone-specific mitigation behaviours aimed at reducing property damage.

While natural hazard preparedness extends beyond just mitigating property damage, understanding what drives cyclone-damage mitigation behaviour will help to address a focus of broader Disaster Risk Reduction (DRR) strategies. Australia’s National Disaster Risk Reduction Strategy, for instance, specifically highlights the importance of understanding behavioural barriers to risk reduction at the individual level (Department of Home Affairs, 2018b). Similarly, The Sendai Framework for Disaster Risk Reduction Framework, which was adopted at a 2015 UN World Conference, specifies the promotion of disaster preparedness as one of the four main priorities. While there are many different approaches to addressing these priorities, this thesis aims to contribute to these broader DRR strategies by investigating the psychological factors that can facilitate or impede disaster preparedness at the individual level. Furthermore, the thesis will primarily focus on explaining preparedness behaviours aimed at reduced cyclone-related property damage as explaining such behaviours has not been a priority in past research.

Much of the psychology-based research investigating natural hazard mitigation behaviour tends to focus on three main explanatory theories/constructs: (1) Expectancy Value theories, (2) Risk Perception and (3) Experience. The research has shown that these psychological theories and constructs do, to some extent, explain mitigation behaviour. The links are, however, dependent on the context (e.g., type of natural hazard) and the conceptualisation/operationalisation of the relevant psychological factors (Becker, Paton, Johnston, Ronan, & McClure, 2017; Bubeck et al., 2012; Lindell & Perry, 2012). This thesis will review these three main areas of psychological research and explore how the underlying theories can be adapted to explain cyclone specific mitigation behaviour.

This thesis starts by examining the phenomenon of cyclones and the particular challenge cyclones represent for people living in North Queensland (Chapter 1). Chapters 2-4 review the literature on Expectancy Value theories of behaviour change (Chapter 2), Risk Perception (Chapter 3) and Experience (Chapter 4). Chapters 5-8 report the results and are presented as individual journal articles. Chapter 9 is a general discussion, which discusses the main findings and implications of this research. A diagram showing how the thesis chapters are connected will be presented at the start of each chapter.

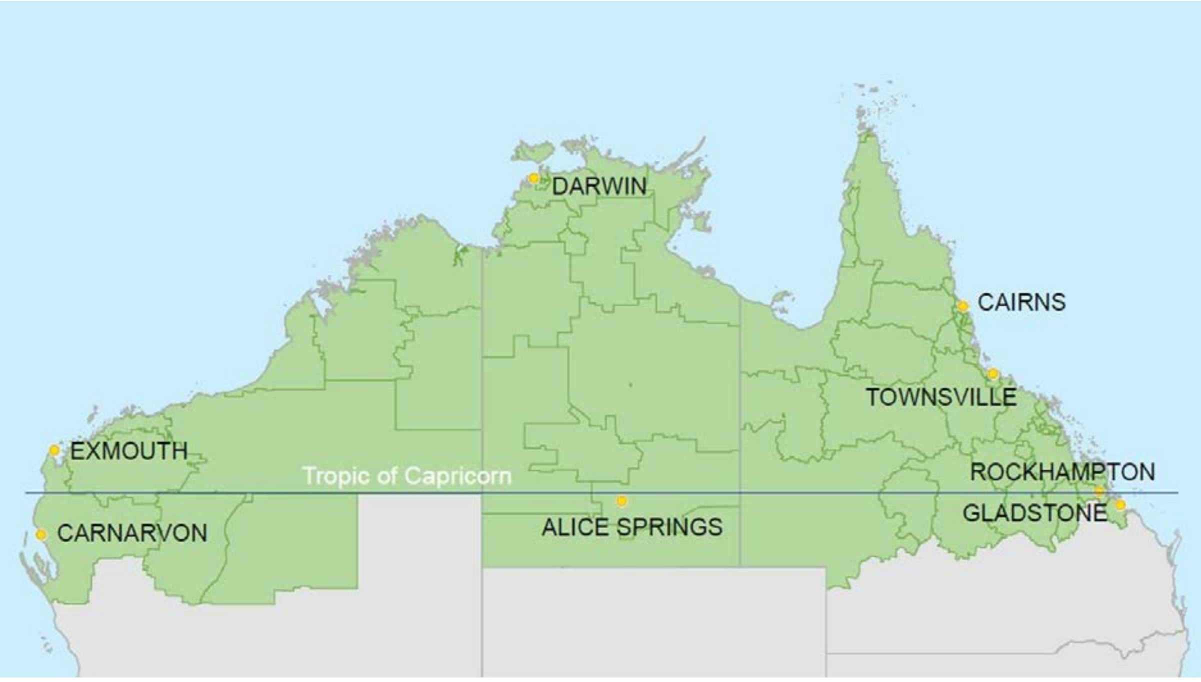
Chapter 1: Cyclones in North Queensland



Northern Queensland is particularly susceptible to tropical cyclones. While North Queensland has no official border, it is usually defined to encompass the area north of Rockhampton (see Figure 1.1). As seen on Figure 1.1, the Tropic of Capricorn runs just south of Rockhampton, which explains why this area of Queensland is also referred to as 'The Tropics'. Compared to other cyclone-prone regions in Australia, this area of Queensland is densely populated. The cities/towns of Rockhampton, Mackay, Townsville and Cairns all have over 60,000 residents each (Queensland Government Statistician's Office, 2017). Conversely, there is only one city (Darwin, Northern Territory) north of the tropic of Capricorn with a population of over 60,000 residents that is outside of Queensland (Australian Bureau of Statistics, 2018).

Figure 1.1

Map of the Northern Part of Australia as indicated by the Tropic of Capricorn (Queensland Treasury, 2019)



This chapter will explain the specific challenges that cyclones present for people living in North Queensland. The chapter will start by introducing what cyclones are and the negative effects they have on people due to the destruction they can cause. The chapter will then review the most common forms of property damage and the recommended methods for mitigating such damage. The chapter will end by discussing the benefits of cyclone mitigation and some of the unique psychological barriers that may impede an individual's decision to pursue cyclone mitigation behaviour.

1.1 What is a Cyclone?

Tropical cyclones are extreme weather events that have significant destructive potential (Bureau of Meteorology, 2020). The meteorological definition of a tropical cyclone is a low-pressure system that forms over warm ocean water (Bureau of Meteorology, 2020). In Australia, tropical cyclones are commonly referred to as *cyclones* but in other parts of the world they are called *hurricanes* or *typhoons*. Although these titles are different they all refer to the same meteorological event (National Ocean and Atmospheric Administration, 2020). The hazards that tropical cyclones cause are strong winds, heavy rainfall and storm surge (Bureau of Meteorology, 2020). The severity of a tropical cyclone is usually categorised by the wind speed and/or pressure of the system. For example, in Australia a Category 1 cyclone is defined as having a 10-minute sustained wind speed of 63-88km/h, whereas a Category 5 cyclone has a 10-minute sustained wind speed of over 200km/h (Bureau of Meteorology, 2018c).

1.2 The Destructive Potential of Cyclones

Cyclones negatively impact people in a variety of ways. They can cause death, injury, the spread of infectious disease, poor mental health outcomes, and economic loss (Shultz et al., 2005). In developed countries, the risk of death and injury from these events is relatively low (due to improved forecasting and evacuation procedures) but what remains a concern to such communities is the property damage that cyclones cause and the associated economic losses (Holmes, 2015; Stewart, 2003). In Australia alone, cyclones have caused 10.16 billion dollars (AUD) of damage and 167 deaths since 1975 (EM-DAT, 2014). Cyclone Yasi, one of the more recent severe cyclones to hit North Queensland, caused over $800 million in damage (Queensland Government, 2011). In addition to economic losses, widespread property damage can lead to population displacement which itself is linked to poor mental and physical health outcomes (Norris, 2005).

Cyclones are also likely to cause more damage in the future due to a changing climate and increasing population density in vulnerable regions. Despite a decrease in predicted frequency, a predicted increase in cyclone intensity and population growth in vulnerable areas is likely to increase the number of vulnerable individuals (Peduzzi et al., 2012). Moreover, cyclones are likely to become a threat to more people in the future due to an expanding tropical region (Kossin, Emanuel, & Vecchi, 2014). That is, populations that were previously unaffected by cyclones may now be at risk (Krupar & Smith, 2019). It is predicted that these climate changes and increasing population in vulnerable areas will lead to greater property damage due to destructive cyclonic winds (Emanuel, 2011). To reduce this predicted increase in property damage due to cyclones, it is vital that all vulnerable individuals are adequately prepared to mitigate damage and in turn, mitigate economic losses, and negative physical and mental health outcomes.

1.3 Insurance Prices

Another problem that stems from cyclone-related property damage is increased insurance prices. In Australia, people living in cyclone-prone regions pay, on average, twice as much for their insurance premium compared the rest of the country (Australian Competition and Consumer Commission, 2018). Furthermore, due to a changing climate, it is predicted that many properties in Northern Australia could become uninsurable in the future (Phelan, 2011). Since 2012 there has been at least 11 government inquiries into the problem of insurance affordability in Australia (Harwood, Smith, & Henderson, 2016). The key take away message from these inquiries was that natural hazard risk is the main factor that is driving up insurance prices, and in North Queensland the main risk is due to cyclones (Harwood et al., 2016). One way to reduce the risk of cyclone related property damage is to make the existing houses in cyclone-prone areas more resistant to property damage (Harwood et al., 2016; Mileti, 1999). Simply put, if there is less risk of property damage due to more resilient housing, insurance prices can be lowered to reflect this reduced risk.

1.4 Cyclone-related Property Damage

Mitigating cyclone-related property damage first requires identifying the most common types of damage seen after a cyclone. As cyclones cause a range of different weather hazards, the type of property damage is dependent on the type of hazard exposure.

Cyclone damage can occur due to a range of different hazards such as wind, rain or storm surge (Boughton et al., 2011). Although all hazards can contribute to damage, post cyclone damage assessments conducted in Queensland have shown that the main cause of damage in these areas is wind related (Boughton et al., 2011). As such, the main strategy for reducing property damage in these areas should be to make properties more resilient to wind-related damage. The following sections will highlight the most common types of wind-related damage and the recommended methods of mitigating that damage. This section will focus on two main types of cyclone mitigation behaviour: *structural mitigation* and *general preparedness*.

1.4.1 Structural Mitigation

Structural mitigation requires making changes to the existing structure of a property. The most commonly recommended structural changes to mitigate potential cyclone damage are roof upgrades and opening protection (i.e. doors and windows). Such behaviours only need to be performed once (unless repair or maintenance is required), usually need to be installed by a professional, and are quite costly compared to general preparedness behaviours. Although changes to building code can sometimes make these upgrades mandatory, many cyclone-related structural upgrades are voluntary for people living in North Queensland. In other words, while building codes can mean that structural resilience is enforced in a population without homeowners having to perform any mitigation behaviours (e.g., all the housing is built to the current building code), in the population of interest, it is the household’s responsibility to perform mitigation behaviours in many instances. The following sections will describe why these measures are important and what types of damage they mitigate.

1.4.1.1 Roof Upgrades. The costliest form of wind-related damage is a roof failure. An analysis of insurance claims data in Queensland after Severe Tropical Cyclone Larry (STC Larry) and Severe Tropical Cyclone Yasi (STS Yasi) found that roof damage was reported in all claims that were over 50% of the insured value (Smith et al., 2015). While only less than 3% of houses received this level of damage, it contributed to 27% of the total damage cost for the affected regions (Harwood et al., 2016). Roof damage can be particularly costly for two main reasons. First, if the roof damage is bad enough, the roof needs replacing. The second reason roof damage is so costly is that it increases the house's exposure to other hazards. For example, a house with roof damage is more likely to experience additional damage due to water ingress and flying-debris entering the house. In some cases, it can cost up to A$250 000 to rebuild a house that has had significant roof damage (Smith et al., 2015).

Roof damage is most commonly seen in houses built before 1982 (Boughton et al., 2011). Before this date, roofs did not have to be designed to withstand cyclone level winds. After observing the widespread damage to housing caused by Cyclone Tracey in the Northern Territory, the Queensland Government changed their building code in 1982. This change meant that all houses built after this date needed roofs designed to withstand cyclone level winds. However, the code change did not mean that pre-1982 houses had to upgrade their roofs. As such, roof damage is still commonly seen with older houses. As pre-1982 houses make up roughly 60% of the housing stock in Queensland (Smith & Henderson, 2015), there is a significant number of houses that are at risk of experiencing severe levels of property damage if they are exposed to future cyclones.

1.4.1.2 Opening Protection. Cyclonic winds can also damage house features such as windows and garage roller doors, which are commonly referred to as openings (Smith et al., 2015). Flying debris is a common cause of damage to openings (Smith et al., 2015). Like a roof failure, damage to openings can cause further knock on effects. Damage to an opening (e.g., a smashed window) means that wind can enter the house, which increases the pressure inside the house, which, in turn, increases the likelihood of a roof failure (Henderson & Ginger, 2008). A damaged opening also means that flying debris and wind driven rain can enter the property, which may threaten the safety of the occupants or cause additional damage to the house's interior.

Mitigating damage to openings requires strengthening an opening or protecting it from impact. Garage roller doors can be strengthened by installing additional bracing (Smith et al., 2015). Due to a Queensland building code change, all new garage roller doors built in cyclone-prone regions after 2010 must be built with additional bracing (Cyclone Testing Station, 2011). People with pre-2010 houses have the option to reinforce their existing roller door, but this upgrade is not mandatory. Mitigating damage to windows requires shielding the window from damage. Recommended methods of window protection are installing fixed cyclone shutters or putting up plywood covers when a cyclone is approaching (Smith et al., 2015). At this stage, installing fixed cyclone shutters is not mandated by the Queensland building code. As such, while window protection is recommended, it is completely voluntary, which makes it a particularly useful outcome to explain differences in people's structural mitigation behaviour as it is unlikely to have been installed without the homeowner having a clear intent to mitigate damage

1.4.2 General Preparedness

There are also many types of minor damage seen after a cyclone. Some examples are torn shade sails, damaged trees and damaged fencing (Smith & Henderson, 2015). Analysis of insurance claims after STCs Larry and Yasi revealed that around 86% of the claims were for minor damage (i.e., less than 10% of the house's value) but because minor damage was so common it made up 25% of the total claims cost (Smith et al., 2015). Much of this damage is preventable if people perform simple household preparedness behaviours (Smith et al., 2015). For example, homeowners can remove shade sails and trim tree branches before a cyclone arrives. Household preparedness behaviours can also mitigate more costly structural damage. For example, cleaning up loose items around a property reduces the chance of damage to windows, doors or walls due to flying debris. Similarly, cleaning roof gutters before a cyclone can help water to drain efficiently, which reduces the chance of flooding and/or water ingress. Unlike structural upgrades, these behaviours are relatively inexpensive, can be performed by the homeowner, and can be performed in response to a cyclone watch or warning. Some behaviours like trimming tree branches and cleaning roof gutters can be performed annually before the cyclone season starts.

As mentioned earlier, another cause of damage is water entering the house due to wind driven rain (also known as 'water ingress'). While water ingress is more likely when there is damage to the roof or an opening, it can also occur without a structural failure (Boughton et al., 2017). For example, strong winds can 'push' water through window seams or through ventilation gaps in the roof (e.g., 'whirly birds'). Water ingress is particularly problematic as it can occur at lower wind speeds, which are unlikely to cause structural damage by themselves (Henderson & Ginger, 2008). Beyond installing roof upgrades and opening protection, one way to mitigate water ingress is to cover windows with plastic and taping the seams (Cyclone Testing Station, 2018). This mitigation measure captures water that may come through the window so that it does not enter the house. Because this preparedness behaviour requires more effort and skill compared to simpler preparedness activities, the variability in intentions to perform this behaviour should provide insights into what influences one's motivation to mitigate structural damage.

1.5 Benefits of Cyclone Mitigation

Both general preparedness and structural upgrades provide a range of benefits. For one, cyclone mitigation practices have been shown to significantly reduce damage after a cyclone (Grayson & Pang, 2014). Changes to the 1982 building code, for example, have significantly reduced the levels of property damage due to cyclones (Boughton et al., 2011; Henderson & Ginger, 2008). One benefit of less damage is a reduced repair cost. It has also been found that the economic benefits of cyclone mitigation (reduced repair cost after a cyclone) outweighs the upfront costs (Hutley & Batchen, 2015; Pinelli, Torkian, Gurley, Subramanian, & Hamid, 2009). Although the benefits of cyclone mitigation outweigh the cost at a population level, this is not to say that this is also the case at the individual level. For example, someone who chooses to upgrade their roof may never actually experience a cyclone severe enough to cause significant roof damage.

Another benefit of cyclone mitigation is that it can lower insurance prices, which are particularly high in cyclone-prone areas (Australian Competition and Consumer Commission, 2018). As cyclone mitigation reduces cyclone damage risk, insurance companies can lower insurance prices to reflect the reduced risk if enough perform the recommended mitigation behaviours(Harwood et al., 2016). Some Australian insurance companies offer rebates to people living in cyclone-prone areas who perform specific cyclone mitigation behaviours (e.g., Suncorp, RACQ). A homeowner can, for example, get a small reduction in their insurance premium if they were to install cyclone shutters on their property. This means that even in the short term, there are incentives in place so that people can receive some immediate benefits.

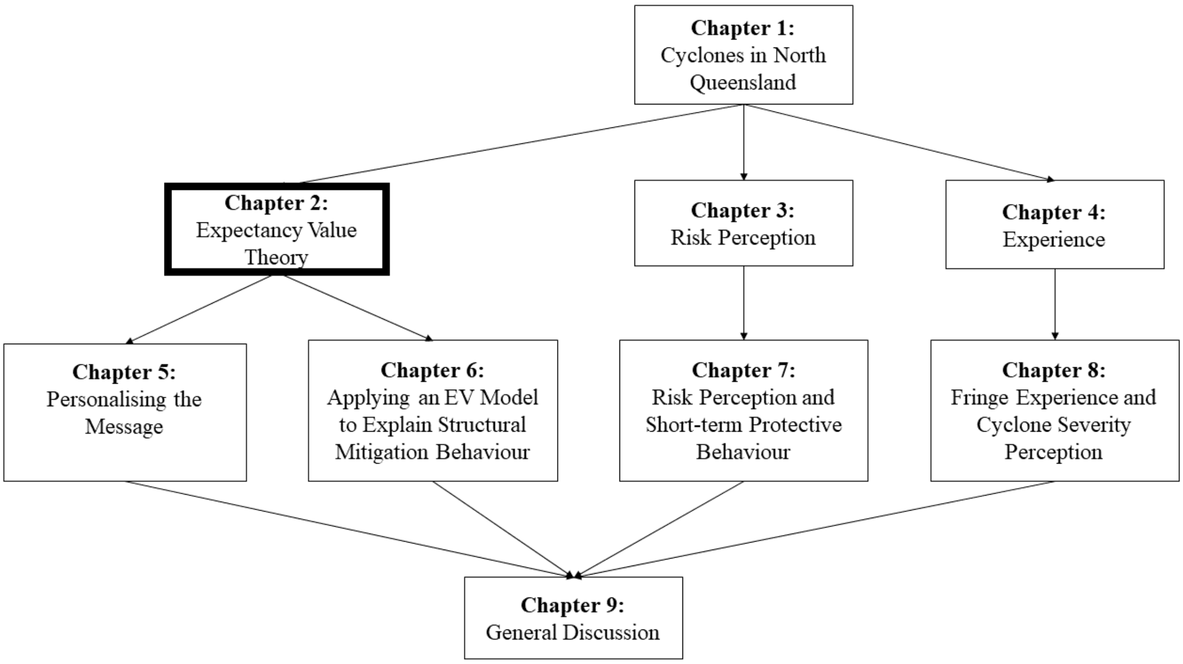
The benefits of cyclone mitigation are, however, not just economic. As mentioned earlier, physical protection is what keeps people safe during a cyclone (Shultz et al., 2005). For example, keeping the roof, windows and walls intact protects people from dangerous hazards such as flying debris and fallen power lines. Beyond physical health, a structurally resilient house may also provide psychological benefits. For one, people are likely to feel safer before an incoming cyclone and therefore feel fewer negative emotions such as anxiety or stress. Structurally resilient housing can also mitigate negative emotions felt during and after an event. Less structural damage usually means a faster clean up and less impact on people's everyday lives (e.g., ability to attend work/school). Minor or no property damage also means that people can stay in their house after a cyclone, which allows people to stay connected with their community after an event. Maintaining social connectedness after a natural disaster is particularly important for the health and wellbeing of the individual and the community (Paton & Johnston, 2001). Conversely, houses that receive more severe damage may be uninhabitable for some time while the house is being repaired thus displacing the residents, inhibiting social connectedness and increasing psychological distress (Merdjanoff, 2013).

1.6 Conclusion

Although mitigation measures are beneficial, research has found that people do not often prepare as much as they should for extreme weather events (Kunreuther, 1996; Peacock, 2003). This is also true in relation to cyclones (Smith et al., 2015). As mentioned earlier, as many as 60% of the houses in Queensland do not have roofs that are built to standard (Smith & Henderson, 2015) and few people have installed voluntary structural upgrades like cyclone shutters and roller door upgrades (Harwood et al., 2016; Smith et al., 2015). Moreover, post cyclone damage assessments have shown that many people underperform general preparedness behaviours (Smith et al., 2015). Despite these findings, to date there has been minimal research investigating why people do, or do not, perform such behaviours.

Most of the research investigating how people respond to natural hazards has done so in relation to other hazards such as earthquakes and floods (see Bubeck et al., 2012; Kellens, Terpstra, & De Maeyer, 2013; Lindell & Perry, 2000 for reviews of such studies). The studies that have investigated cyclone preparedness behaviour do not focus specifically on behaviours aimed at reducing property damage. For example, much of the research has been interested in understanding what drives cyclone evacuation behaviour (see Huang, Lindell, & Prater, 2016 for a review). While some studies have focused on household preparedness behaviours for cyclones (e.g., Norris, Smith, & Kaniasty, 1999; Morrissey & Reser, 2003; Sattler, Kaiser, & Hittner, 2000), these studies have not assessed behaviours aimed at reducing property damage. Instead, these studies (Norris et al., 1999; Morrissey & Reser, 2003; Sattler et al., 2000) focused on more survival preparedness behaviours like 'preparing an emergency kit' and 'having enough canned food'. This thesis aims to address this knowledge gap by specifically investigating the psychological factors that influence the performance of mitigation behaviours aimed at reducing property damage. The following chapter will review some of the commonly applied theories of protective behaviour in a natural hazard context and establish why these theories need to be adapted to better explain the variability in performance of the types of behaviours required to reduce cyclone related property damage.

Chapter 2: Explaining Cyclone Mitigation Behaviour



As introduced earlier, explaining protective behaviour requires an appropriate theoretical framework (Weinstein, 1988). While there a range of different theories that attempt to explain human behaviour across contexts, some theories seem to explain certain types of behaviour better than others (Weinstein, 1993). This chapter will propose that an Expectancy Value based theory of human behaviour is a useful framework for explaining cyclone specific mitigation behaviour. To support this claim, this chapter will review some of the most commonly applied theoretical models for explaining protective behaviour. In addition to explaining their theoretical foundation, this chapter will focus on the empirical studies that have applied these models in a natural hazard context. The chapter will end with a proposed model for explaining cyclone specific mitigation behaviour.

2.1 Expectancy Value Theories

Expectancy Value (EV) theories suggest that people's behaviour is dependent on the *expected* outcome of that behaviour and the associated *value* of that outcome (Milne et al., 2000; Witte, 1992). If, for example, someone believes that smoking causes lung cancer (expectancy) and that this outcome is undesirable (negative value), then the individual should be motivated to avoid that outcome. Similarly, if the expected outcome is positive (e.g., avoiding lung cancer) the individual should be motivated to pursue that outcome. Put simply, EV theories suggest that people's behaviour is the result of a mental 'cost-benefit analysis' (Floyd et al., 2000). The resulting behaviour is selected on the basis of the best result of the cost-benefits analysis (Loewenstein, Weber, Hsee, & Welch, 2001; Weinstein, 1988). An EV theory should, therefore, be particularly useful for explaining cyclone-related structural mitigation behaviour due to emphasis on the perceived benefits and cost of the response.

Some of the most commonly applied EV theories are the Theory of Reasoned Action, the Health Belief Model, the Protection Motivation Theory and the Subjective Expected Utility Theory (Weinstein, 1993). While there are some differences between these models, they all emphasise that behaviour is driven by the outcome of cognitive processes (Becker, 1974; Edwards, 1954; Fishbein & Ajzen, 1975; Rogers, 1975). The main differences between each theoretical stance are the nature of the cognitive factors proposed to be predictors of behaviour (Weinstein, 1993). However, all of the theories suggest that understanding how people think about hazards, and their ability to mitigate harm, is the key to understanding behaviour (Weinstein, 1993). While most of these theories have shown to be strong predictors of protective behaviour, the strength of the relationship is dependent on the context in which it is applied (Weinstein, 1993). Though some theories are better suited to explaining some types of behaviour than are others. The Protection Motivation Theory, for example, explicitly references the perceived cost of a behaviour, which may be useful for explaining behaviour that have an objectively high cost like cyclone-damage mitigation behaviour. As such, the predictive validity of a theory in a specific context needs to be empirically tested to identify its value for predicting said behaviour.

2.1.1 The Protection Motivation Theory

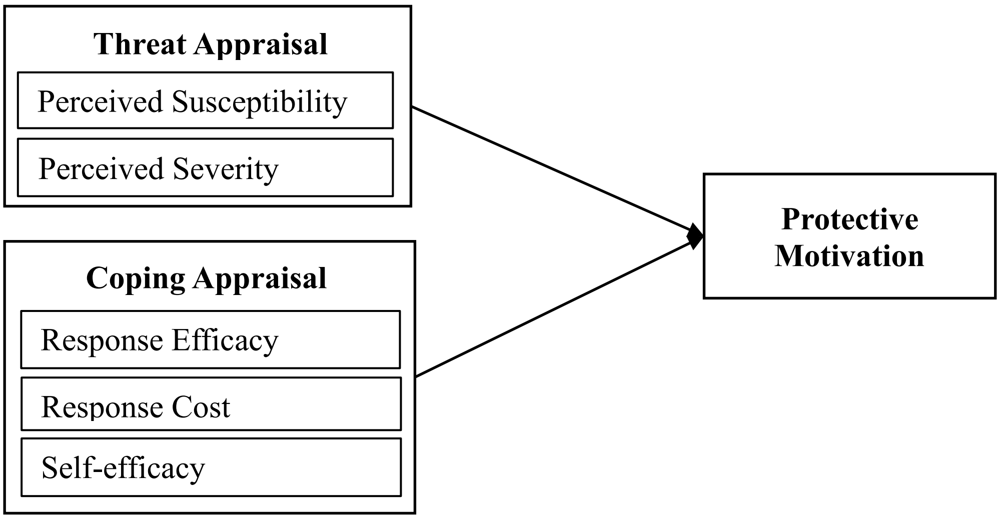
One of the main EV theories that has been used to explain natural hazard mitigation behaviour is the Protection Motivation Theory. The PMT was initially developed by Rogers (1975) as a framework for designing risk communication messages. More specifically, the PMT was designed to guide the development of messaging that encouraged people to adopt healthier behaviours (e.g., smoking cessation or condom use). Before the PMT was developed, there was no framework for empirically validating the efficacy of a fear appeal. As such, there was no theoretical foundation on which to build an effective fear appeal. One of the main claims made by Rogers (1975) is that cognition mediates the link between the message and the protective response. Furthermore, he theorised that there were specific cognitive factors that could explain why an individual performed a protective behaviour. The claim that behaviour change was cognitively mediated was somewhat revolutionary at the time as earlier theories suggested that behaviour change in response to a fear appeal was dependent on emotional processes (Janis & Feshbach, 1953; Leventhal, 1970). Unlike the PMT, these earlier theories proposed that people were motivated to reduce a feeling of fear as opposed to reducing future harm, which requires a more cognitive evaluation of threat (Rogers, 1975).

As mentioned earlier, the PMT, like other EV theories, posits that the key to changing behaviour is changing attitudes. However, before the PMT was developed, researchers had not identified any appraisal processes that lead to behaviour change (Rogers, 1975). Based on previous work by Hovland, Janis, and Kelley (1953), Rogers (1975) hypothesised that there are three components of an effective fear appeal. To motivate protective behaviour a fear appeal must show that (a) an outcome is harmful, (b) that the outcome is likely to occur and (c) a particular protective response will be effective at mitigating the harmful outcome. The degree to which these variables are portrayed in a fear appeal is hypothesised to then determine the likelihood that people will develop an intention to perform a protective response (Rogers, 1975). It is this intention which is called the *protection motivation*. In his original paper, Rogers (1975) suggested that *protective motivation* can be calculated by multiplying the weights of the three contributing components. As such, if one component is not present in the fear appeal (i.e., a weight equal to zero) there will be no *protective motivation*.

Since its initial publication in 1975 there have been many adaptations of the PMT. One of the biggest changes was the introduction of *self-efficacy* (Maddux & Rogers, 1983; Rogers, 1983). Based on the work by Bandura (1977, 1982), this updated version of the PMT proposed that in addition to perceiving that protective response as effective, people also need to believe they have the ability to perform the behaviour (i.e., *self-efficacy*). Another important addition to the PMT was the addition of the *response cost* component. This component was conceptualised as the extent to which people perceived the protective response as having a cost to them in terms of time, effort or money (Rogers, 1983). Figure 2.1 shows an adapted version of the PMT model outlined by Rogers and Prentice-Dunn (1997).

Figure 2.1

The Protection Motivation Theory



As seen in Figure 2.1, this version of the PMT suggests that there are five key cognitive factors that influence protective motivation. The five cognitive factors are grouped into two appraisal processes: *threat appraisal* and *coping appraisal*. The *threat appraisal* process is composed of two variables: *perceived susceptibility* and *perceived severity*. *Perceived susceptibility*[1] is usually defined as the appraised likelihood of personal harm from a hazard. Whereas *perceived severity* is usually defined as the appraised extent of personal harm that a hazard can cause. The second process, *coping appraisal*, is composed of the variables *self-efficacy*, *response efficacy* and *response cost*. *Self-efficacy* is defined as the perceived ability to perform a protective response; *response efficacy* is the perceived

[1] Researchers that apply the PMT in a natural hazard context tend to label this construct *perceived probability*. As such, the term *perceived probability* will be used in this thesis when referring to studies that use this term. It is, however, important to note that researchers usually ask people how *likely* a negative outcome is when they assess *perceived probability*; they do not ask people to report a probability (e.g., .2) as the term suggests.

protective benefit from performing a protective response; and *response cost* is perceived cost of performing a protective response in terms of time, money and effort (Floyd et al., 2000).

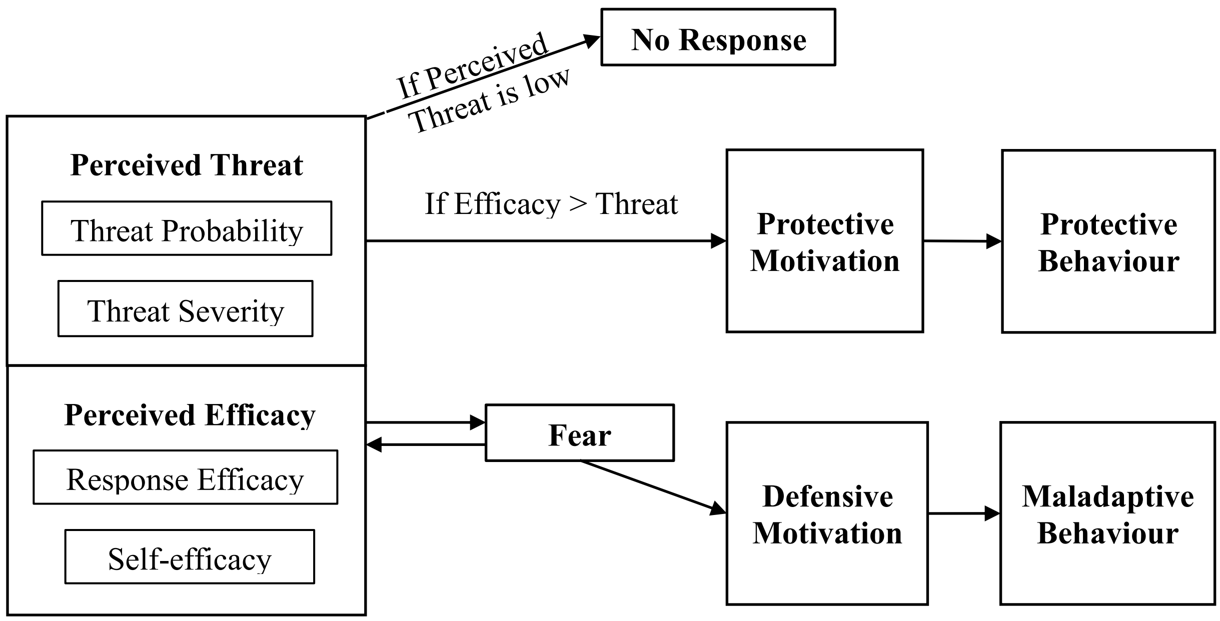
The PMT model has been comprehensively applied in the field of health psychology, and to a lesser extent in the natural hazard preparedness literature. For now, the application in health psychology will be discussed whilst the natural hazard preparedness literature will be discussed in detail in section 2.2. Two meta-analysis studies have examined the explanatory value of the PMT and found that increased levels of threat and coping appraisal are associated with greater intentions to perform protective behaviours such as smoking cessation and sunscreen use (Floyd et al., 2000; Milne et al., 2000). As the model predicts, these meta-analyses found that higher levels of perceived *susceptibility*, *severity*, *self-efficacy* and *response efficacy* were associated with greater protective intentions, whereas higher levels of perceived *response cost* were associated with lower levels of intention (Floyd et al., 2000; Milne et al., 2000). The meta-analyses also found that *coping appraisal* variables explained more variability in protective intentions compared to *threat appraisal* variables. The findings suggest that the perceived ability to mitigate harm is more important than the belief that harm from a hazard is likely and severe.

2.1.2 Extended Parallel Process Model

While the PMT has been shown to be a reliable predictor of adaptive behaviour, the theory, as initially developed by Rogers (1975) cannot explain maladaptive behaviour. A maladaptive behaviour is a response that attempts to reduce negative emotions as opposed to mitigating harm. Common examples of maladaptive behaviour are wishful thinking, denial and fatalism (Milne et al., 2000). The Extended Parallel Process Model (EPPM) was developed to explain both adaptive and maladaptive behaviour (Witte, 1992). Like the PMT, the EPPM claims that perceiving adequate amounts of threat (i.e., *threat appraisal*) and efficacy (i.e., *coping appraisal*) lead to protection motivation (i.e., intention), which then leads to protective behaviour. Witte (1992) refers to this as the *danger control process*. Unlike the PMT, however, the EPPM outlines another appraisal process that leads to maladaptive behaviour. This additional (parallel) process is the *fear control process*. Figure 2.2 shows an adapted version of the original model as outlined by Witte (1992).

Figure 2.2

The Extended Parallel Process Model



As seen in Figure 2.2, fear plays a central role in determining the type of appraisal process that occurs. The EPPM suggests that fear is the proximal cause of a *fear control process*. Witte (1992) claims that if fear is too high, people are motivated to reduce fear (i.e., *defensive motivation*) as opposed to mitigating harm (i.e., *protection motivation*). The theory behind the *danger control process* was based on the *fear-as-acquired-drive model* (Janis & Feshbach, 1964) and the *parallel response model* (Leventhal, 1970). A central claim made by both theories is that people are motivated to reduce fear as opposed to reducing harm. These theories, however, did not specify the conditions under which people are motivated to reduce fear (Witte, 1992). The EPPM provides an explanation for this process.

The EPPM proposes that high levels of fear – and the resulting *fear control process* – occurs when perceived threat is high but perceived efficacy is low (Witte, 1992). Put simply, people feel fear when they do not think they can protect themselves from harm (Witte, 1992). However, Witte (1992) also explains that fear may not always lead to a maladaptive response: fear can sometimes amplify threat appraisal, which in turn may increase the likelihood of a protective response. So, while fear may not be a direct cause of a protective response it can lead to a protective response through its influence on *threat perception.* This premise is supported in research by Paton et al. (2005) who found that certain levels of anxiety can have a positive influence on earthquake preparedness through its effect on response efficacy.

Another unique claim made by Witte (1992) is that threat perception is necessary for protection motivation to occur. That is, if people do not perceive they are at risk of a negative outcome, they will not be motivated to protect themselves. This proposition was based on previous research, which found that low levels of threat perception lead to low levels of behaviour change, regardless of the level of perceived efficacy (Witte, 1991). Other researchers have since provided additional evidence that perceived threat is necessary for a protective response to occur (Brewer et al., 2007; Weinstein, Rothman, & Sutton, 1998). The EPPM also proposes that if perceived efficacy is high enough, perceived threat is what determines the magnitude of the protective response (Witte, 1992). For example, if two people perceive the same (high) level of efficacy, the person that perceives greater threat will be more motivated to protect themselves from harm.

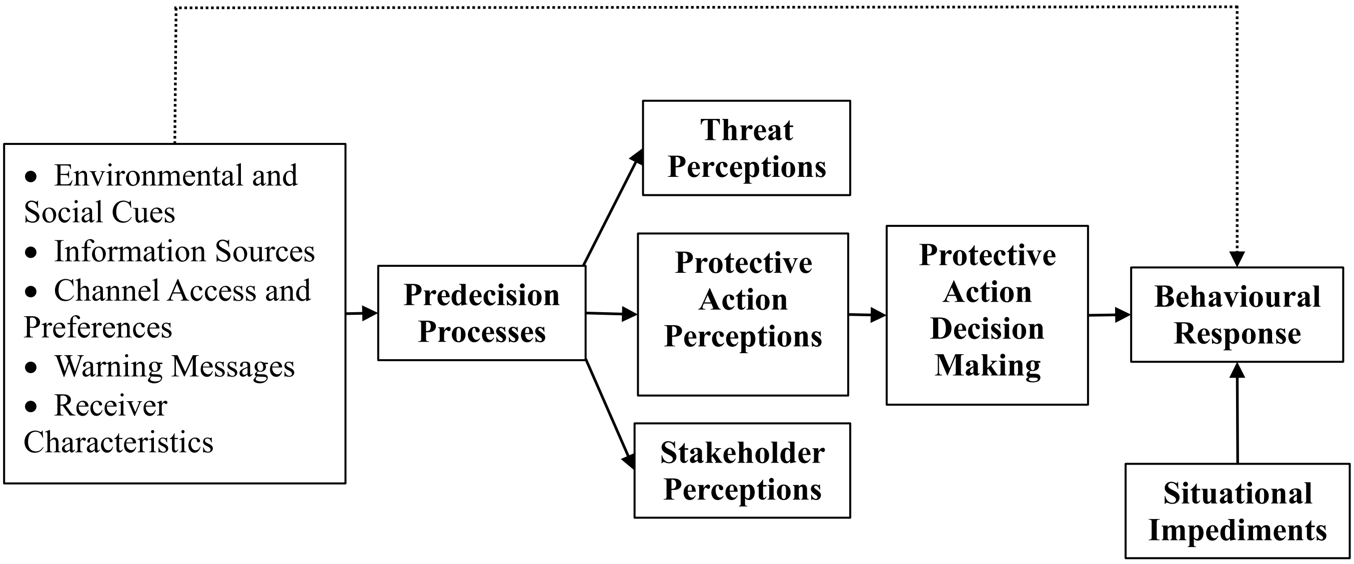
Unlike the PMT, however, the EPPM does not explicitly include *response cost*. As *response cost* is not in the EPPM, empirical studies using the EPPM to inform their study design do not tend to include *response cost* as potential predictor of protective behaviour (e.g., Miller, Adame, & Moore, 2013). Witte (1992) does not provide a theoretical justification for not including *response cost* in the EPPM, even though the model is heavily influenced by the PMT. Regardless of the rationale behind its removal, there is evidence to suggest that adding *response cost* to the EPPM increases its predictive validity (Rintamaki & Yang, 2014). Additional empirical studies have also found that *response cost* is significant predictor of more costly protective behaviours (Bubeck, Botzen, Kreibich, & Aerts, 2013; Poussin, Botzen, & Aerts, 2014). Because some types of cyclone mitigation are quite costly (i.e., structural upgrades), it is expected that *response cost* should influence such behaviour. As such, a theoretical model for explaining cyclone mitigation should include *response cost.* With the exception of *response cost*, the conceptualisation of the other psychological factors within the EPPM are the same as the PMT.

2.1.3 Protective Action Decision Model

Another popular theory for explaining variability in the performance of natural hazard mitigation behaviour is the Protective Action Decision Model (PADM). Unlike the PMT and the EPPM, the PADM was specifically designed to explain how people respond to natural and technological hazards (Lindell & Perry, 2012). As such, it is a more detailed model compared to the PMT and EPPM. The PADM goes beyond identifying the appraisal process that lead to protective behaviour; it also attempts to define many of the antecedents to the appraisal process. For example, the PADM outlines that being able to appraise a threat (i.e., *threat perception*) is dependent upon exposure to information about the threat, which can come from a range of difference sources. Figure 2.3 shows an adapted version of the PADM as outlined by Lindell and Perry (2012).

Figure 2.3

The Protective Action Decision Model



As seen in Figure 2.3, the PADM is a stage model. Like other stage models, the PADM proposes that people go through a series of psychological stages, which lead to a protective behaviour (Lindell & Perry, 2012). For example, the PADM outlines that early in the behaviour change process people may think about whether they need to pay attention to a threat (Lindell & Perry, 2012). As people work through the stages they may start to consider more practical issues like how and when to perform specific protective behaviours (Lindell & Perry, 2012). While Lindell and Perry (2012) propose that people go through these stages before a protective response occurs, they explain that it is primarily cognitive appraisal processes that determine which stage people are in. For example, if someone perceives a cyclone as unlikely in the future, they would likely be in an early stage of behaviour change (i.e., contemplating whether they should pay attention to the potential threat). Therefore, like the PMT and EPPM, the PADM emphasises the importance of cognition for explaining whether or not people perform mitigation behaviours.

Being a more detailed model than the PMT and EPPM, the PADM can be adapted to explain both preparedness behaviour as well as how people interpret and respond to weather warnings (Lindell & Perry, 2012). However, the value of the level of detail included in the PADM is diminished when explaining long-term mitigation behaviour due to the target behaviour being performed in the absence of a warning. As such, studies that use the PADM to explain natural hazard preparedness behaviour focus on the cognitive components whilst ignoring the many contextual and individual factors that lead to the predecision processes (e.g., Arlikatti, Lindell, & Prater, 2007; Ge, Peacock, & Lindell, 2011; Terpstra & Lindell, 2013). When it is used in this way the model is very similar to the PMT (Lindell & Perry, 2012; Terpstra & Lindell, 2013). Like the PMT, the PADM includes a *threat appraisal* and a *coping appraisal* component. However, within the PADM framework, these appraisal processes are referred to as *threat perception* (or *risk perception*) and *protective action perceptions* (Lindell & Perry, 2012). *Threat perception* within the PADM is usually conceptualised as the “certainty, severity, and immediacy of disaster impacts to the individual, such as death, property destruction and disruption of work and normal routines” (Lindell & Perry, p. 127). The main difference between the PADM and earlier models is the way in which the construct *protective action perceptions* (i.e., *coping appraisal*) is operationalised. The PADM contextualises these cognitive factors specifically and exclusively for a natural hazard context. Lindell (2013) explains that the PADM usually includes five main perceptual factors in the model: efficacy, safety, time requirements, implementation barriers (e.g., knowledge or skill requirements) and cost (e.g., effort, monetary cost and aesthetic costs).

In the PADM model, perceptions about the benefits/efficacy of a specific behaviour are referred to as *hazard-related attributes*. As such, this factor is very similar to *response efficacy* within the PMT. However, in the PADM, perceived efficacy for reducing damage and increasing personal/family safety are considered two distinct types of *hazard-related attributes* (Terpstra & Lindell, 2013). Another important addition to the PADM is that perceived secondary benefits are also considered. For example, some studies consider the perceived utility that a mitigation behaviour has for other purposes as another type of *hazard-related attribute* and have found that helps to explain preparedness behaviour (Lindell & Prater, 2002; Russell, Goltz, & Bourque, 1995; Terpstra & Lindell, 2013). The perceived utility for other purposes may be particularly useful for explaining the uptake of cyclone-related structural upgrades. Cyclone shutters, for example, not only mitigate cyclone related property damage but also provide security as they protect windows from breaking due to unlawful entry. As opposed to the PMT, the theory behind the PADM acknowledges that perceived secondary benefit may be as important as the primary benefit for explaining mitigation behaviour (Lindell & Perry, 2012).

The other appraisal component of the PADM is *resource-related attributes*. This component is similar to *response cost* within the PMT framework. However, the types of 'costs' are more tightly defined within the PADM framework. For example, the concept of *resource-related attributes* has a more explicit separation of different types of response costs (i.e., time, effort and money). The PADM framework also incorporates the perceived knowledge and skill requirement, and the perceived extent of cooperation required from others (Lindell & Perry, 2012). One benefit of separating out *resource-related attributes* in this way is being able determine why some mitigation behaviours may be favoured compared to others as the perceived time and cost will differ depending on the behaviour (Smith et al., 2015). For example, some people may prefer putting up plywood covers on their windows as it is cheaper than installing commercial cyclone shutters. Others may prefer commercial cyclone shutters as they can hire a professional to install them as they themselves may lack the skills to install cyclone shutters or put up plywood covers. Assessing perceived monetary cost and effort as one factor (e.g., *response cost*) means that the model would provide a less detailed explanation as to what type of perceived cost has the greatest influence on a specific type of behaviour.

The concept of perceived knowledge and skill requirement also overlaps with *self-efficacy* in the PMT (Lindell & Perry, 2012). That is, if someone perceives they lack the knowledge or skill required to put up plywood covers on their windows, it would also indicate they have low *self-efficacy*. The main difference between the concepts is how they are operationalised. To understand why people perform some mitigation behaviours it may be more appropriate to assess perceived level of knowledge and skill as opposed to perceived ability to perform a behaviour. Some people may believe they have the ability to do a specific behaviour without actually thinking about whether they have the knowledge or skills to do so. Asking people the extent to which they believe they have the requisite knowledge and skills to perform a behaviour may prompt people to think more precisely about whether they can perform a task and may, therefore, be a more appropriate way to assess *self-efficacy* in the context of explaining cyclone mitigation behaviour.

The main difference between the PADM and earlier models is its inclusion of a concept called *hazard intrusiveness*. Within the PADM framework, *hazard intrusiveness* is defined as the degree to which a threat occupies the consciousness of an individual (Lindell & Perry, 2003) and it is usually operationalised as the frequency with which people think and talk about the natural hazard (Ge et al., 2011; Lindell & Prater, 2000; Lindell & Prater, 2002). *Hazard intrusiveness* is, therefore, similar to what other researchers call *critical awareness* as it is assessed in a similar way (Paton, 2003; Paton et al., 2005, 2006). While Lindell's (2012) justification for including *hazard intrusiveness* in the PADM seems to be based on empirical findings, other researchers have provided a theoretical explanation as to why *hazard intrusiveness* may influence mitigation behaviour. One theoretical explanation is that most

EV theories do not consider that people have many competing demands for their attention (Weinstein, 1988). As such, even if people determine the benefits of mitigation outweigh the cost, they may have other priorities in life to attend to first. *Hazard Intrusiveness* may reflect the degree to which thoughts about cyclones (and the related mitigation measures) are prioritised over other decisions. This explanation also suggests that *hazard intrusiveness* may be particularly important for explaining the uptake of structural upgrades as they must be installed in the absence of an immediate threat. That is, *hazard intrusiveness* may reduce the temporal distance between intention and behaviour.

2.2 Empirical Evidence for Expectancy Value Theories

While there are other psychological theories that have been applied to explain natural hazard mitigation behaviour (see Paton, 2019 for a review), many of these are not expectancy value theories. Of the expectancy values theories that have been used, only studies that use the PMT and the PADM tend to explicitly assess both *risk perception* (or *threat appraisa*l) and *protective action perceptions* (or *coping appraisal*). Moreover, the PMT and the PADM have been the most commonly applied theories in this area of research. The following subsections will review the empirical studies that have applied these theories in the natural hazard context.

2.2.1 Protection Motivation Theory

Researchers in the field of disaster mitigation have found the PMT useful for explaining flood mitigation behaviours (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Kievik & Gutteling, 2011; Poussin et al., 2014; Zaalberg, Midden, Meijnders, & McCalley, 2009). The use of PMT has become a useful explanatory model due to the *coping appraisal* component of this model (Grothmann & Reusswig, 2006). Before the use of the PMT, most of the studies were focused on the first component of the PMT, the *threat appraisal* or *risk* *perception* component (Bubeck et al., 2012). However, these studies were reporting that *threat appraisal* had weak links with flood preparedness or no link at all, so a broader interpretation of the appraisal process was needed (Bubeck et al., 2012). This has led to more studies measuring the coping appraisal variables found in the PMT as well as the threat appraisal variables.

2.2.1.1 Threat Appraisal. Most studies using the PMT to explain flood mitigation behaviour have identified that at least one of the *threat appraisal* variables (i.e., *threat probability* or *threat severity*) predicts some types of mitigation behaviour (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Poussin et al., 2014; Zaalberg et al., 2009). However, it has been found that when controlling for *coping appraisal* variables, *threat appraisal* explains a relatively small amount of variability in mitigation behaviour. For example, Grothmann and Reusswig (2006) found that *threat appraisal* added only between 3-6% of the explained variability in a multiple regression analysis. Other studies have found that either *threat severity* or *threat probability* had no relationship with behaviour, or sometimes negatively predicts behaviour (Poussin et al., 2014; Zaalberg et al., 2009). One explanation for the inconsistent link between *threat appraisal* and mitigation behaviour may be due to the way *threat appraisal* is conceptualised and operationalised. This issue will be discussed further in Chapter 3.

Another explanation for the inconsistent link between threat appraisal and mitigation behaviour is based on methodological limitations. Researchers argue that cross-sectional studies, by their very nature, assess both threat appraisal and mitigation behaviour at the same point in time. The negative correlation in cross-sectional studies may be due to past mitigation behaviour lowering subsequent threat appraisal. Take, for example, someone who installed cyclone shutters because they believe that cyclones are likely to cause significant damage to their house in the future. After installing cyclone shutters this individual may perceive that the risk of damage from future cyclones, and the severity of that damage, would be lower in the future. Therefore, if a study was to assess the connection between this person's threat appraisal and their mitigation behaviour at the one point in time it would likely find a negative association because performing the behaviour has lowered the perceived threat level. This effect would be observable even though a higher threat appraisal is what drove the performance of the behaviour in the first place.

This process of past protective behaviour having an influence on threat appraisal has been labelled a 'feedback loop' and has been identified in many studies. For example, one study found that *threat appraisal* had no relationship with the institution of structural changes and the purchase of flood insurance (Bubeck et al., 2013). Similarly, Poussin et al. (2014) found that perceived *threat severity* was negatively associated with the extent of implemented structural upgrades but was positively associated general preparedness behaviour. The findings suggest that the feedback loop tends to interfere the most with analyses investigating the link between *threat appraisal* and behaviours, such as structural upgrades, that only need to be performed once. The feedback loop does not seem to influence the relationship between *threat appraisal* and general preparedness behaviour (Poussin et al., 2014). Researchers have recommended that to avoid the influence from the feedback loop in cross-sectional studies it is important to assess people's *intention* to perform structural behaviours instead of their *past behaviour* (Bubeck et al., 2012; Poussin et al., 2014).

2.2.1.2 Coping Appraisal. Most of the studies applying the PMT in a natural hazard context have found that *coping appraisal* variables are some of the strongest predictors of behaviour (Bubeck et al., 2013; Grothmann & Reusswig, 2006). One study found that *coping appraisal* can explain 2-21% of the variability in their model depending on the type of mitigation behaviour. For example, they found that coping appraisal only explained 2% of the variability in responses to, 'informing oneself about self-protection' and 21% of the variability in the, 'avoidance of expensive furnishings' (Grothmann & Reusswig, 2006). This explained variability was in addition to that explained by *threat experience* and *threat appraisal*, which were both significant predictors of preparedness. Grothmann and Reusswig (2006) show that *coping appraisal* can be a strong predictor of behaviour, but it does not show which specific factors have the strongest influence on behaviour (e.g., *response cost* vs *response efficacy*).

In the health literature, *self-efficacy* tends to be the strongest predictor of protective behaviour (Floyd et al., 2000). Studies investigating natural hazard mitigation behaviour have also found evidence for the importance of *self-efficacy* (Kanakis & McShane, 2016; Martin, Martin, & Kent, 2009; Mulilis & Lippa, 1990). For example, Kanakis and McShane (2016), investigating general preparedness behaviour for floods and cyclones, found that *self-efficacy* added 7% to the explained variability in their model in addition to five other significant predictor variables. Studies have also found that there is a link between *self-efficacy* and structural flood mitigation measures (Bubeck et al., 2013; Poussin et al., 2014). It is, however, important to note that structural upgrades for flood differ to those for a cyclone. Installing structural mitigation for a cyclone cannot be performed by most people. For example, most people do not have the ability to upgrade their own roof or install fixed cyclone shutters. As such, *self-efficacy* may be less of a predictor for more skill-based upgrades that cannot be performed by most people.

Rather than confidence in the ability to perform a behaviour, studies have found that people who perceive mitigation behaviours as effective at reducing damage are more likely to perform these behaviours (Paton, 2008). One study found that *response efficacy* was the strongest predictor of protective actions for a flood (Zaalberg et al., 2009). Similar results were found in another study where response efficacy was a significant predictor of three out of four flood mitigation outcomes (Bubeck et al., 2013). It has also been found that higher levels of response efficacy are associated with increased future intentions to implement both structural and non-structural mitigation measures (Poussin et al., 2014). This finding suggests that *response efficacy* would likely be an important factor for cyclone mitigation, especially for intentions to structurally upgrade property.

The last variable in the PMT model, *response cost*, is the only variable in the model that is predicted to lower the likelihood of a protective response (Rogers, 1975). However, studies have found that that a significant negative association between *response cost* and mitigation behaviour is dependent on the type of mitigation behaviour and the way in which *response cost* is operationalised (Bubeck et al., 2013; Poussin et al., 2014). One study, for example, asked participants to, ‘estimate the cost of implementing a specific flood measure’ and found that this operationalisation of *response cost* did not predict mitigation behaviour (Bubeck et al., 2013). Assessing *response cost* in this way, however, does not reflect how it should be conceptualised according to Rogers (1983). While Bubeck et al. (2013) did assess a form of perceived cost, such an operationalisation does not capture the relative cost to the individual. That is, even if someone estimates the monetary cost of installing structural mitigation as high, if an individual is wealthy, installing mitigation may be not be considered a ‘costly’ response. *Response cost* should, instead, be assessed so that the cost relative to the individual is captured. Moreover, Bubeck et al. (2013) did not specify if they were measuring cost in terms of monetary, time or effort costs. These perceived costs may have different effects on behaviour depending on the individual and the type of behaviour being performed. To properly understand all the barriers to mitigation behaviours it may be useful to use a more detailed conceptualisation of *response cost* as outlined by the PADM.

2.2.2 Protective Action Decision Model

As it is a newer model, fewer studies have empirically tested the PADM. Furthermore, many studies that claim to use the PADM do not assess all of the psychological factors outlined by Lindell and Perry (2012). For example, both Ge et al. (2011) and Peacock (2003) reference using the PADM to inform their methodology but do not assess people's *protective action perceptions*. As studies using the PMT have found that perceptions toward protective actions (i.e., *coping appraisal*) are particularly important for predicting mitigation behaviour, only studies using the PADM that have included this component will be reviewed. As such, this section will primarily discuss the findings from Terpstra and Lindell (2013) as it is one of the few studies informed by the PADM that assesses *protective action perceptions.* This section will review whether the conceptualisation and operationalisation of *coping appraisal* as seen in the PADM is better suited for explaining natural hazard mitigation behaviour than the PMT. This section will also review whether *hazard intrusiveness* will add additional predictive validity beyond traditional PMT variables.

2.2.2.1 Protective Action Perceptions

2.2.2.1.1 Hazard-Related Attributes. One of the first studies to apply the PADM found that *hazard-related attributes*, a similar concept to response efficacy, were a significant predictor of earthquake mitigation behavior (Lindell & Whitney, 2000). In this study the researchers assessed *hazard-related attributes* as three separate factors: perceived efficacy for protecting property, perceived efficacy for protecting people and perceived utility for other purposes. They found that all three factors positively correlated (moderate strength) with intention to perform behaviours such as installing cabinet latches and strapping water heaters (Lindell & Whitney, 2000). These findings suggest that people are more likely to pursue mitigation if they perceive benefits beyond just reducing future damage. This study, however, only conducted univariate analysis so it is unclear if the significant findings would have persisted if the analysis controlled for other factors.

A more recent study found that *hazard-related attributes* also predict flood mitigation behaviour, even when controlling for other well-researched factors (Terpstra & Lindell, 2013). This study found *hazard-related attributes* was the strongest predictor of flood mitigation intention when controlling for other variables like perceived risk and costs. This study operationalised *hazard-related attributes* as a scale in the same way as Lindell and Whitney (2000). Terpstra and Lindell (2013) found that higher scores on all three *hazard-related attributes* indicated greater intentions to perform six mitigation behaviours such as preparing an emergency kit, getting emergency information and purchasing flood insurance. The study found that *hazard-related attributes* explained between 32% and 41% of the variability in intentions to seek emergency information and purchasing flood insurance (Terpstra & Lindell, 2013). It is, however, important to note that compared to structural upgrades for cyclones, the flood mitigation behaviours assessed by Terpstra and Lindell (2013) were relatively low effort/low cost behaviours.

Compared to the PMT studies reviewed, the study by Terpstra and Lindell (2013) was able to explain a high proportion of the observed variability in mitigation intention. One explanation for the difference in explained variability is the operationalisation of *hazard-related attributes*. Compared to the PMT studies that used a single measure for the *response efficacy* factor (e.g., Bubeck et al., 2013; Poussin et al., 2014; Zaalberg et al., 2009), Terpstra and Lindell (2013) assessed *hazard-related attributes* based on three subfactors. The findings suggest that when it comes to considering natural hazard mitigation, reducing damage may not be the only motivating factor. What may be also be important is that that mitigation measures are perceived to be effective at keeping people safe and have utility for other purposes. As such, a theoretical model that conceptualises *hazard-related attributes*, or *response efficacy*, as a multifaceted construct may be more appropriate for explaining cyclone mitigation behaviour.

The findings from Terpstra and Lindell (2013) suggest that people tend to appraise the overall utility of a mitigation measure, not just its ability to reduce damage. In other words, what seems to influence mitigation behaviour is the degree to which the individual perceives a mitigation measure to be an investment. As such, it is reasonable to suggest that there may be other perceived benefits of mitigation that may also influence behaviour. For example, the perceived value of the investment may be particularly important for predicting the uptake of structural mitigation, as these upgrades often require a significant financial investment. Although the importance of this factor has yet to be tested empirically, other researchers have highlighted that it is understandable that people do not install mitigation measures if they do not think they are valued by the market (Kunreuther, 2006). This idea has also been supported by flood mitigation survey results, which found that people were concerned about the potential negative effects that mitigation measures may have on their property value (Thurston et al., 2008). The same research also found that people have concerns about the aesthetic or visual presentation of mitigation measures (Thurston et al., 2008). These findings suggest that it may be important to consider how people perceive additional benefits of mitigation measures beyond those specified by the PADM and the PMT.

2.2.2.1.2 Resource-Related Attributes. Most of the studies using the PADM have found that *resource-related attributes*, a similar concept to *response cost*, does not predict mitigation behaviour (Lindell & Prater, 2002; Lindell & Whitney, 2000; Terpstra & Lindell, 2013). Like the PMT studies, research using the PADM has found when *hazard-related attributes* (i.e., *response efficacy*) are included in a statistical model, *resource-related attributes* do not explain any additional variability (Lindell & Prater, 2002; Lindell & Whitney, 2000; Terpstra & Lindell, 2013). These findings suggest the *resource-related* *attributes* may be an unnecessary component in a model for explaining cyclone mitigation behaviour.

There is, however, another explanation for these null findings in past research. That is, most of research to date has mainly assessed relatively low-cost behaviours (e.g., emergency preparedness). In such cases the perceived cost of performing a mitigation may not be high enough to be considered a barrier because the actual cost of behaviour is very low. One study found that scores on a *resource-related attributes* scale were dependent on the type of mitigation measure being assessed (Lindell, Arlikatti, & Prater, 2009). That is, scores on the *resource-related attributes* scale were high only when the actual cost of the mitigation behaviour was high. The same researchers explained that this may be the reason why there has been no relationship between *resource-related attributes* and mitigation behaviour in past studies. It is possible that these other studies did not have enough variability in responses to find a significant relationship as the behaviours were relatively simple and inexpensive to perform (Lindell et al., 2009). These findings by Lindell et al. (2009) demonstrate that *resource-related attributes* may only be relevant for explaining more costly behaviours like structural upgrades. This link, however, has yet to be empirically validated.

2.2.2.2 Hazard intrusiveness. Another factor that has only been tested using the PADM framework is *hazard intrusiveness*. Only a few studies to date have investigated the extent to which *hazard intrusiveness* influences mitigation behaviour. These studies, however, have found it to be one of strongest predictors of mitigation behaviour for cyclones and earthquakes (Ge et al., 2011; Lindell & Prater, 2000; Lindell & Prater, 2002). Similarly, studies that have considered the influence from *critical awareness* (a closely related construct) find it to be a reliable predictor of natural hazard preparedness (Paton et al., 2005, 2006). Many studies also suggest that *hazard intrusiveness* is a stronger, and more consistent predictor of mitigation behaviour compared to *threat perception* (Ge et al., 2011; Lindell &

Prater, 2000; Lindell & Prater, 2002). Although *hazard intrusiveness* does correlate with *threat perception*, research has shown that *hazard intrusiveness* explains additional variability in mitigation behaviour when controlling for *threat perception* (Ge et al., 2011; Lindell & Prater, 2000). A review study also found that although *hazard intrusiveness* has only been included in four studies, it was significantly correlated with mitigation behaviour in all those studies. *Risk perception*, on the other hand, whilst included in 20 studies, was only significantly correlated with mitigation behaviour in 13 studies (Lindell, 2013). These findings support the suggestion that *hazard intrusiveness* is conceptually unique and warrants further investigation in its inclusion in a model for explaining cyclone mitigation behaviour.

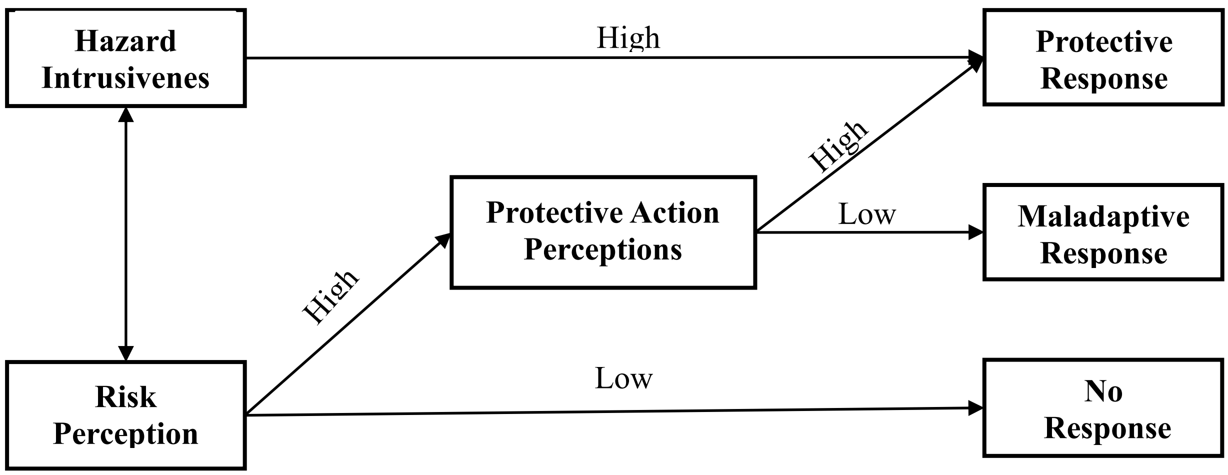
Hazard intrusiveness also seems to be particularly important for predicting long-term mitigation behaviour (Ge et al., 2011; Lindell, 2013; Lindell & Prater, 2000; Lindell & Whitney, 2000). One study investigated whether *hazard intrusiveness* was a predictor of people's interest in participating in cyclone mitigation incentive programs (Ge et al., 2011). This study assessed the degree to which people were interested in receiving, for example, a low interest loan to cover the cost of installing cyclone shutters. The results showed that *hazard intrusiveness* was the strongest predictor of intentions when controlling for other variables such as *risk perception*, *hazard experience* and demographic factors (Ge et al., 2011). These findings suggest that *hazard intrusiveness* may be important for explaining long-term mitigation behaviours that must be performed when a threat is not imminent. Ge et al. (2011) did not, however, include *protective action perceptions* in their model so it is unclear from their research if *hazard intrusiveness* would still have predicted intention if they had controlled for these factors.

2.3 An Adapted Model

As highlighted above, the PMT, PADM and EPPM were created to explain protective behaviour in response to a hazard. These models are, however, not precise in relation to the type of protective behaviour they proport to explain. Even the PADM, which was specifically created to explain protective behaviour in response to a natural hazard, has been used to explain a range of different responses like evacuation, general preparedness and structural mitigation (Huang et al., 2012; Poussin et al., 2014; Terpstra & Lindell, 2013). Structural mitigation behaviour, though, should be considered a distinct type of protective response in that such behaviours are either expensive and require significant effort and/or skill. An adapted model is, therefore, needed to explain this distinct type of preparedness behaviour. It is unclear from the research to date whether Expected Value theories like the PMT and the PADM can predict such behaviours. Based on the theories and empirical studies reviewed this section will propose an adapted theoretical method for explaining cyclone-specific structural mitigation behaviour. Figure 2.4 shows the adapted model.

Figure 2.4

The Adapted Expectancy Value Model



The model in Figure 2.4 is based on the PMT, EPPM and PADM. As such, it is an EV model that assumes that decision making is primarily driven by cognition. Like the PMT and the EPPM the main outcome variable of interest is whether an individual has performed, or intends to perform, a protective response. Some researchers may operationalise this outcome as behaviour but others will need to use intention for two main reasons. The first is to avoid the influence from the negative feedback loop. As discussed earlier, mitigation behaviour can lower *risk perception,* which may result in a negative correlation between the variables even though *risk perception* may have been a driver of mitigation behaviour in the first place (Bubeck et al., 2012). Assessing intentions instead of behaviour avoids this problem. The second reason for using intentions is more practical. Past research has shown that most people have not installed structural upgrades (Harwood et al., 2016). As such, it may be difficult to empirically validate this model if there is only a small number of people that have installed such upgrades.

The adapted model proposes that perceiving a sufficient level of risk is necessary for a protective behaviour to occur. *Risk perception* in this model is conceptualised in the same way as *threat perception* and *threat appraisal* as it includes perceived probability and perceived severity components. However, the term *risk perception* is used as it is a broader term and is more commonly used in the literature (the following chapter will review this concept in more detail). For now, it is important to note that this model posits that *risk perception* needs to reach a specific threshold before people start considering a protective response. As such, the proposed model is like the EPPM in that perceiving a negative outcome as likely and severe is necessary for a protective behaviour to occur. As discussed earlier, neither the PMT nor the PADM specifically make this claim.

As also supported by the EPPM, this model proposes that *protective action perceptions* determine whether a protective or a maladaptive response occurs. That is, if the perceived benefits of mitigation outweigh the cost, the individual will pursue a protective response. However, this component of the proposed model is more like the PMT's *coping appraisal* in that it explicitly references the importance of perceived cost. Even though studies to date have found little support for the predictive value of this component (e.g., Bubeck et al., 2013), it has yet to be tested as a predictor of more costly behaviours. As such, this model proposes (like the PMT) that higher levels of perceived cost will lead to lower levels of intentions to perform cyclone mitigation. This model, however, uses the terms *hazard-related attributes* (response efficacy) and *resource-related attributes* (response cost) as the operationalisation of these factors more closely aligns with the PADM. In other words, this model will consider a range of different perceived benefits and costs beyond those outlined by the PMT.

Unlike the PMT and the EPPM, the proposed model does not include *self-efficacy*. Unlike most short-term behaviours, installing structural upgrades usually requires a specific set of skills. As such, most people would not be able to install these upgrades themselves. It is, therefore, hypothesised that *self-efficacy* – as operationalised by the PMT and EPPM – will not predict intentions to install structural upgrades. In this aspect the proposed model reflects the PADM. However, if the model is used to explain simpler preparedness behaviour (e.g., cleaning up yard), *self-efficacy* should be added to model and *resource-related attributes* should be removed. This suggestion is based on the findings that when the actual cost of behaviour is low (i.e., it requires minimal effort, time or money) the *perceived cost* does not seem to have an influence on behaviour (Lindell et al., 2009). Further, unlike structural upgrades, most preparedness behaviours (e.g., trimming trees and cleaning gutters) do not require a specific skillset. As such, it is predicted that the perceived ability to perform these activities (i.e., *self-efficacy*) will be a predictor of simpler preparedness behaviour.

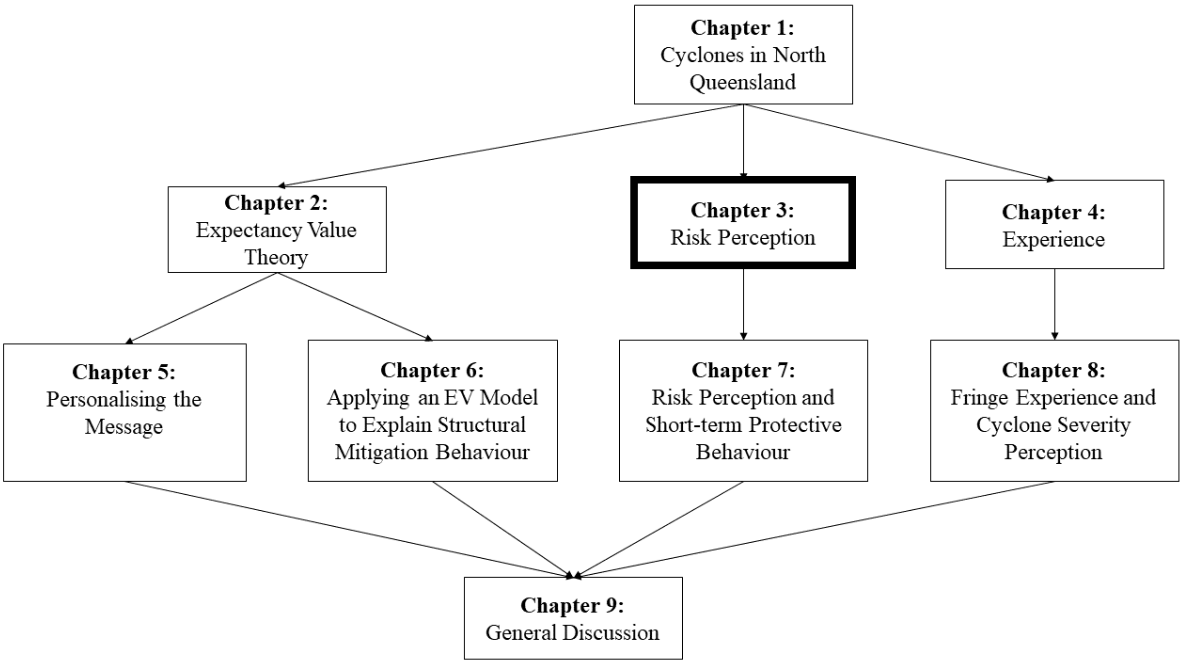
The final component taken from the PADM is *hazard intrusiveness*. The adapted model proposes that *hazard intrusiveness* relates to *risk perception* but will also have a direct influence on intention. This hypothesised relationship is based on both theory and empirical findings. As stated by Lindell and Perry (2003) *hazard intrusiveness* is particularly important when protective behaviour has to be performed in the absence of an immediate threat. Installing structural cyclone mitigation is a clear example of such a behaviour. When a threat is not imminent, the decision to invest in structural upgrades must compete with the demands of everyday life. As such, it is proposed as depicted in the adapted model that thinking and talking about cyclones more often (i.e., higher *hazard intrusiveness*) should lead to a high intention to invest in structural mitigation.

2.4 Conclusion

As discussed earlier, the main benefit of having a theory of cyclone mitigation behaviour is that it can be used to inform risk communication messaging. It is proposed that an adapted model based on the PMT, EPPM and PADM should be able to inform such messaging. Like earlier theories, the adapted model proposes that an effective message should emphasise that cyclones are likely and severe, and that the benefits of mitigation behaviour outweigh the costs. However, like any theoretical model, its utility is dependent on the whether it can be empirically validated (Kellens et al., 2013).

It is also important to note that EV-based models of behaviour change are not without limitations. One main limitation is that these theories cannot explain why two people presented with the same message may perceive it differently. These models, instead, posit that if the requisite components are included in the message (i.e., high levels of threat and efficacy), protective behaviour should occur (Milne et al., 2000). This link between message and behaviour is based on the assumption that the magnitude of appraisal will be roughly proportional to magnitude of the stimulus (Rogers, 1975). Put simply, if people are told that a hazard is harmful, they should appraise it as such. This proposition implicitly assumes that people behave rationally when confronted with a threat. There are, however, researchers that argue this is not the case (e.g., Loewenstein et al., 2001; Slovic, Finucane, Peters, & MacGregor, 2004). The following chapter will review some of this research and attempt to explain why people perceive threats differently.

Chapter 3: Risk Perception



As discussed in the previous chapter, most Expectancy Value (EV) theories suggest predicting a negative consequence caused by a hazard as likely and severe is a necessary precursor to performance of protective behaviours (Weinstein, Rothman, & Sutton, 1998). While research using an EV framework tend to refer to this psychological construct as *threat perception* or *threat appraisal*, it is more commonly referred to as *risk perception* in the natural hazard literature (Bubeck et al., 2012; Grothmann & Reusswig, 2006). Keeping with this norm, this chapter will also refer to this appraisal process as *risk perception*.

Due to its theoretical importance, researchers have focused on empirically validating the link between risk perception and hazard mitigation behaviour (Meyer, Baker, Broad, Czajkowski, & Orlove, 2014; Peacock, Brody, & Highfield, 2005). As identified in Chapter 2, however, results to date have been inconsistent with some studies showing no link or weak links between risk perception and mitigation behaviour (Bubeck et al., 2012). This chapter will argue that these inconsistent findings reflect risk perception being operationalised in hazard mitigation research in a way that does not reflect the current theories of risk perception. This chapter will start by defining risk perception and explaining why people find it hard to interpret risk, especially in relation to low-probability high-consequence events. The chapter will also emphasise the importance of understanding how people perceive cyclone severity to explain mitigation behaviour. The chapter will end by proposing that being able to anticipate the potential emotional consequences of a cyclone may help to explain how people conceptualise cyclone severity.

3.1 'Objective Risk' in a Cyclone Context

There are many definitions of 'risk' (Aven & Renn, 2009), but the general consensus among researchers is that risk has two dimensions: probability and effect (Breakwell, 2014). In other words, risk reflects the likelihood of an outcome and how bad it will be if it does occur (Kates, Hohenemser, & Kasperson, 1985). There are many different approaches to quantifying risk. A common approach seen in technical fields is to quantify risk using expected utility framework (Renn, 2017). In other words, risk is something that can be calculated by multiplying the probability and effect. For example, a 20 per cent likelihood of losing $20 and a 10 per cent likelihood of losing $40 have an equal expected loss as 20 multiplied by .2 and 40 multiplied by .1 both equal four. Therefore, using this framework, these two options have the same level of risk. However, quantifying risk is usually not this simple. Most of the time probability and effect are unknown or uncertain (Renn, 2017).

Other researchers argue that risk is purely subjective. This view of risk often stems from cultural relativism and a social constructivist view of science (Hansson, 2010). The common theoretical framework within this paradigm is the cultural theory of risk (Douglas & Wildavsky, 1982). This theory basically claims that risk is not a physical phenomenon and it only exists in peoples' minds, and the nature of this mental representation is influenced by culture (Rosa, 1998). The theoretical underpinning of the psychometric model of risk perception is also influenced by this view. As Slovic (1992) states, “Risk does not exist ‘out there,’ independent of our minds and cultures, waiting to be measured” (p. 5). Many researchers have critiqued the validity of the cultural theory (Boholm, 1996; Shrader-Frechette, 1991; Sjöberg, 2000), but it does highlight a point that can be overlooked in technical risk analysis, which is that a loss is only considered a loss if people perceive it as such. The risk of losing money, for example, is only a risk if the individual values money.

While it is true that it is impossible to quantify the subjective ‘badness’ of a risk, other researchers argue that ‘real risk’ or ‘objective risk’ are useful terms when referring to some types of risk (Sjöberg, 2000). The philosophical underpinning of this position is *ontological realism* (Rosa, 1998). This position states that while people and experts may disagree about what risk is (i.e., the epistemology of risk), risk does exist in the world. This claim is based on two axioms. First, there are states of the world that people value more/less than other states, regardless of culture. Second, these states, although uncertain, can occur. Rosa (1998) also outlines a framework for identifying risks that are more appropriate to examine using a realist/objectivist epistemology. The criteria are that of ostensibility (people can identify examples of risk) and repeatability (people consistently identify examples of risk). This framework suggests that there are risks that are more ostensible and repeatable in relation to both human value and uncertainty. For example, experiencing an injury (e.g., broken leg) is a risk that can be quantified in terms of its value and uncertainty as it can be reasonably assumed that most people do not want to be injured and there is reliable data that indicate these outcomes do occur (Krug, Sharma, & Lozano, 2000).

Because some risks are quantifiable, they are, therefore, comparable (Campbell, 2005). If, for example, statistical data indicates that people are more likely to die from one disease compared to another, it is useful to say that one disease presents a greater risk of death than the other. While there may be differences in the degree to which people value life, the fact remains that death is more likely to occur from one disease as compared to the other. Similarly, even if people disagree about the subjective 'badness' of cyclone consequences, a Category 5 Cyclone, on average, causes more property damage, physical harm, monetary loss and psychological distress compared to a Category 1 Cyclone (Kessler, Galea, Jones, & Parker, 2006; Pielke. et al., 2008). Even without historical data, meteorologists understand that cyclones differ in intensity and a more intense cyclone is likely to cause greater impacts. As such, the objective risk of a Category 5 Cyclone can be argued to be higher than that of a Category 1 Cyclone. To properly understand how people perceive and respond to risk, it is, therefore, important to first acknowledge that some cyclones are objectively more severe than others. The following sections will explore cyclone risk at the household level and explain why it these types of risk need to be considered when investigating the link between risk perception and mitigation behaviour.

3.1.1 Household-level Cyclone Risk

In developed countries, the risk of death and injury from cyclones is relatively low. What remains the main concern for such communities is the property damage that cyclones can cause (Holmes, 2015; Stewart, 2003). At the level of individual households, property damage costs money to repair, it threatens the safety of the occupants and it disrupts people's daily lives (Norris, 2005). Because of these knock-on effects, many of the risks that people living in cyclone-prone regions face stems from the risk of property damage. However, quantifying the extent of this risk at the household level is difficult for a variety of reasons, which has implications for explaining protective behaviour.

One reason it is difficult to quantify household level cyclone risk is due to the unpredictability and uncertainty of cyclones (Cox, House, & Lindell, 2013). In other words, it is difficult to quantify all the necessary variables to make accurate cyclone predictions and such predictions are still uncertain in that they may or may not occur. For short-term predictions, meteorologists have significantly improved the accuracy of their cyclone track and intensity predictions (Aberson, 2001), but there is still uncertainty in such forecasts. Cyclones still change direction and intensity after they have been forecast (Cox et al., 2013). This means that even when a cyclone is forecast, household-level risk is constantly changing. Determining household-level risk over a longer period (e.g., over the next 10 years) is even more difficult (Ranger & Niehörster, 2012). Due to the uncertainty and unpredictability of cyclones over a long time period, people cannot easily access information telling them there is, for example, a 20% chance of a Category 4 Cyclone passing over their house in the next 10 years.

In addition to cyclones being difficult to predict, the damage that they can cause is also difficult to predict. This is especially true at the household level. Although there are structural factors that increase a house's risk of damage (e.g., a roof not built to cyclone code), there is a range of other variables that are harder to quantify. For example, two identical houses exposed to the same cyclone may experience different wind loads due to differences in elevation, proximity to water and shielding by other structures (Henderson, Ginger, Leitch, Boughton, & Falck, 2006). Moreover, two houses built with the same materials exposed to the same wind loads could still experience different levels of damage due to the shape of their roof or the location of their windows (Henderson et al., 2006). These points further highlight the complexity of quantifying risk at the household level, even for a relatively unambiguous outcome such as property damage. The unpredictability of future cyclone damage makes it particularly difficult for people to decide on a 'rational' protective response because the variables that one would use to make such a decision (i.e., the probability and severity of future damage) are unknown or uncertain.

3.2 Quantifying Risk Perception

Even if the risk of property damage at the household level could be quantified, people still need to appraise this objective risk information as a relevant risk and respond appropriately. Research has shown that people do not respond to objective risk, they respond to how they perceive the objective risk (Kahneman, Slovic, & Tversky, 1982). The importance of acknowledging this distinction was first highlighted by Starr (1969) who found that people's risk acceptance was not just a reflection of technical risk estimates. Starr (1969) explained that risk acceptance was also influenced by the degree to which the exposure to the risk was voluntary. That is, people who made a choice to expose themselves to a risk (e.g., rock-climbing) were more likely to accept the risk. This study was one of the first to show that risk perception was subjective and did not just reflect technical risk estimates. Because of this identified differentiation in objective verse subjective risk, understanding why people perceive risks in the way that they do has since become an important area of research (Sjöberg, 2000).

The earlier work on risk perception has led researchers to focus on explaining risk perception using a psychometric approach (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). The psychometric approach was developed as a method for explaining why people perceive risks from certain hazards differently (Slovic, 1992). One of the most famous representations of the psychometric paradigm is a graph that plots hazards on two axes with *unknown* on one axis and *dread* on the other (Slovic, 1987). Hazards that score high on *dread* (perceived as uncontrollable with catastrophic potential) and *unknown* (a new risk or the risk is difficult to observe) are perceived as being risker (Slovic, Fischhoff, & Lichtenstein, 1985). For example, the psychometric models suggests that people perceive nuclear power as high risk because it rates high on *dread* risk and is also relatively *unknown* (Slovic, 1987). The psychometric model also helps to explain why lay people and experts have different risk perceptions as experts base their judgements on technical estimates of annual fatalities whereas lay people are more influenced by the *dread* and *unknown* factors (Slovic, 1987). Although this method has been one of the dominant approaches to quantifying risk perception, some have argued that it misses an important component of risk perception (Sjöberg, 2000). That is, risk perception, as conceptualised by the psychometric model, does not capture the variability in how people perceive the severity of a threat (Sjöberg, 1999).

3.3 The Importance of Perceived Severity

As mentioned earlier, risk has two components: probability and effect (Breakwell, 2014). However, when people are asked to rate how 'risky' a situation is, people do not seem to weigh the contribution from probability and effect equally (Sjöberg, 1999). Instead, people tend to overweigh the influence of probability. One study asked people to 'judge the risk' of specific outcomes (e.g., 'to be injured by smoking' or 'to have a train accident') and found that risk judgment correlated strongly with perceived probability of personal harm (Sjöberg, 1999). Conversely, there was a weak negative correlation between risk judgement and the perceived negativity of the consequences if harmed. Interestingly, however, perceived negativity of consequences was strongly correlated with a demand for risk reduction, whereas both risk level and perceived probability were not (Sjöberg, 1999). Sjöberg (1999) also conducted a multiple regression analysis and found that the perceived negativity of consequences was the strongest predictor of the perceived importance of mitigating damages in relation to all the events assessed (e.g., home burglary, home fire). Neither risk nor probability of harm were significant predictors of the perceived importance of mitigation damage in the multiple regression analysis. The findings suggest that while likelihood of harm is what people think about when asked to determine risk, the perceived severity of the consequences is what influences mitigation behaviour.

As highlighted by Sjöberg (1999), asking someone to 'rate the risk' does not seem to be capturing the component, the severity of consequences, that leads to protective behaviour. Measuring risk perception through rating the risk may help to explain why it is not a consistent predictor of protective behaviour in response to natural hazards (Bubeck et al., 2012). Studies reviewed by Bubeck et al. (2012) found that most studies assess *perceived probability* of a negative outcome (e.g., likelihood that your house will be flooded) and found that this correlates weakly, or not at all, with adopting flood mitigation measures. The review paper only referenced one previous study that used a combined measure of *threat perception* (perceived probability and severity of a future flood) and found that this was a significant predictor of mitigation behaviour (Grothmann & Reusswig, 2006). The findings further support the claim made by Sjöberg (1999) that capturing differences in how people perceive severity is what explains protective behaviour.

In terms of cyclone risk perception specifically, research to date has also mainly focused on perceived probability (Peacock et al., 2005). For example, the most commonly applied cyclone risk perception scale asks people to rate their likelihood of experiences of negative outcomes: damage to property, not being able to work, or disturbance to your daily life (Peacock et al., 2005). The cyclone risk perception scale was intended to capture the Lindell and Perry (2003) conceptualisation of risk perception as the "certainty, severity, and immediacy of disaster impacts to the individual, such as death, property destruction and disruption of work and normal routines" (p. 127). The Peacock et al. (2005) operationalisation, however, does not assess differences in how people perceive the severity of a cyclone. For example, the scale does not ask people to predict the severity of property damage. This gap in the scale is problematic in capturing perceived risk as a person can think that cyclone damage is likely but not think that it is severe. The importance of assessing severity has been outlined in theoretical frameworks such as the Protective Motivation

Theory and Extended Parallel Process Model (Chapter 2). Both models specify that it is a combination of the probability and severity of a threat that determines whether a protective response will occur (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Poussin et al., 2014). As can be demonstrated through the above literature, assessing both probability and severity has yet to be used in a cyclone mitigation context.

The Peacock et al. (2005) scale also does not consider that when people are asked to report the likelihood of damage, they may be thinking about different types of damage. Cyclones can cause many different types of property damage that differ in their objective severity. For example, cyclone damage can be as minor as a cracked window but as severe as a destroyed roof. If two people both rate property damage from a future cyclone as 'unlikely' but one is referring to a cracked window, whereas the other is referring to a destroyed roof, scores on this scale would incorrectly indicate that these people perceive the same level of cyclone risk. In this scenario, however, the person who thinks that a destroyed roof is 'unlikely' is the person that perceives less cyclone risk because they are putting less weight on a more severe outcome. Future studies assessing risk perception by only asking people to report the perceived likelihood of damage, as with Peacock et al.'s (2005) scale, should be mindful of the importance of keeping the objective damage severity component constant.

It is also important to keep differences in determinants of cyclone risk (e.g., wind speed) as constant as possible to properly assess risk perception. As highlighted by other researchers, objective risk does influence risk perception (Botzen, Aerts, & van den Bergh, 2009; Knuth, Kehl, Hulse, & Schmidt, 2014; Sjöberg, 2000). The influence from objective risk is important to consider as when people are asked to report the 'likelihood of cyclone damage?' or 'the severity of cyclone damage?' they may think of different types of cyclones. For example, one person may think of a Category 1 Cyclone and report that damage is 'unlikely' and if it does happen, the damage will be 'low'. However, another person may think of a Category 5 Cyclone and still report that damage is ‘unlikely’ and that the damage will be ‘low’. A scale assessing risk perception in this way would reflect that these two people, incorrectly, perceive cyclone risk in the same way (i.e., they both think damage is unlikely and, if it does happen, low). However, in this case the person that thinks that damage from a Category 5 Cyclone is unlikely and would cause low damage may perceive cyclones to be less risky than does the other person. The following section will provide a theoretical explanation as to why perceiving cyclone severity is important for predicting mitigation behaviour.

3.4 The Difficulty with Conceptualising Cyclone Severity

As mentioned previously, it is difficult to quantify the risk of property damage at the household level (Smith & Henderson, 2015). To add to this complexity, individuals must make sense of ambiguous and uncertain risk information. Even if the risk of property damage could be measured, the individual still must interpret risk information in a meaningful way. To demonstrate why this is difficult it is useful to think of a hypothetical scenario in which people are aware of objective cyclone risk. Consider a situation where someone knows that a Category 5 Cyclone will, with 100% certainty, pass over their house within the next year. In this case, the person would not have difficulty interpreting the probability; however, the subjective component, the perception of the cyclone’s severity, would be more difficult for the person to interpret. In this situation the individual must attempt to predict the outcome of a Category 5 Cyclone and determine the severity of that outcome. While people are given information about expected wind speed, for example, it is their task to predict the impact that event would have on their life. Two people presented with the same risk information may interpret the same threat differently and this differentially impacts on the way each person would respond.

To take this thought experiment one step further, consider a scenario where the property damage caused by a Category 5 cyclone could be predicted with certainty. For example, it is known that if a specific type of house is subjected to Category 5 level winds, 40% of the roof cladding will be destroyed. Even in this scenario, the homeowner needs to comprehend the severity of this outcome in a meaningful way. One homeowner may think that this type of outcome would be a temporary inconvenience and would therefore not consider any protective action. Another homeowner may predict that this damage would be costly, require a lot of time to fix and could potentially threaten their, or a member of their family's safety. People with insurance may find it even more difficult to interpret the severity of roof damage: preventing a $5000 dollar loss, for example, by only having to pay an excess of $1000 dollars could be considered a ‘good’ outcome. Furthermore, the homeowner might find it desirable that their roof is being replaced at the insurer’s expense, thus not perceiving the outcome as severe. However, the insured homeowner may not consider that they may need to live elsewhere for six months while their roof is repaired. The homeowner may also not consider that property damage leads to a higher risk to their family’s safety. Being able to predict consequences in a meaningful way is essential for a homeowner to make appropriate decisions. The following sections will provide a theoretical explanation as to how people make sense of hazard severity and how this influences people’s protective behaviour.

3.4.1 Lack of Knowledge

Understanding cyclone severity requires a degree of knowledge (Milch, Broad, Orlove, & Meyer, 2018). People need to know about the types of cyclone related hazards and what damage these events can cause. If a homeowner with a pre-1980s house in Queensland is unaware that their roof is more vulnerable to roof damage (compared to a newer house), they are likely to perceive the impact of cyclones as less severe than they should. Even people with newer housing may be unaware that garage doors built before 2013 in Queensland (before another building regulation code change) are more vulnerable to wind-related damage compared to houses built after that date (CTS report). There is also a range of outdoor items (e.g., loose fencing and shade sails) that people fail to recognise as potential hazards (Smith & Henderson, 2015). Moreover, some people may not be aware that cyclones cause hazards other than strong wind (Milch et al., 2018). Water ingress in the form of wind-driven rain entering properties is one of the main contributors to cyclone-related property damage in Australia (Harwood et al., 2016). If people are only concerned about strong winds, they are unlikely to consider mitigation measures to reduce damage due to water ingress. Underestimating potential severity in some cases may be due to a lack of knowledge about the types of damage that cyclones can cause.

3.4.2 Risk as Feeling

Early research looking at risk perception implicitly assumed that risk perception was purely cognitive (Loewenstein et al., 2001). That is, perceived risk was something that could be ‘calculated’, albeit subjectively, using an interpretation of probability and effect. Most theories of protective behaviour are also based on this assumption (Loewenstein et al., 2001). For example, the Protection Motivation Theory (PMT) assumes that appraised levels of threat susceptibility and consequences determine whether a protective response will occur (Rogers, 1975). Although researchers acknowledge that people are prone to miscalculating risk, Expectancy Value based theories implicitly assume that the cause of errors are due to cognitive biases (Loewenstein et al., 2001). This understanding of risk perception assumes that all decisions, preferences and attitudes are cognitively appraised. Many researchers, however, have argued that this is not the case. Affective reactions to stimuli are often the first reaction to a threat and do not require any cognitive processing (Zajonc, 1980). In other words, affective appraisal is independent of cognition (Zajonc, 1980).

More recent theories of risk perception build upon the claim that there are two modes of thinking. The dual-process theories of cognition suggest that people have an *experiential system* and a *rational system* (Epstein, 1994; Sloman, Gigerenzer, & Regier, 1996). The *experiential system* is holistic, driven by affect and uses metaphors and narratives to make sense of reality (Epstein, 1994). The *rational system*, on the other hand, is analytical, logical and uses symbols, words and numbers to reason (Epstein, 1994). Similar modes of thinking have also been popularised by Kahneman (2011) as *system one* (the *experiential system*) and *system two* (the *rational system*). Acknowledging the presence of an *experiential system* helps to explain a range of cognitive biases and cases where people deviate from normative theories of decision making (Kahneman, 2011).

The *risk as feeling hypothesis* provides a theoretical framework for explaining the link, and overlap, between feeling and cognition and how these factors influence risk perception (Loewenstein et al., 2001). The theory behind the *risk as feeling hypothesis* highlights the importance of differentiating between *anticipatory* emotions and *anticipated* emotions. *Anticipatory* emotions (e.g., fear, anger and dread) are experienced immediately and viscerally on being exposed to a threatening situation or stimulus (Loewenstein et al., 2001). Being suddenly confronted by a bear, for example, would likely produce the *anticipatory* emotion of fear. *Anticipated* emotions, on the other hand, are what people expect to feel after experiencing a negative consequence (Loewenstein et al., 2001). For example, an individual may be able to feel the *anticipated* emotion (e.g., feeling regret) if they were to lose money on a gamble. Similarly, someone may be able to anticipate they will feel sad or frightened if a cyclone were to damage their house. Most research looking at the role of emotions in decision making has only focused on specific types of *anticipated* emotions (Loewenstein et al., 2001). For example, economists have considered the role that an anticipated feeling of regret has on decision making (Bell, 1982). Few researchers to date have considered the influence of other *anticipated* emotions on decision making. It may be the case that when confronted with a hazard like a cyclone, being able to accurately anticipate a range of negative emotional consequences in relation to a predicted outcome may increase the likelihood of a protective response.

3.4.2.1 Neuroscientific Evidence. Neuroscientific research provides some of the clearest evidence that emotion is important for effective decision making. Interest in the importance of emotion in effective decision-making stems from earlier research showing that people who experienced frontal lobotomies could not conjure thoughts of pleasure or discomfort as it appeared that they did not have the ability to think in images (Cottle & Klineberg, 1974). The findings suggest that appraising consequences can only have an influence on decision making to the extent that the appraised consequences evoke affective responses (Cottle & Klineberg, 1974). The influence from emotion on decision making can be explained by the *somatic marker hypothesis* (Damasio et al., 1996). The rationale underlying the *somatic marker hypothesis* suggests that emotions guide rational decision making and that 'rationality' and 'emotion' are not antithetical. Citing a series of neuroscientific studies, Damasio (2006) presents evidence showing that the prefrontal cortex, in particular, plays an important role in translating cognitive inputs that the emotional brain can process.

One experiment shows how people with damage to their prefrontal cortex (PFC) accept more risk in gambling tasks (Bechara, Damasio, Tranel, & Damasio, 1997). In this experiment, participants were asked to draw cards from a choice of four decks. Each card that they drew signalled that they had either gained money or lost it. Two decks had high potential gains ($100) and two decks had lower potential gains ($50). However, the higher paying decks had occasional large losses, which meant that deck had a net negative expected value. The researchers found that all participants would avoid the net negative decks when they experienced a large loss (Bechara et al., 1997). However, the researchers also found that participant with PFC damage would return to drawing cards from the net negative deck more quickly after experiencing a loss. PFC damaged patients would often lose all of their money in this gambling game even though they reported that they were trying to win and they understood the game.

The research by Damasio and colleagues suggest that understanding severity is, to some extent, dependent on affective appraisal. The researchers' results showed that without being able to experience what it *feels* like to lose money, an individual cannot properly encode the severity of the consequence. The neuroscience research highlights that cognitively relevant information (i.e., that probability and consequence of a loss) needs to be translated in a way that the emotional brain can interpret (i.e., that outcome feels bad). In other words, a loss only becomes a loss when it can be appropriately 'tagged' with negative affect (Peters & Slovic, 2000). These findings suggest that being able to anticipate that cyclone related property damage will cause negative emotional consequences may be necessary for protective behaviour to occur.

3.4.2.2 Dual-Process Risk Perception. Because affect seems to explain how people perceive risk, some studies have developed dual-process risk perception scales to determine whether it is a better predictor of protective behaviour. One study investigating flood mitigation behaviour used a measure of risk perception that combined an affective and a cognitive component (Miceli, Sotgiu, & Settanni, 2008). In this study, the researchers asked people to determine both the likelihood of a negative outcome (e.g., house damage) and the degree to which they felt worried about those outcomes (Miceli et al., 2008). The same researchers found that their risk perception scale had a positive relationship with preparedness behaviour. Moreover, it was found that the emotional component had a stronger independent influence on preparedness than the perceived probability component (Miceli et al., 2008). Similarly, Trumbo et al. (2016) have since developed a scale for measuring cognitive and affective risk perception towards hurricanes. The Trumbo et al. (2016) scale includes questions that assess the degree which people feel specific emotions towards a hurricane (e.g., fear or worry) and how likely they think hurricanes will cause a range of negative outcomes (e.g., damage or destruction). The researchers found that this scale significantly predicted hurricane evacuation expectation (Trumbo et al., 2016). It is, however, yet to be tested whether a dual process risk perception scale predicts other types of protective behaviour (e.g., short-term cyclone preparedness).

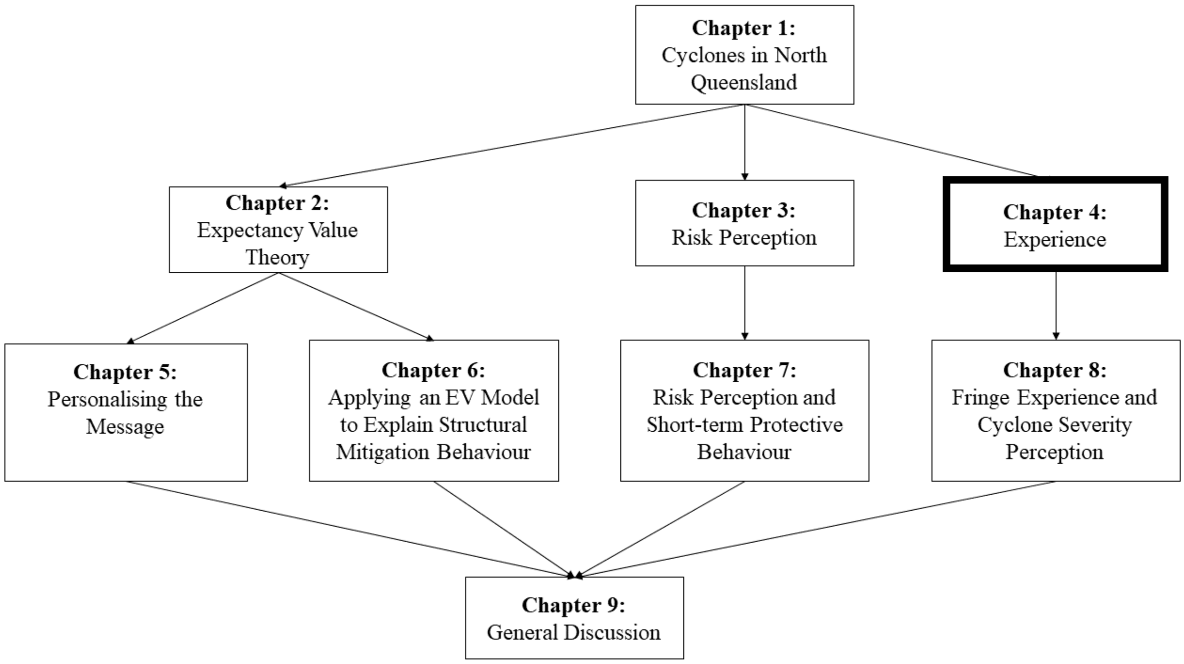
3.4.2.3 Long-term Risks. It is well understood that people tend to underweight the impact of future events and overweight short-term benefits (Frederick, Loewenstein, & O'Donoghue, 2002). Not being able to feel the potential negative outcome of a temporally distant event may explain why people tend to underweight their impact (Weber, 2006). Weber (2006) proposes that this discrepancy is one reason why some people are not fearful of climate change. That is, while some people may be able to reason that global warming is a threat, the threat is not emotionally salient enough to warrant a protective response for most people (Weber, 2006). Similarly, if someone knows a Category 5 cyclone is certain to occur in the next 10 years, they may still find it difficult to interpret the severity of this outcome due to its temporal distance. The *temporal construal theory* also supports this explanation as it suggests that emotional reactions correlate with the temporal proximity of the event (Trope & Liberman, 2003). In other words, it is difficult for people to predict how they will feel about an event that will happen in the future.

3.5 Conclusion

The psychometric paradigm was created to understand why some risks seem ‘riskier’ than others. Researchers have since used scales of risk perception based on the psychometric paradigm to explain how risk perception differs between people (Peacock et al., 2005) and how it influences cyclone mitigation behaviour (Peacock, 2003). This chapter argued that this psychometric approach to assessing risk perception is insufficient. The first reason is that commonly applied risk perception scales do not keep the objective severity of the threat constant. The scales do not, for example, consider that people might be thinking about different category cyclones and different types of damage when asked to report the likelihood or severity of future damage. Future research needs to control for objective severity in order to understand why people perceive risk differently and how it influences mitigation behaviour.

This chapter also highlighted that future research should recognise that risk perception is shaped by cognition and emotion. Most studies to date applying models such as the Protection Motivation Theory and the Protective Action Decision Model implicitly assume that risk perception is a purely cognitive task (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Peacock et al., 2005; Poussin et al., 2014; Terpstra & Lindell, 2013). However, as argued by the *risk as feeling hypothesis*, emotion is an essential component of risk perception (Loewenstein et al., 2001; Slovic, Finucane, Peters, & MacGregor, 2007). This chapter gave particular attention to the importance of emotion for helping people determine the ‘badness’ of a specific outcome. For example, it may help to explain why two people who both think that damage from a future cyclone is likely and severe (both hold high cognitive risk perception) may still perceive the ‘badness’ of the risk differently. Asking people to predict how different types of property damage would make them feel may help to explain why some people prepare more than others. The findings reported in this chapter suggest that people who associate property damage with negative emotional states are more likely to invest in mitigation to reduce that damage, and therefore, mitigate the negative emotion associated with the damage. The next chapter will explore how people's experience with cyclones may help them to conceptualise the severity of a cyclone in relation to both damage potential and negative emotional consequences.

Chapter 4: Experience



Studies have generally found that people with natural hazard experience are more likely to prepare for future events compared to people without experience (Blanchard-Boehm & Cook, 2004; Weinstein, 1989). One explanation as to why experience promotes mitigation behaviour is because experience increases risk perception (Dunn, Ahn, Bostrom, & Vidale, 2016; Lindell & Hwang, 2008; Tierney, Lindell, & Perry, 2001; Wachinger, Renn, Begg, & Kuhlicke, 2013; Weinstein, 1989). Personal experience also decreases optimistic bias, which is the tendency for people to believe they are less at risk from a hazard than others (Weinstein, 1988). Experience with a natural hazard seems to help people understand the potential consequences of an event (Becker, Paton, Johnston, Ronan, & McClure, 2017), which, in turn, promotes protective behaviour (Janoff-Bulman & Frieze, 1983; Russell et al., 1995; Sjöberg, 1999). Studies investigating this specific pathway have found that risk perception at least partially mediates the relationship between experience and future protective behaviour in the manner described above (Demuth, Morss, Lazo, & Trumbo, 2016; Lindell & Hwang, 2008; Mishra & Suar, 2007).

However, the link between experience and protective behaviour is not always consistent (Baker, 1991). For example, some studies have found that people's level of preparedness does not increase after experiencing a tornado (Comstock & Mallonee, 2005) or a hurricane (Dow & Cutter, 1998). A meta-analysis of 38 studies also found that experience did not have a significant effect on future evacuation behaviour for a hurricane (Huang, Lindell, & Prater, 2016). Other investigations have paradoxically found that experienced people prepare less for subsequent cyclones (Rincon, Linares, & Greenberg, 2001) or that risk perception decreases after experience of a cyclone (Meyer, Broad, Orlove, & Petrovic, 2013). To add to this inconsistency in research findings regarding the positive and negative relationship between experience, risk perception and mitigation behaviour, there is also evidence to suggest that experience has no effect on risk perception (Weinstein, 1989).

One explanation for these inconsistent links between experience, risk perception and mitigation behaviour is that researchers have not been consistent about the types of experiences they assess (Baker, 1991; Becker et al., 2017; Demuth et al., 2016; Weinstein, 1989; Zaalberg, Midden, Meijnders, & McCalley, 2009). For example, 'experience' can mean 'experience with damage' or 'experience with negative emotional consequences', depending on the study. The current chapter aims to identify which types of experience may be relevant for predicting future mitigation behaviour for cyclones. Specifically, this chapter will explore whether experience with damage or an experience with a near miss or a fringe event influence people's behaviour. Finally, this chapter will review recent literature that has focused on the importance of emotional experience for explaining mitigation behaviour.

4.1 Learning and Experience: Why People Cannot Learn Adequate Preparedness for Cyclones.

One way people gain knowledge is through their experience (Kolb, 2014). One mechanism by which people learn is based on the positive and negative feedback they receive from their environment (Skinner, 1967). Operant conditioning suggests that if people receive reinforcement in response to a behaviour, they will repeat that behaviour. If they receive a punishment they will not repeat said behaviour. Even if people are not cognitively aware of the risks and benefits of a decision, people learn adaptive behaviours if these behaviours are paired more frequently with positive outcomes than are non-adaptive behaviours. (Kalai & Lehrer, 1993). Based on this understanding of human behaviour, people should learn to prepare to mitigate a negative consequence if they have experienced such negative consequence in the past. Yet this straightforward view of learning and behaviour has some limitations in application to contextually complex scenarios. For instance, what happens when someone lives in an environment where adaptive behaviour is rarely rewarded (a positive outcome), and maladaptive behaviour is rarely punished (a negative outcome). Living in a cyclone-prone region provides one example of a poor environment for optimised behaviour, such as adequate levels of preparedness, to occur from learning from consequences of past events (Meyer, 2012).

Learning to prepare for cyclones is difficult because exposure to the negative consequences caused by a cyclone is relatively rare. Severe cyclones, which cause widespread destruction, are low-probability, high-consequence events (Camerer & Kunreuther, 1989). This means that most people living in cyclone-prone regions will rarely experience property damage from a cyclone (Jarrell, Hebert, & Mayfield, 1992). To further complicate learning, people in these regions often have experience with near misses or fringe cyclone events. There is a growing body of evidence which suggests such experience makes it even more difficult to learn how to respond to future cyclones (Meyer, 2006). For instance, research by Myer (2012) explored how infrequently delivered feedback about the efficacy of a mitigation behaviour influences future cyclone mitigation decision making (Meyer, 2012). In this study the researcher asked participants to make real time decisions in response to hypothetical cyclone events in a simulated environment. After each round of the simulation, respondents were told whether they had experienced damage and the cost of the damage. They were given a choice regarding whether or not they would like to prepare (at a cost) before the next round. The study found that because exposure to cyclone damage is so rare, there are minimal opportunities to experience reward or punishment, which causes low levels of preparedness (Meyer, 2012). It was found that this finding was consistent for both short-term (e.g., household preparedness) and long-term (e.g., installing cyclones shutters) mitigation behaviours. These findings suggest that it is unlikely that people living in cyclone-prone regions will learn to adequately prepare based on experience alone.

Even if people do prepare for a cyclone and damage is avoided, the cause of no damage may be unclear (Meyer, 2012). For example, a homeowner’s windows may not have broken due to the installation of cyclone shutters or because no flying debris hit their window. As there is no clear feedback that the mitigation behaviour was effective, people may be less likely to make future investments. Unclear feedback about the efficacy of mitigation measures also means that ineffective behaviour is rarely punished. For example, a common cyclone preparedness behaviour is to tape a cross pattern on the inside of windows even though it does not stop windows from breaking. However, as most people will not experience a broken window, they do not get the opportunity to learn that the behaviour is ineffective. Conversely, if the homeowner with taped windows does experience a broken window, they may think that preparedness, in general, is ineffective. Based on the unclear feedback people receive living in a cyclone-prone region, it is unlikely that certain types of experience lead to more mitigation behaviour through a learning reinforcement/punishment process. Unclear feedback about the efficacy of mitigation behaviour is, however, not the only negative influence experience can have on future mitigation behaviour. Learning from experience may also lead to people to behave as if future cyclones are less likely than they actually are.

4.1.1 Decision from Experience vs Description

While the information people receive about cyclone risk based on their experience is unclear, so too is descriptive information. As discussed in the previous chapter (Chapter 3), it is difficult to quantify all the relevant variables to determine household-level cyclone risk. If it were possible, people would be more likely to make a *decision from description*. A *decision from description* is when people use information about probability and severity to make a decision. For example, someone may decide to take an umbrella outside based on a rain forecast they read that morning. This is a decision that people can make, to some extent, with their analytical system. A person could calculate, for example, the expected utility of taking an umbrella vs not taking an umbrella. However, not all decisions can be informed with statistical probabilities. Deciding whether to invest in structural upgrades is a decision that is difficult to make with descriptive information. As discussed in Chapter 3, the probability of experiencing a severe cyclone in the next 10 years, for example, is more uncertain than today's rain forecast. As such, people cannot access accurate descriptive information about their future cyclone risk.

When people cannot use descriptive information, people tend to make *decisions from experience* instead (Hertwig, Barron, Weber, & Erev, 2004). The result is that people make different decisions when using experiential information compared to descriptive information (Hertwig et al., 2004). The most important difference is that when making a *decision from* *experience* people behave as if they underweight the probability of low-probability, high-consequence events (Hertwig et al., 2004). In other words, they behave as if the probability of an event occurring is lower than it is. This finding contradicts with *prospect theory,* which suggests that people generally overweight low-probability events (Kahneman & Tversky, 1979). So, while people may think that a future severe cyclone is more likely if they are provided with descriptive information, the absence of a severe cyclone in subsequent years may override this and cause people to underestimate the probability of a future event. This may also explain why people tend to prefer insuring against high-probability, low-consequence events as opposed to low-probability, high-consequence events (Slovic, Fischhoff, Lichtenstein, Corrigan, & Combs, 1977).

This difference in decision making from description or experience was first identified in a study investigating how people respond to gambles (Hertwig et al., 2004). In this study, each participant was asked to make a choice between two gambles by pressing one of two buttons. One gamble was always riskier than the other (i.e., attracted a higher expected loss). Participants in this experiment were allocated to one of two groups: a description group and an experience group. The experience group were only told the result of the gamble after each decision (e.g., you lost $5), whereas the description group were told the risk of the gamble before they made their decision (e.g., 1 in 50 chance of losing $5). Before recording responses, all participants were able to sample each gamble by pressing the buttons as many times as they liked. That is, both groups were able to sample the probability of a win/loss experientially but only the description group was told the actual probability of a win/loss. When finally asked to pick the gamble that was the least risky, the researchers found a significant difference between the *description group* and the *experience group* in relation to the percentage that selected the riskier game in each condition (Hertwig et al., 2004). Specifically, 64% of people in the *description group* preferred a sure loss (with a lower expected loss) compared to a low-probability, high-consequence gamble (with a higher expected loss). Conversely, only 28% of people in the *experience group* preferred the sure loss even though it was the decision that had the lower expected loss.

The tendency to underweight the probability of low-probability, high-consequence events when relying on experience has also been replicated in a similar study (Weber, Shafir, & Blais, 2004). The researchers explain that people act as if they overweight the information provided by a recent event. As such, people make decisions as if they underweight the effect of rare events because rare events, on average, are less likely to have occurred recently (Weber et al., 2004). These findings are also consistent with classical reinforcement learning theory, which suggests the recent and unexpected experience has a greater influence on behaviour (Weber et al., 2004). The results of these studies suggest that if people use their experience to guide decision making for cyclone mitigation, people living in cyclone-prone regions may also be prone to this cognitive bias because they are evaluating low-probability/high-consequence events. That is, people will act as if severe cyclones are rarer than they are because, as severe cyclones are rare, they are less likely to have experienced one recently. The recency of the event, however, is not the only factor that determines the magnitude of the response. The following section will review some of the different types of experience a person can have and how these experiences have different influences on behaviour.

4.2 Different Types of Natural Hazard Experience

Put simply, not all experiences with natural hazards are created equal. However, past research has not consistently acknowledged that experiences can differ between people (Demuth et al., 2016). When trying to assess people's experience, researchers have asked questions ranging from, 'Have you experienced a cyclone?' to 'Have you experienced property damage from a cyclone?'(Huang et al., 2016; Sattler et al., 2000). While these two questions are both assessing experience, they are not assessing the same type of experience. Experiencing severe property damage due to a Category 5 cyclone is objectively different to preparing for a cyclone that did not occur. But asking the question, ‘Have you experienced a cyclone?’ does not capture this difference. Assessing experience without differentiating between these types of experiences makes it difficult to understand how and why experience influences future mitigation behaviour (Demuth et al., 2016). Precisely assessing experience is particularly important to understand how experience influences people’s cognition. This precision of measurement does not only come down to assessing if a person has ‘experienced a cyclone’ or ‘experienced damage’ but also recency of the event experience, the proximity to the high impact zone, and the non-event experiences.

4.2.1 Recent Experience

People also tend to overweight information obtained from a recent or more memorable event (Lerner, Gonzalez, Small, & Fischhoff, 2003; Tversky & Kahneman, 1973; Weber, 2006). The *availability heuristic* provides an explanation for this finding. That is, recent or memorable events are more ‘available’ to the decision maker (Tversky & Kahneman, 1973). However, the effect seems to fade over time. One clear example of how recent experience influences behaviour is the change in the number of insurance policies purchased after a flood event (Atreya, Ferreira, & Michel-Kerjan, 2015). Flood insurance purchasing rates tend to increase after an event but only up to a point, with the purchasing rates returning to baseline three years after the event (Atreya et al., 2015). A similar effect has also been found in relation to people’s cyclone preparedness behaviour. One study found that people who had experienced a cyclone four years prior to the study were more prepared for a future event than people without experience but people who experienced a cyclone seven years prior did not prepare any more than people without experience (Sattler, Kaiser, & Hittner, 2000).

It appears that recent experience seems to influence future behaviour because it increases risk perception. People who recently experienced an earthquake, for example, thought they were more likely to suffer personal harm from future earthquakes compared to people without experience (Burger & Palmer, 1992). However, the experienced peoples' level of concern decreased back to baseline three weeks after the event (Burger & Palmer, 1992). Another study investigating hurricane risk perception found similar results (Trumbo, Meyer, Marlatt, Peek, & Morrissey, 2014). In this study, the researchers assessed levels of risk perception and optimistic bias (the tendency for people to think they are at less risk than their peers; Weinstein, 1980) towards hurricanes immediately after participants were impacted by Hurricane Katrina. The same researchers followed up with the participants two years later and found that risk perception had decreased and optimistic bias had increased from post-event levels (Trumbo et al., 2014). That is, compared to their estimates reported just after experiencing Hurricane Katrina, the participants at two years follow up perceived hurricanes as less likely to cause damage and that other people were more likely to experience damage than the participant. These studies, and others (Doyle et al., 2014; McClure et al., 2015), suggest that while recent experience can influence future preparedness behaviour, people seem to 'forget' their experience over time.

4.2.2 Fringe Experience

Compared to other hazards, clearly assessing a specific type of experience with a cyclone is difficult. For instance, one reason it is difficult to assess experiences with cyclones is that wind speeds vary greatly within the impact zone depending on the proximity to the eye of the storm (Boughton et al., 2011). That is, a house in the direct path of a Category 5 Cyclone will likely experience more severe property damage than another house located 200kms away from the eye of the cyclone. In this scenario, however, both homeowners may correctly report they experienced the same cyclone even though they were exposed to different wind speeds (Weinstein, 1989). However, one of these people only has fringe experience with the cyclone event as they were not near the eye of the storm. People with fringe experience may incorrectly think they have experienced the full impact of a severe cyclone, when they may have actually experienced lower-level wind speeds consistent with a weaker cyclone system (Leik, Carter, Clark, Kendall, & Gifford, 1981). This has been labelled by other researchers as type of 'false experience' and may lead to misconceptions of severity and susceptibility (Simpson-Housley & Curtis, 1983).

The effect of fringe experience was identified in one experimental study investigating real time preparedness behaviour in response to an incoming cyclone in a simulated environment (Meyer et al., 2013). Although Meyer et al. (2013) hypothesised that participants with cyclone experience would start preparing earlier for an incoming cyclone, the authors instead found the opposite effect: instead of motivating preparedness, experienced people were more likely to postpone their preparedness behaviours. Meyer et al.'s (2013) explanation for this finding was that experienced respondents were less worried about cyclones compared to people without experience. Although unable to empirically validate the claim, the authors thought this complacency may be due to the respondent's most recent experience being that of a fringe event (Meyer et al., 2013). In other words, the participants may have thought they experienced a worse event than they did and due to this faulty baseline, underestimated the impact of a future severe cyclone. Other researchers suggest that a reduction in motivation to prepare after a minor impact can be explained by a 'normalisation bias' where people tend to generalise their ability to cope with a natural hazard due to what they experienced from minor event (Johnston et al., 1999; Mileti & O'Brien, 1993).

Only having exposure to fringe events presents a case where experience may lower risk perception and hinder future preparedness. This is a concerning finding as most people either have experience with fringe events or with weaker category cyclones (e.g., Category 1 or 2 cyclones). Jarrell et al. (1992), using population level data, found that in 1990, 85% of people living on the east coast of the USA (from Maine to Texas) did not have direct experience with a major cyclone (Category 3 or above). In Florida, the most hurricane prone state in the USA, only 5% of the population had experienced a direct hit (Jarrell et al., 1992). In other words, while most of the population may have experienced a cyclone, only a minority have experienced a direct hit from a severe cyclone. For people in Australia, this pattern of experience would be similar as all severe cyclones (Category 3 or above) over the past 10 years have not directly hit the most densely populated cities in North Queensland (Bureau of Meteorology, 2018a). The findings suggest that most people's firsthand experience with a cyclone is that of a fringe event, which may not accurately represent the damage potential of future cyclones. As such, experience with fringe events may reduce risk perception and future mitigation behaviour. A similar effect may occur when a predicted cyclone misses an area entirely.

4.2.3 Near Misses

In addition to fringe experience, many people also have experience with near misses. A near miss can be defined in variety of ways but is most commonly defined as a predicted outcome that did not occur (Dillon & Tinsley, 2008). A near miss is therefore similar to a 'false alarm' in that a predicted event does not occur even though a warning has been given (Dow & Cutter, 1998). The risk of cyclone-related property damage is an example of an outcome that is uncertain and, therefore, can result in a near miss. A common example of this is when a predicted cyclone track changes direction. When a cyclone changes direction, people who expected to experience a cyclone may experience no negative effects at all (Dillon, Tinsley, & Cronin, 2011). However, instead of people concluding that they were 'lucky' to have avoided the event at this time, some people think that because they avoided this outcome, they will also avoid it in the future. This pattern of thinking is still the case even if their actions (e.g., preparation or evacuation) had no effect on the outcome (Dillon, Tinsley, & Burns, 2014; Dillon et al., 2011; Eisenman, Cordasco, Asch, Golden, & Glik, 2007; Halpern-Felsher et al., 2001). In other words, people tend to perceive a near miss as an event that *did not happen*, opposed to an event that *could have happened*.

It was thought that predicting the probability of a future event as a near miss could be explained in terms of Bayesian updating, or a lack there of (Dillon & Tinsley, 2008). That is, as an event did not occur, people update their prior understanding of how likely they think it is that they will be negatively affected by a cyclone. However, research has shown that near misses do not seem to influence cognitive appraisal. Instead, near misses seem to influence people's affective appraisal of an event: experiencing the negative effects from a cyclone *feels* less likely after a near miss (Dillon & Tinsley, 2008). In other words, near misses seem to lower people's affective risk perception, which can, in turn, reduce future mitigation behaviour (as discussed in Chapter 3). The researchers also explained that people are more likely not to prepare in the future because they were rewarded for not preparing in the past (Dillon & Tinsley, 2008). Put another way, the non-protective response is reinforced as it resulted in a positive outcome, even though their own actions had no influence on the result. So, like fringe experience, near misses also seem to reduce risk perception and future protective behaviour. It may be the case that direct experience with negative consequences from a cyclone is the only type of experience that leads to increased risk perception and future protective behaviour.

4.2.4 Experience with Loss or Property Damage

Experience with loss or property damage is one type of experience that seems to consistently increase risk perception and future preparedness (Helweg-Larsen, 1999; Mileti &

O'Brien, 1992; Solberg, Rossetto, & Joffe, 2010; Weinstein, 1989). For instance, one study found that hurricane damage experience had an influence on people's risk perception, but hurricane experience without damage did not (Peacock, Brody, & Highfield, 2005). Other studies have also found that experience with damage predicted future hurricane evacuation (Riad, Norris, & Ruback, 1999) and preparedness (Norris, Smith, & Kaniasty, 1999). However, as with evidence on responses following near misses, vicarious or indirect experience does not seem to have the same influence on future preparedness (Becker et al., 2017). In other words, seeing or hearing about the negative effects due to a natural hazard does not have the same effect on preparedness as experiencing an event firsthand. Experience with damage seems to help people understand the potential consequences of an event (Becker et al., 2017). This aligns with the above evidence on recency, fringe and near miss events as the significance of the consequences for an event erode with time or are underweighted due to the fringe or near-miss experience. Yet with the experience of damage, an individual may realise, for example, that cyclones can cause specific types of damage that they did not expect (e.g., water ingress), thus enhancing their understanding of the consequence of the event. Another explanation is that, as with experience with near misses, experience with damage taps into a person's affective evaluation of an event. That is, after experiencing damage, people may realise the emotional harm that a cyclone can cause.

4.3 Affect and Experience

The evidence presented thus far and in Chapter 3 indicates that affect plays an important role in the individual's conceptualisation of their experience. Recent research suggests that it is important to consider people's subjective experience (Becker et al., 2017; Demuth et al., 2016). In addition to experiencing different types of events (e.g., fringe event vs direct hit), people appraise events differently. Experience with damage, for example, may not necessarily lead to increased risk perception if the experienced individual did not perceive the event as negative. Conversely, cyclones can be frightening for an individual, even without experiencing the full extent of a storm (Woods, West, Buettner, & Usher, 2014). Demuth et al. (2016) explains this as the difference between objective experience (e.g., property damage) and subjective experience (e.g., emotional). This distinction is important as while subjective and objective experience may be connected (e.g., property damage causes negative emotions), a negative emotional experience is not dependent on the severity of an objective experience. There are a range of factors that could cause a negative emotional experience. As such, researchers are starting to focus on people's emotional experience with natural hazards and how it influences risk perception and future protective behaviour (e.g., Demuth, Morss, Lazo, & Trumbo, 2016; Siegel, Shoaf, Afifi, & Bourque, 2003; Siegrist & Gutscher, 2008).

One study specifically investigated how negative emotional experience influences future behaviour (Siegrist & Gutscher, 2008). The researchers hypothesised that people with flood experience prepare more in the future because they can accurately predict the emotions evoked compared to people without flood experience (Siegrist & Gutscher, 2008). They, therefore, recruited two groups of participants: an affected group who had experienced a flood and a group which had not. The researchers then asked the experienced group to recall the worse part of a previous flood and the non-experienced group to imagine what would be the worst thing about experiencing a flood. The researchers found that the non-experienced group more commonly reported outcomes like 'destruction' and 'casualties' as the worst consequences from a flood. The experienced group, however, more commonly reported negative emotions like 'fear' and 'helplessness' as the worst part about experiencing a flood. The researchers also found that the experienced group more commonly reported that 'fear of flood damages' was a 'very important' reason for future preparedness compared to people without experience (Siegrist & Gutscher, 2008).

A qualitative study also found that emotional experience was related to future preparedness for earthquakes (Becker et al., 2017). The researchers found that people had stronger emotions and feelings if they had physically experienced an earthquake (including damage or injury) as opposed to indirect experience (e.g., not being able to go to work) or hearing about the event from friends, family or the media (Becker et al., 2017). People with direct experience also used more emotive words to describe their experience (e.g., frightening, scary or horrific) compared to people with an indirect experience (e.g., exciting, concerning or nervousness). These findings suggest that first-hand exposure to a natural hazard provides an emotional experience that people cannot acquire through other means. Information provided indirectly or vicariously does not seem promote the same type of emotions as direct experience (Becker et al., 2017). Direct experience is arguably more vivid (Fiske & Taylor, 2013; Nisbett & Ross, 1980; Norris et al., 1999), which may explain why people with direct experience can more accurately conceptualise how they will feel after an event.

4.3.1 Affect Determines the 'Badness' of an Experience

The *affect heuristic* provides one explanation as to how and why emotional experience influences future behaviour. The theoretical foundations of the *affect heuristic* suggest that people 'tag' past events with emotionally salient information, thus making the experience easy to recall in the future (Slovic, Finucane, Peters, & MacGregor, 2007). The *affect heuristic* suggests that information becomes more 'available' when it is emotionally salient (Slovic, Finucane, Peters, & MacGregor, 2004). For example, the *affect heuristic* helps to explain why people fear nuclear power (Slovic, 1987) but are not afraid of climate change (Weber, 2006). In the case of nuclear power, people tend to feel negatively about it because they can easily recall emotionally salient events like the Chernobyl disaster (Drottz-Sjöberg & Sjoberg, 1990). Most people cannot think about climate change in the same way as the negative effects are temporally distant and abstract, and therefore do not provoke the same emotional response (Weber, 2006).

As highlighted by Slovic et al. (2007) the *somatic marker hypothesis* helps to explain the neurological mechanism behind the *affect heuristic*. That is, emotional experience seems to help to encode the 'badness' of an event within the brain. Negative emotional experience seems to give people the ability to appraise the valence of an outcome and are therefore more motivated to avoid that outcome in the future. As highlighted by Damasio's (2006) research in Chapter 3, having an analytical understanding of risk does not necessary lead to an appropriate behavioural response (e.g., hazard mitigation behaviour). Instead, there is the argument that protective behaviour requires the individual to feel the 'badness' of the outcome they are trying to avoid (Damasio, 2006). The *somatic marker hypothesis* suggests that for people to feel a potentially negative outcome they need to link thoughts (usually in the form of images) with somatic or bodily states. The *somatic marker hypothesis* explains why people with a direct experience can more accurately predict how they will feel after a natural hazard (Siegrist & Gutscher, 2008). After a frightening experience with a cyclone, for example, seeing a cyclone warning in the future may elicit somatic markers that the individual recognises as 'fear' or 'anxiety'. If the thought of a cyclone is tagged with a negative emotion, the individual would then be motivated to avoid that feeling in the future.

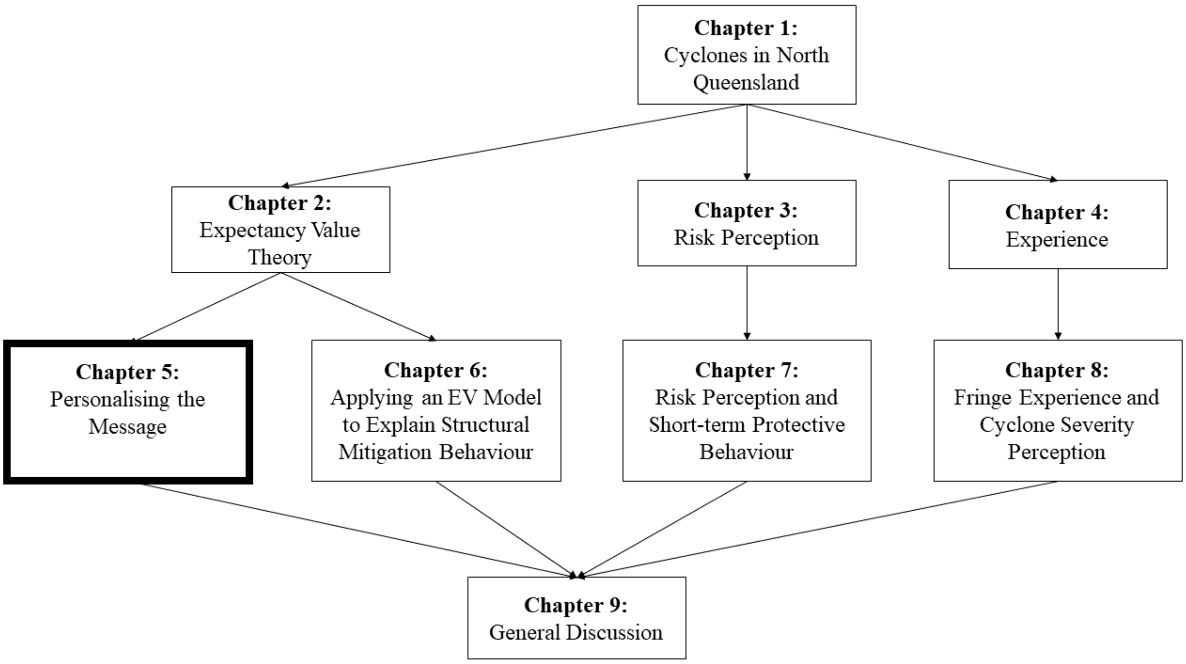
Emotional experience may also change people's cognitive appraisal of risk. As outlined by the Extended Parallel Process Model (Chapter 2), experiencing fear can increase the perceived likelihood and severity of a hazard (Witte, 1992). One study assessing emotional injury found that participants thought that damage due to a future extreme weather event was more likely after experiencing an emotional injury in the past due to a different type of natural hazard. (Siegel, Shoaf, Afifi, & Bourque, 2003). Another study found that negative emotion increased perceived vulnerability to future flood damage, which in turn increased protective behaviour (Zaalberg et al., 2009). In line with the other theories acknowledging the connection between cognition and emotion, Rüstemli and Karanci (1999) suggest that in a natural hazard context fear shapes cognition and motivates adaptive responses. These findings taken together suggest that emotional experience influences cognitive appraisal of future events, not just the emotional appraisal. The findings also provide further evidence for the relationship between cognitive and emotional systems (Loewenstein, Weber, Hsee, & Welch, 2001). In other words, having a negative emotional experience (emotional system) may cause people to think that natural hazards are more likely or severe (cognitive system).

4.4 Conclusion

Research suggests that when people cannot obtain clear descriptive information about risk, they tend to rely on experience to guide future decision making (Hertwig et al., 2004). This may lead to lower rates of preparedness than should be warranted, in light of the objective probability and severity of the risk. As severe cyclones are low-probability, high-consequence events, there is even less opportunity to learn from experience about benefits of mitigation (Meyer, 2012). However, while people may not learn optimum levels of preparedness based on experience alone, there are specific types of experience (e.g., experience with damage) that seem to promote both risk perception and mitigation behaviour (at least in the short term). It is, therefore, important to understand how and why these types of experience influence future behaviour.

Being more precise when using the word ‘experience’ will help future research to understand how ‘experience’ influences risk perception and behaviour. As discussed in this chapter, people can have a range of different natural hazard experiences. Acknowledging that, for example, exposure to the fringe of a cyclone is different to a direct hit will help researchers to be more precise in the way they measure experience and provide better explanations as to why it may influence risk perception or mitigation behaviour. This chapter also highlighted the importance of considering how experience shapes people's emotional appraisal of natural hazards. Negative emotional experience seems to help people comprehend the severity of a natural hazard, which, in turn, promotes mitigation behaviour. Future research should continue to assess people's emotional experience to further understand how it influences risk perception (both cognitive and emotional) and mitigation behaviour. The end of chapter marks the end of the literature review component of this thesis. The following four chapters discuss the findings of this research project.

Chapter 5: Personalising the Message



5.1 Rationale

As explained in Chapter 2, the psychological factors included in most Expectancy Value (EV) based theories help to explain natural hazard mitigation behaviour. A theory that encompasses both *risk perception* and *protective action perceptions* has, however, yet to be applied to explain the uptake of structural upgrades to protect against cyclone damages. The first aim of this study was to address this research gap by testing whether an EV based theory can significantly predict whether homeowners in North Queensland have installed, or intend to install, cyclone shutters on their property.

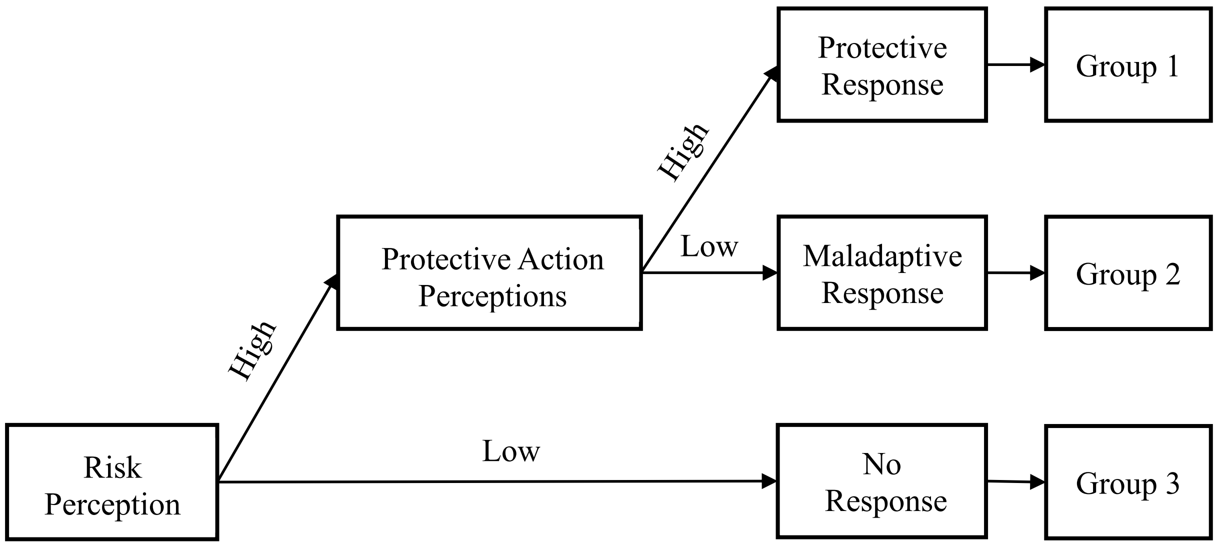
The study in this chapter also aims to enhance risk communication messaging for tropical cyclones. As already identified in past research, messaging based on EV theories such as the Protection Motivation Theory tends to improve message acceptance (Mulilis & Lippa, 1990; Slater, 2006). However, more recent research shows that this 'one size fits all' approach to messaging may not be the most effective method; instead, people are more likely to change their attitude/behaviour if the message is more relevant to them (Moser, 2010). One way to improve message acceptance is to tailor the information to the individual's psychological or cognitive profile (Kreuter, Strecher, & Glassman, 1999; Kreuter & Wray, 2003). The approach of segmenting the audience based on what is known about them is a common procedure used in social and commercial marketing (Lefebvre & Flora, 1988; McDermott, 2000). Audience segmentation has, however, become increasingly popular in the area of health behaviour promotion (Rimal et al., 2009). Many studies have found that tailored messaging based on audience segmentation leads to greater uptake of healthy behaviour compared to traditional (non-tailored) messaging (Kreuter, Farrell, Olevitch, & Brennan, 2013; Noar, Benac, & Harris, 2007; Rimal et al., 2009; Rimer & Glassman, 1999; Skinner, Campbell, Rimer, Curry, & Prochaska, 1999).

The efficacy of tailored messaging, though, does seem to be dependent on how the population has been segmented. The traditional approach is to use demographic data (e.g., age, gender, income) to segment the population (Hine et al., 2014; Rimal et al., 2009). This approach works well when demographic factors are reliable predictors of behaviour (e.g., higher income individuals buying more expensive products). Demographic factors are, however, not reliable predictors of protective behaviour in response to natural hazards (Bubeck et al., 2012; Lindell, 2013). Because psychological factors are stronger predictors of protective behaviour, researchers are starting to use EV based theories to inform the way in which they segment the population (Campo, Askelson, Carter, & Losch, 2012; Rimal et al., 2009). In other words, researchers are segmenting the population based on psychological factors as opposed to demographic factors. A meta-analysis investigating the efficacy of tailored messaging found that a theory based approach to audience segmentation leads to better message acceptance compared to an atheoretical approach (Noar et al., 2007). To create effective tailored messaging it is, therefore, important to select a theory that can explain behaviour in a given context and segment the population based on that theory.

The adapted theoretical model proposed in Chapter 2 suggests that there are three main patterns of cognition that lead to three different types of behaviour (see Figure 5.1). This component of the adapted model is informed by the Extended Parallel Process Model (EPPM). Witte (1992) explained that for a *protective response* (i.e., mitigation intention or behaviour) to occur people need to perceive sufficiently high levels of both threat and efficacy. A *maladaptive response*, on the other hand, is explained by high levels of perceived threat but low levels of perceived efficacy whereas *no response* is explained by low levels of perceived threat. While there are three types of behavioural responses, only one of the responses leads to protective behaviour; both *maladaptive response* and *no response* do not, theoretically, lead to mitigation intention or behaviour. Therefore, the final aim of this chapter is to determine if there are three main patterns of cognition and if only one of those leads to the uptake of structural upgrades for cyclones as the EPPM suggests. By empirically validating the adapted EV model in this context, a tailored approach to messaging can then be built upon the findings.

Figure 5.1

Hypothesised Groups based on the Adapted Model



Based on this rationale and the theory reviewed in Chapter 2, the following research questions were developed:

1. Does an Expectancy Value based theory explain the uptake of structural upgrades to protect against cyclone damages?
2. Within the target population, are there a) three main psychological profiles for the evaluation of a cyclone threat and b) will only one of these profiles lead to increased protective behaviour as proposed by the adapted theoretical model?

This rest of this chapter has been published as a paper in the Australian Journal of Emergency Management as the following citation:

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Paper Starts Here

5.2 Introduction

In Australia, tropical cyclones caused over $6 billion in insured damage between 2006 and 2016 (Harwood et al., 2016). Housing is particularly vulnerable as cyclones can cause significant structural damage (Smith et al., 2015). However, some of this damage is preventable if appropriate structural measures are in place, for example, cyclone shutters can be installed to reduce window damage caused by cyclones (Smith et al., 2015). Despite these benefits, installation of cyclone shutters is low in high-risk areas such as North Queensland (Harwood et al., 2016). This paper identifies some of the psychological factors that explain why people choose to invest or not in cyclone shutters. A method of segmenting risk communication messaging is investigated with the aim of improving the uptake of structural damage mitigation measures.

Past research has identified a range of psychological factors that help predict mitigation behaviour for natural hazards (Bubeck et al., 2012; Kanakis & McShane, 2016; Kellens et al., 2013; Koerth, Vafeidis, & Hinkel, 2016; Smith, McShane, Swinbourne, & Henderson, 2016). Psychological factors are considered better predictors of mitigation behaviour than demographic factors (Ge et al., 2011; Lindell & Hwang, 2008; Peacock, 2003). In particular, psychological factors within two popular psychological models, the Protective Action Decision Model (PADM) and the Protective Motivation Theory (PMT), have been found to be reliable predictors of mitigation behaviour (Bubeck et al., 2013; Ge et al., 2011; Grothmann & Reusswig, 2006; Poussin et al., 2014; Terpstra & Lindell, 2013). Although the conceptualisation of factors within these models differs, most studies have found that perceived threat (threat appraisal) and perceived ability to respond to the threat (coping appraisal) are significant predictors of mitigation behaviour.

By identifying the psychological factors that relate to cyclone mitigation behaviour, effective risk communication messages can be built on these findings (Kellens et al., 2013). However, using a one-size-fits-all approach to risk communication means some people may not receive or heed the information (Fekete, 2012). People-centred risk communication messaging, which acknowledges the psychological differences between groups, outperforms traditional approaches of giving everyone the same message (Haer, Botzen, & Aerts, 2016). One way to implement a people-centred approach is to understand how groups differ based on psychological predictors of mitigation behaviour and tailoring messages to address these differences. Creating a ‘typology’ or ‘cluster’ groups based on psychological factors has been successfully applied to gain good understanding of how different groups respond during bushfires (Strahan, Whittaker, & Handmer, 2018) and adaption to coastal flooding (Koerth, Vafeidis, Carretero, Sterr, & Hinkel, 2014). This study uses a similar approach to identify the differences in peoples' perceptions towards cyclones and cyclone shutters and how these differences relate to intentions to undertake structural changes to their homes.

5.3 Method

5.3.1 Participants

Respondents were recruited using social media platforms of Facebook and Twitter. Links to an online survey were promoted and were also shared through other social and professional networks. Information about the survey was disseminated via broadcast media platforms throughout North Queensland (i.e. TV, radio and newspapers). People who were living in coastal North Queensland between Cairns and Rockhampton were able to respond.

This survey was part of a larger research project that assessed many different factors. However, the focus of this study was to investigate homeowners' structural mitigation behaviours. As such, only homeowners who provided information about their cyclone mitigation behaviours or intentions were included in the analysis.

Respondents were asked to report their gender, age, relationship status, years spent in North Queensland, income and their highest level of formal education. They were also asked to specify if they had any dependent children and if they had experience with cyclone-related property damage.

After removing ineligible responses, the final response sample size was 339, with 112 (33%) males and 227 (67 per cent) females. The average age of respondents was 47 years with a standard deviation of 11.9 years and a range of 18 to 76 years. The median household income category was $80,000–$125,000. A bachelor's degree was the most commonly reported highest level of education (31%). The average number of years living in North Queensland was 25.5 years with a standard deviation of 17.3 years and a range of 1 to 75 years. Most frequently, respondents reported that they were married (68%) and 50 per cent had at least one dependent child.

5.3.2 Materials

5.3.2.1 Shutter installation. A shutter installation variable was used to assess cyclone mitigation behaviour as all home owners can install shutters and their primary use is to mitigate cyclone-related property damage. The shutter installation variable was created by combining scores from two other variables: shutter installation behaviour and intention to install shutters.

First, behaviour was assessed by asking respondents if they had installed cyclone shutters since building or buying their property[2]. If respondents indicated they had not installed cyclone shutters, they were asked to indicate how likely they were to install them in the coming five years. Intention to install shutters was measured on a seven-point Likert scale with higher scores indicating a higher intention to install shutters.

There were minimal responses to some levels of the seven-point intention scale so scores were combined to create three ordered categories (i.e. a low, moderate and high intention group). The shutter installation variable was the outcome variable used in the subsequent analysis and was scored as follows: 1 = low intention to install shutters, 2 = neither likely nor unlikely to install shutters, 3 = likely to install shutters and 4 = already installed shutters.

5.3.2.2 Mitigation and resource perceptions. Risk perception was assessed based on five questions. Using a similar operationalisation to Peacock et al. (2005), questions assessed perceptions of damage likelihood, the extent to which their daily life/ability to work

[2] In the survey respondents were asked if cyclone shutters had been installed, not if they had installed the shutters themselves. See question wording in Appendix B.

would be affected and the extent to which their mental/physical health would be negatively impacted by experiencing a cyclone.

Other psychological factors based on the PADM/PMT were also assessed, as shown in Table 5.1. Variable conceptualisation was adapted from the study by Terpstra and Lindell (2013) but was defined using PMT terms (i.e. response efficacy and response cost). The factors in Table 5.1 were created by summing and averaging the scores of subscales of risk perception, response efficacy and response cost. All subscales were scored on a 7-point Likert scale, with higher scores indicating stronger agreement with each statement.

Table 5.1

Scoring of Psychological Factors

Factors	Statements
Response Efficacy	
Efficacy (damage)	Shutters are effective for reducing property damage and associated costs.
Efficacy (safety)	Shutters are effective for increasing family's safety.
Utility	Shutters are useful for other purposes besides protecting property.
Increases value	Shutters increase property value.
Response Cost	
Monetary cost	Shutters are expensive to install.
Time and effort	Shutters take a long time and a lot of effort.
Knowledge/skill required	Shutters take a lot of skill and knowledge to get installed.
Cooperation required	Shutters require a lot of help/cooperation from others.
Visual Appeal	
Visual appeal	Shutters are visually appealing.
Self-efficacy	
Self-efficacy	Requires the ability of the respondent or a family to organise for the shutters to be installed.

5.3.3 Procedure

Ethical approval was obtained through the James Cook University Human Research Ethics Committee (H7007). The survey was available online using the Qualtrics platform and took approximately 25 minutes to complete. Most of the respondents were recruited online between the 30 June and 9 November 2017. The survey was first diseminated via social media platforms such as Facebook and Twitter and a Facebook page was created providing information about the study and a link to the survey.

5.4 Results

5.4.1 Psychological factors that predict shutter installation

Ordinal regression was used to determine the psychological factors that predict shutter installation[3]. As shown in Table 5.2, response efficacy, response cost, visual appeal and risk perception were all significant predictors of shutter installation (all $p<0.05$). Self-efficacy, however, was not. In total, the variables explained 24 per cent of the variability in the model, which suggests that the significant predictors in the model are important for explaining shutter installation behaviour.

[3] Ordinal regression was used as the dependent variable was assessed on an ordinal scale. The psychological factors were included in the model as the theory behind the PMT and PADM posits that they explain protective behaviour.

Table 5.2

Results of an Ordinal Regression Analysis

Psychological factors	Coefficient	*p*
Response efficacy	0.436	0.001
Response cost	-0.315	0.004
Self-efficacy	0.007	0.923
Visual appeal	0.343	<0.001
Risk perception	0.277	0.022
Total model	Nagelkerke $R^2 = 0.24$	

5.4.2 Cluster analysis

K-means cluster analysis was used to divide respondents into groups based on their standing on four psychological variables. The psychological variables used in the cluster analysis were risk perception, response efficacy, response cost and visual appeal. The four variables were converted to Z-scores before analysis. Three cluster groups were chosen for the k-means analysis[4]. Figure 5.2 shows each cluster group's standing relative to the mean on each factor used in the cluster analysis. The numbers on the y-axis represent standard deviation units (or Z-scores).

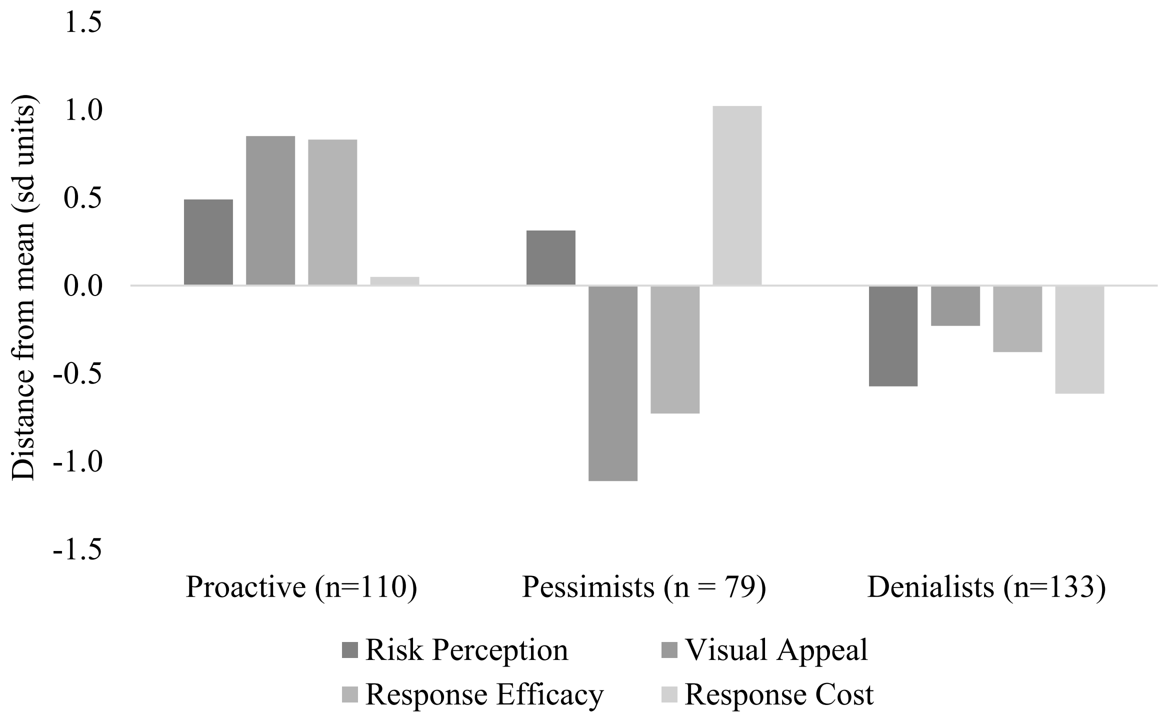
As seen in Figure 5.2, cluster groups were given names to represent the average perceptions of the group. The first group was labelled *'proactive'* because, compared to other groups, they perceived the highest levels of risk, the highest-level shutter efficacy and visual appeal, and perceived a moderate level of response cost. The second group, *'pessimists'*,

[4] Three cluster groups were chosen as the theory behind the EPPM suggests that there are three main appraisal patterns that lead to different types of behaviour.

perceived slightly less risk than the proactive group but perceived the lowest level of efficacy and visual appeal of shutters and the highest level of response cost. The last group, 'denialists', perceived the least risk, a moderate level of shutter efficacy and visual appeal and the least response cost.

Figure 5.2

Cluster Group Relative Standing on Perceptual Factors



5.4.3 Clusters and mitigation behaviour

A chi-square test was used to determine the relationship between cluster groups and shutter installation intention. The results of the chi-square test show there was a significant association between cluster groups and shutter installation ($\chi^2(6)=41.98$, $p<0.001$).

Table 5.3 shows the number of people in each cluster group who have also installed cyclone shutters (group count). The expected count represents the projected number of respondents if there was no association between variables. The percentage of people from each cluster group who responded to each shutter installation option is also shown. Table 5.3

shows that most respondents who said they had already installed shutters belonged to the proactive cluster group. Similarily, the majority who were likely to install shutters in the future were also part of the proactive cluster group. Conversely, most of the respondents who said they were unlikely to install shutters in the future were either in the pessimists or denialists cluster groups.

Table 5.3

The Association Between Cluster Groups and Shutter Installation Behaviour

Cluster groups	Unlikely	Neither likely or unlikely	Likely	Already installed
Proactive group count	43	37	20	10
Proactive expected count	65	30	11	4
Proactive % within shutter installation response	23%	42%	63%	77%
Pessimist group count	63	12	3	1
Pessimist expected count	46	22	8	3
Pessimist % within shutter installation response	33%	14%	9%	8%
Denialists group count	83	39	9	2
Denialist expected count	78	36	13	6
Denialist % within shutter installation response	44%	44%	28%	15%

5.4.4 Clusters and demographic factors

Analysis identified demographic factors that differentiated cluster groups. Three types of statistical analysis were used depending on the scale of measurement. One-way analysis of variance was used for scale variables (e.g. age), Kruskal-Wallis H test for ordinal variables (e.g. income) and chi-squared for nominal variables (e.g. gender of respondent). Table 5.4 shows the variables that were significantly associated with cluster groups (p<0.05) and those that were not (p>0.05).

Table 5.4

Table Showing Factors that Differentiated Cluster Groups

Significant	Not Significant
Years in North Queensland (p=0.02)	Gender
Income (p=0.03)	Age
Education (p=0.01)	Dependent child
Cyclone Experience (p=0.02)	Marital status

Tukey post-hoc tests indicated that those in the proactive group (M=28.46, SD=18.18) had lived in North Queensland significantly longer than those in the pessimists group (M=21.43, SD=15.05). There was no significant difference between any other cluster pairs. The denialists group had the highest levels of income and education. Conversely, the proactive group had the lowest level of formal education and almost the lowest levels of income. The results also showed differences in types of cyclone experience. The pessimists group were more likely to have not experienced a cyclone, the denialists group were more likely to have experienced a cyclone causing no property damage and the proactive group were more likely to have experienced a cyclone that caused moderate property damage.

5.5 Discussion

This study identified the psychological factors that predict cyclone mitigation behaviour to develop groupings of people based on these factors. It was found, in accordance with the theory behind the PADM/PMT, that perceived risk, mitigation efficacy and low resource costs were significant predictors of behaviour. The perceived visual appeal of structural mitigation, an uncommonly investigated factor in previous research, was found to be one of the strongest predictors of mitigation behaviour. However, self-efficacy was not a significant predictor of shutter installation. This finding suggests that the perceived ability for a home owner to organise the installation of cyclone shutters does not inhibit mitigation intention or behaviour.

Respondents were categorised into three groups based on attitudes towards cyclones and structural mitigation. The proactive group, who scored highly on both threat and coping appraisal (using PMT terminology), were more likely to have installed shutters or were more likely to endorse installing them in the future. This contrasts with the denialists and pessimists groups who perceived lower levels of threat and coping appraisal. These two groups were less likely to have installed shutters and less likely to intend to do so in the future. In other words, protective behaviour is more likely to occur when people have high levels of both threat and coping appraisal. The difference in behaviour and intention between these groups provides further support for the usefulness of the PMT/PADM in predicting variations in behaviour. Future research could investigate if similar psychological clusters can be identified in different cyclone-prone regions (outside of North Queensland) and in relation to other natural hazards (e.g. floods).

This study shows that it is possible to differentiate cluster groups using demographic information. This finding has important practical implications. For example, governments and insurance companies interested in delivering tailored risk messaging can segment people using demographic data without having to assess attitudes towards cyclones and structural mitigation. However, it is important to highlight that while the results show that differentiating cluster groups based on demographic information is possible, more research is needed to explain why specific links were found. Future research should focus on whether it is possible to accurately identify psychological clusters using demographic factors. This research would allow stakeholders to confidently disseminate tailored messages based on demographic information.

Types of cyclone experience was also shown to differentiate cluster groups. The proactive group was more likely to have experienced moderate property damage from a cyclone compared to other groups. This suggests that previous experience with cyclone and damage helps people realise the damage potential of a cyclone as well as the importance of structural mitigation. This reasoning explains why people who have experienced a cyclone that did not cause property damage were more likely to have 'denialist' attitudes. Experience with a cyclone that results in no damage may lead to people discounting cyclones as a threat and, therefore, thinking that structural upgrades are not necessary.

Finally, the pessimists group was more likely to have not experienced a cyclone. Without direct experience, attitudes towards cyclones can only be formed from what they have seen or heard from other people. As such, they may have only heard about the destructive potential of cyclones (commonly reported in news media) without hearing about effective methods for mitigating damage. People in the pessimists group may think that cyclone damage cannot be avoided. These findings suggest that until property damage from a cyclone has been experienced first-hand, people are less likely to understand and acknowledge the benefits of structural mitigation. It is important and beneficial to find ways to give people the experience of a cyclone and its destructive potential without experiencing the event or the damage.

5.5.1 Communicating with cluster groups

The findings suggest that risk communication messaging aimed at promoting structural mitigation should be tailored to the target audience. As the pessimists group already acknowledge cyclones as a threat, they could be provided with information about the benefits of structural upgrades and how the long-term benefits of upgrades outweigh the upfront costs. The denialists group may benefit from messages that explain the damage potential of cyclones. The proactive group already have perceptions that are indicative of mitigation behaviour, so messaging should provide cues to make investing in structural mitigation easier. For example, insurance companies or governments could provide contact information for contractors who can install structural upgrades. Future research could investigate if this targeted approach to risk communication improves the uptake of structural upgrades in cyclone-prone regions.

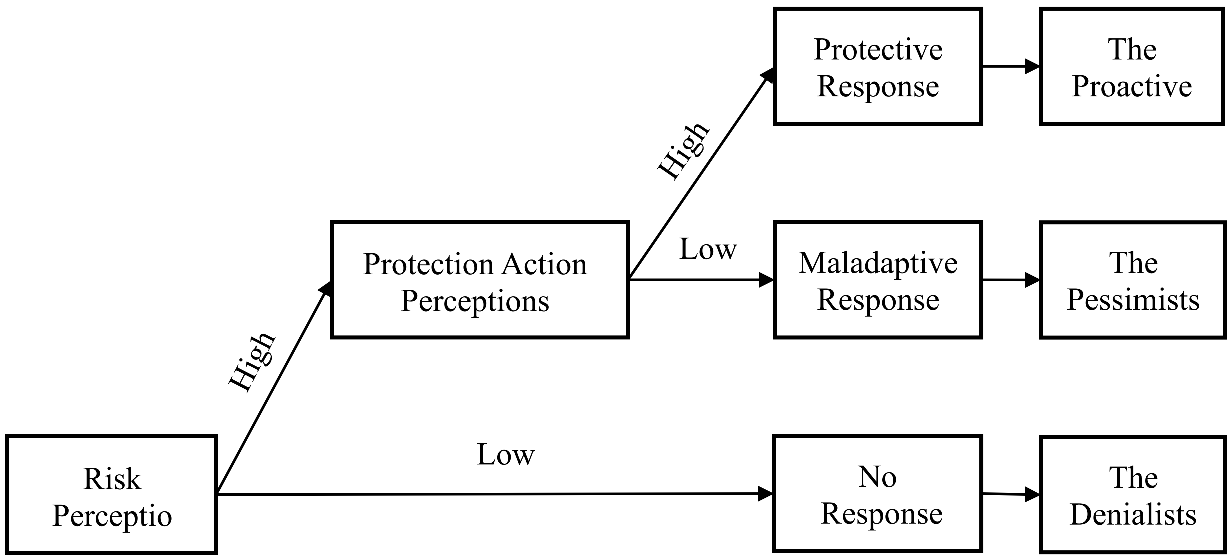
Paper Ends Here

5.6 Summary

Support was found for the first research question posed in this chapter, in that a simplified version of the adapted EV model can explain a significant proportion of the variability in structural mitigation intention/behaviour. More specifically, the results show that, as the model suggests, both *risk perception* and *protective action perceptions* are associated with higher levels of protective behaviour. As this component of the adapted model was mainly informed by the EPPM, the results also provide support for the EPPM as useful explanatory framework in this context. The study also provides further evidence that an EV based theory of human behaviour, in this case the EPPM, can explain the differences between groups in the population and is, therefore, a useful theoretical framework for informing how risk communication messaging should be tailored for specific groups. This targeted approach to communication is also supported by other research showing that people are at different stages of preparedness (Paton, 2019). Figure 5.3 shows the groups identified in this study and how they relate to the proposed adapted model.

Figure 5.3

The Association Between the Adapted Model and the Psychological Cluster Groups

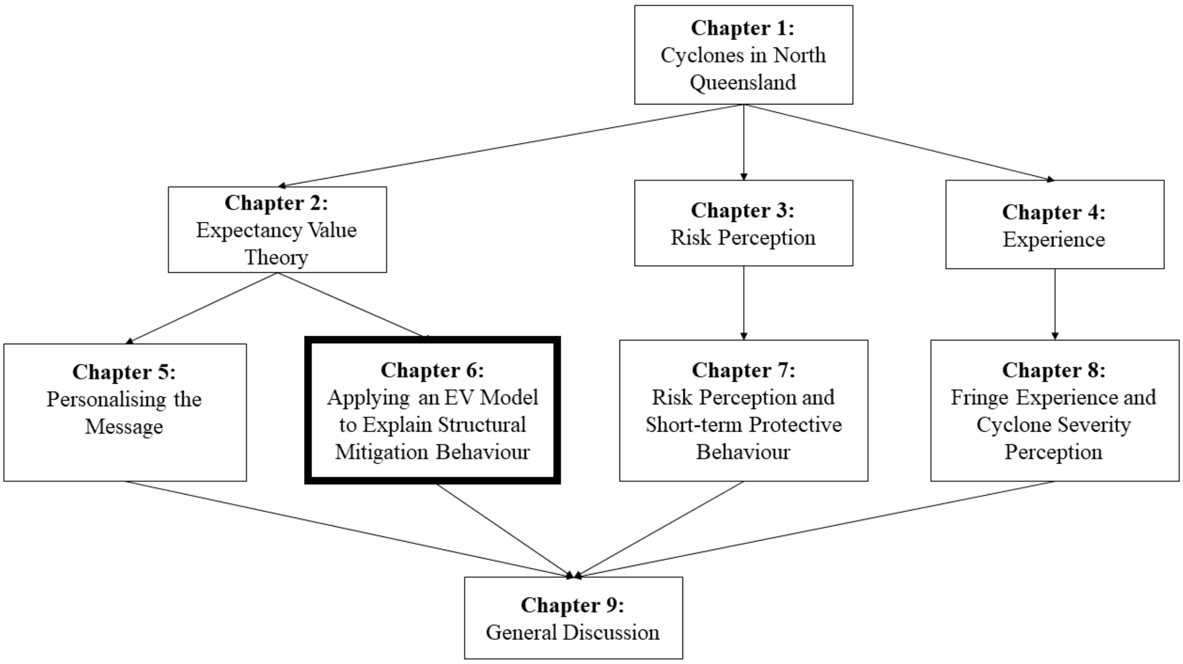


In response to the second research question, this study supports the claim made by Witte (1992) that there is only one pattern of cognition that reliably leads to protective behaviour. In this study, the 'proactive' were the cluster group that perceived the highest amount of threat (i.e., risk perception) and efficacy (i.e., high response efficacy in relation to low response cost). As predicted by the adapted theoretical model (and the EPPM), this group was the most likely to have either installed shutters or likely to do so in the future. As the 'denialists' had lower levels of shutter installation behaviour and intention, this association provides support for the hypothesised link between low levels of *risk perception* leading to *no response*. The 'pessimists' also had relatively low levels of shutter installation behaviour and intention, but the adapted model would explain that this is the result of a *maladaptive response* (opposed to *no response*) as the 'pessimists' had relatively high levels of *risk perception* but low levels of *response efficacy* in relation to *response cost*. Although specific types of *maladaptive responses* were not assessed in this study (e.g., wishful thinking or denial), the relatively low levels of shutter installation and behaviour are also indicative of a *maladaptive behaviour.* Overall, the findings show that perceiving a relatively high level of *risk perception* is necessary for a response to occur. It is, however, *protective action perceptions* that determine whether the response will lead to a protective behaviour. The following chapter will test the adapted model in more detail to identify the most important psychological factors for predicting the uptake of structural upgrades.

While not explicitly mentioned within the paper, the items used to assess both *response efficacy* and *response cost* were based on the items used by Terpstra & Lindell (2013). *Self-efficacy* was also assessed in similar way to past research, which uses one item to assess the extent to which one rates their own ability to perform a specific task (Bubeck et al., 2013, Poussin et al., 2014). Although multi-item measures are sometimes used to assess *self-efficacy* in disaster preparedness research, such scales assess more trait-based *self-efficacy* as opposed to task-specific *self-efficacy* (Kanakis & McShane, 2016; Paton et al., 2001). The perceived *visual appeal* of cyclone shutters was a new variable that had not been considered in past research. As such, *visual appeal* was added as a predictor to explore the extent to which it explains shutter installation status in addition to traditional *protective action perceptions* (i.e., *response efficacy* and *response cost*). Convergent and discriminant validity for *self-efficacy* and *visual appeal* was supported based on the extent to which these measures correlated with others psychological constructs in the study. The measures also had face validity as the items was reviewed and evaluated by the co-authors of the paper. As *visual appeal* did help to explain differences in shutter installation status, the following chapter explores in more detail how this additional factor relates to other *protective action perceptions* using principal components analysis.

Although it was not a primary aim of this chapter, the results provide preliminary evidence for the association between psychological factors, experience and demographic characteristics. In this study, the proactive group had the lowest level of both education and income, which suggests a negative association between these demographic characteristics and structural mitigation behaviour. It was also found that those with damage experience were more likely to be in the proactive group, which suggests a positive relationship between damage experience and mitigation behaviour. There was, however, no relationship with cluster groups and standard demographic characteristics like sex and age. These findings suggest that only demographic and experience factors that are related to skills and resourcing (e.g., income and education), and risk perception (e.g., first-hand experience with damage), may help to explain structural mitigation behaviour. The associations between demographic characteristics, experience, psychological factors and how they predict structural mitigation behaviour will be explored further in the next chapter.

Chapter 6: Applying an EV Model to Explain Structural Mitigation Behaviour



6.1 Rationale

As shown in Chapter 5, a simplified version of the adapted theoretical model can explain structural mitigation behaviour. The previous chapter also provides evidence for the psychological mechanism that leads to protective behaviour as hypothesised by the adapted model. The previous chapter, however, did not test all the components hypothesised to influence behaviour. Furthermore, Chapter 5 did not investigate the extent to which the adapted model explains protective behaviour above and beyond demographic and experience factors. As such, there are still several unanswered research questions regarding the predictive validity of the adapted model. The unanswered research questions are as follows:

1. Do the factors in the adapted model explain more variability in the uptake of structural mitigation behaviour than demographic factors and cyclone experience?
2. Do perceptions towards the protective action (i.e., *hazard related attributes* and *resource related attributes*) explain more variability in structural mitigation

behaviour/intention than perceptions towards cyclones as a hazard (i.e., *risk perception* and *hazard intrusiveness*)

3. Is *hazard intrusiveness* a significant predictor of structural mitigation behaviour/intention?
4. What is the best way to operationalise *protective action perceptions* in relation to cyclone specific structural upgrades?
5. Are higher perceived costs (i.e., *resource-related* attributes) associated with reduced levels of structural mitigation behaviour/intention?

The rest of this chapter has been accepted for publication in *Natural Hazards Review* as the following citation.

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6.2 Introduction

Tropical cyclones can cause severe wind-related damage to properties located in high-risk areas (Holmes, 2015; Pielke et al., 2008). There are, however, a range of long-term structural upgrades that can be installed to reduce this damage. Common upgrades include cyclone shutters, roof upgrades and windproofing sheds and roller doors (Smith et al., 2015). Although these upgrades have been shown to be effective, the uptake of these upgrades in cyclone-prone regions is still quite low (Scovell, McShane, Swinbourne, & Smith, 2018). This paper investigates the psychology behind people’s decision to invest in long-term cyclone mitigation to inform risk communication messaging aimed at promoting long-term cyclone mitigation behaviour.

Research to date has found many factors can influence mitigation behaviour in response to natural hazards (Bubeck et al., 2012; Lindell & Perry, 2000; Peacock, 2003). Of particular importance, however, is how an individual perceives natural hazards and their perception of their capacity to mitigate adverse outcomes flowing from the impact of the event (Bubeck et al., 2012; Lindell & Perry, 2000; Peacock, 2003). These findings suggest that people's attitude towards a threat is one of the strongest predictors of how they will respond (Eagly & Chaiken, 1993; Morrison, Bennett, Butow, Mullan, & White, 2012). The link between attitude and behaviour provides the theoretical underpinning for two commonly applied psychological models: The Protection Motivation Theory (PMT) and The Protective Action Decision Model (PADM). The theory behind both models suggests that for a protective response to occur, an individual must both perceive a threat and feel they can do something about the threat (Fishbein & Ajzen, 1975; Lindell & Perry, 2012; Rogers, 1975). This paper aims to test the appropriateness of a model based on the PADM and the PMT for predicting long-term cyclone mitigation behaviour.

6.2.1 The Importance of Attitudes

Although the PADM and the PMT have similar theoretical underpinnings, the conceptualisation of variables within the models is different. The theory behind both models suggests that perceiving something can be done about a threat is an important factor for explaining protective behaviour. However, different terminology is used depending on the model. Under the PMT model, the perceived ability to do something about the threat is referred to as *coping appraisal* (Rogers, 1975). Whereas this component is labelled *hazard adjustment attributes* within the PADM framework (Lindell & Perry, 2012). *Coping appraisal* is hypothesised to include three variables: *self-efficacy, response efficacy* and *response cost.* In a hazard mitigation context, *self-efficacy* is the perceived ability to perform mitigation behaviour; *response efficacy* is the perceived effectiveness of the behaviour at mitigating damage and *response cost* is the perceived cost of the mitigation behaviour in terms of money, time and effort (Grothmann & Reusswig, 2006). Variables within the PADM's *hazard adjustment attributes* category are not as tightly defined (Lindell & Perry, 2012). However, these attitudes are usually broken up into two subcategories: *hazard-related attributes* and *resource-related attributes* (Lindell & Perry, 2012). Examples of *hazard-related attributes* are the perceived efficacy of mitigation behaviour (similar to *response efficacy*) and perceived utility for other purposes (Lindell, 2013; Terpstra & Lindell, 2013). As such, the conceptualisation of *response efficacy* within the PADM extends beyond just the perceived efficacy for mitigating damage.

The main difference between the PMT and the PADM is the conceptualisation of *response cost* and *self-efficacy.* In the PADM, this component is defined as *resource-related attributes* and includes perceived cost, effort and knowledge required to complete a mitigation behaviour (Lindell, 2013; Terpstra & Lindell, 2013). A benefit of splitting up these variables is that researchers can assess the influence of each variable separately (Terpstra & Lindell, 2013). For example, in a cyclone mitigation context, perceiving an action as expensive may be relevant but perceiving an action as taking a long time to install may not. The traditional application of the PMT combines these factors and considers them all a *response* cost (e.g., Bubeck et al., 2013; Poussin et al., 2014). Combining variables in this way is problematic when the model is applied to understand mitigation behaviours that require adjustments to a structure (e.g., cyclone mitigation) as people, for the most part, cannot install structure upgrades themselves. In this case, the monetary cost may be an important factor whereas time and effort may not. As such, the PADM framework is more applicable in this context as it helps to unpack *response cost* and identify which factors are the most relevant.

While conceptually different, research has supported the explanatory value of both models. In particular, studies investigating natural hazard mitigation have found that the *coping appraisal* variables or *hazard adjustment attributes* are the strongest predictors of mitigation behaviour (Bubeck et al., 2013; Grothmann & Reusswig, 2006; Terpstra & Lindell, 2013). In other words, people who have favourable attitudes toward mitigation behaviour are more likely to perform these behaviours. Health promotion research also supports the importance of these attitudes. Two meta-analysis studies found that *coping appraisal* variables are strong predictors of protective health behaviours (Floyd et al., 2000; Milne et al., 2000). However, it is unclear to date if *coping appraisal* (or *hazard adjustment attributes*) helps to explain long-term cyclone mitigation behaviour. Most of the research to date has focused on flood and earthquake mitigation behaviour (Bubeck et al., 2012; Lindell & Perry, 2000). As cyclone mitigation requires different behavioural responses concerning time, effort and cost, it is essential to test the validity of this type of model in this different context.

6.2.2 Research to Date

Only a few studies to date have applied psychological theory to explain long-term cyclone mitigation behaviour (e.g., Ge et al., 2011; Lindell & Hwang, 2008; Peacock, 2003). These studies used an adapted PADM framework, which did not include any *hazard adjustment attribute* variables. Researchers found that hurricane experience, hurricane risk perception and hurricane knowledge are significant predictors of hurricane mitigation behaviour (Lindell & Hwang, 2008; Peacock, 2003). Another study applied a similar framework to predict expectations to participate in various cyclone mitigation incentive programs (Ge et al., 2011). Ge et al. (2011) found that risk perception and hazard intrusiveness (the degree to which someone thinks and talks about cyclones) were the strongest predictors of expectations but, again, did not include *hazard adjustment attributes* in their model. Not including these variables presents a potential gap in the current understanding of what psychological factors predict long-term cyclone mitigation behaviour.

While researchers have not applied *hazard adjustments attributes* in a cyclone mitigation context, studies suggest such these variables do predict flood and earthquake mitigation behaviour. More specifically, studies including *hazard adjustment attribute*s in their models have found that the *hazard-related attributes* (i.e., the perceived efficacy and utility of a mitigation measure) are usually the strongest predictors of behaviour (Lindell & Perry, 2003; Lindell & Perry, 2012; Terpstra & Lindell, 2013). Two earthquake studies operationalised *hazard-related attributes* as a single variable based on combining the perceived efficacy of a mitigation measure for protecting people, property and its utility for other purposes. These studies found that *hazard-related attributes* correlated with household mitigation intentions, but *resource-related attributes* did not (Lindell & Prater, 2002; Lindell & Whitney, 2000). That is, perceiving mitigation efficacy was important but the installation cost was not. A flood study using the same operationalisation of variables found similar results. Terpstra and Lindell (2013) found that while *resource-related attributes* were significant predictors of flood mitigation intentions, *hazard-related attributes* were the strongest predictors of intention. While these studies do support the importance of *hazard adjustment attributes* for predicting some mitigation behaviours it is unclear if they explain long-term cyclone mitigation behaviour.

Long-term cyclone mitigation behaviour is unique compared to common household preparedness behaviours. Structural upgrades (e.g., installing cyclone shutters) are relatively expensive and need to be installed in the absence of a threat (i.e., no cyclone warning). Most research applying the PADM has focused on relatively low-cost behaviours that can be performed in response to an immediate threat. For example, Lindell and Prater (2002) assessed earthquake mitigation behaviours such as purchasing and maintaining a transistor radio, first aid kit and fire extinguisher. Another studying focusing on flood preparedness assessed intentions to prepare an emergency kit, create a household plan and use sandbags (Terpstra & Lindell, 2013). Compared to long-term cyclone mitigation, these behaviours are quite inexpensive. Installing cyclone shutters, for example, can cost a household around $AU3000 (Smith et al., 2015). Whether or not the PADM can explain more costly behaviours that need to be installed in the absence of an immediate threat is, to date, unclear.

Studies focusing on long-term mitigation have done so using the PMT framework. Although, as highlighted earlier, the conceptualisation of *resource-related attributes* is not the same in the PMT so it is difficult to compare findings directly. Nevertheless, findings from these studies suggest that the perceived monetary cost of a mitigation measure may be relevant when considering some structural upgrades. For example, Poussin et al. (2014) found that people installed fewer structural measures (e.g., raised the ground floor above flood level and installed anti-backflow valves on pipes) if they perceived them as costly. However, another study that measured structural flood mitigation did not find any relationship with *response cost* and behaviour (Bubeck et al., 2013). These studies suggest that the perceived cost may only be relevant for certain upgrades as they both assessed different structural measures. As cyclone mitigation is particularly costly, it is essential to consider the relevance of perceived cost in future research.

6.2.3 Additional Variables

Another potential reason for the unclear link between *resource-related attributes* mitigation behaviour is that the operationalisation of this factor may not be capturing all the barriers. As highlighted by Terpstra and Lindell (2013), studies applying different theories in which *resource-related attributes* are defined as a personal attribute, rather than the individual's perception of a specific behaviour, found stronger relationships. For example, *self-efficacy* is usually operationalised as the overall perceived ability to perform a task, regardless of the task's specific knowledge or skill requirement. This type of *self-efficacy* is not included in the PADM framework. However, while *self-efficacy* is a strong predictor of protective health behaviours (Floyd et al., 2000; Milne et al., 2000), *self-efficacy* may only be necessary for behaviours that require skill and perseverance (Weinstein, 1988). As such, higher levels of perceived *self-efficacy* may not be necessary for the installation of structural upgrades as, although upgrades require skill to install, the labour is usually delegated to someone other than the homeowner. Furthermore, no perseverance is required as once the upgrade is installed the upkeep of the protection requires little to no maintenance. The only *self-efficacy* required in most cases is the perceived ability to organise someone else to install the upgrades for them and may, therefore, be a form of a *resource-related attribute*. Regardless, *self-efficacy*, conceptualised as a personal attribute, has yet to be considered alongside other PADM variables in natural hazard research.

Other additional contextual factors may also help to explain long-term mitigation behaviour. One unique aspect of cyclone mitigation is that it can drastically change the appearance of a house. To date, it is unclear if this is something that people that think about when considering cyclone mitigation. Some researchers suggest that the perceived market value of structural mitigation may influence behaviour (Kunreuther, 2006; Simmons & Sutter, 2007). That is, the more someone economically values a mitigation measure, the more likely they are to install it. Results from a survey studying attitudes towards flood mitigation found that 39% of the sample thought that installing mitigation would not increase their property value (Thurston et al., 2008). The researchers did not, however, investigate how this attitude affects behaviour. Beyond this study there is minimal empirical research investigating how the perceived market value of structural mitigation influences behaviour. Understanding the influence of perceived market value is particularly relevant for cyclone mitigation as some structural upgrades (e.g., cyclone shutters) can change the appearance of a house significantly. As such, the perceived visual appeal of cyclone shutters could also affect their perceived market value (or vice versa). The degree to which perceived visual appeal and market value of a structural upgrade affect mitigation behaviour is an empirical question that has yet to be addressed.

6.2.4 Present Study

The present study aims to use a more complete version of the PADM to explain cyclone mitigation behaviour. This study will also investigate the relationship between mitigation behaviour and demographic factors, but due to inconsistent relationships between these variables in past research, the nature of the specific relationships are not hypothesised (Bubeck et al., 2012; Kellens et al., 2013; Lindell, 2013). The present study will also assess hazard intrusiveness, risk perception and cyclone experience due to its relevance in past natural hazard mitigation research (Baker, 1991; Ge et al., 2011; Lindell, 2013; Lindell & Whitney, 2000). Based on the theory behind the PADM/PMT and empirical research to date, a number of hypotheses were tested:

1. The psychological factors within the PADM will explain additional variability in behaviour beyond demographic and experience factors. Moreover, when psychological variables are added into the model, demographic predictors will no longer be significant predictors
2. *Hazard Intrusiveness* will be a stronger predictor of behaviour than *risk perception*.
3. Both *hazard-related attributes and resource-related attributes* will be significant predictors of behaviour, but *hazard-related attributes* will be a stronger predictor of behaviour than *resource-related attributes*.
4. Both *hazard-related attributes and resource-related attributes* will be stronger predictors of behaviour than *risk perception*.
5. *Self-efficacy* will not be a significant predictor of mitigation behaviour.

6.3 Method

6.3.1 Participants/Procedure

This study used a cross-sectional survey design to assess variables of interest (more information in the materials section). Respondents had to be currently living in coastal North Queensland, Australia (between Cairns and Rockhampton) to participate. The survey was available both online and as a paper version. A majority of the participants were recruited online via a Facebook page, which was created to provide information about the study and a link to the survey. The present study's Facebook page was shared by other weather-related Facebook pages (e.g., Oz Cyclone Chasers) to reach a broader audience. Information about the survey was also disseminated via local media outlets (newspaper, radio and TV) in various locations throughout North Queensland.

Although this survey was part of a larger research project, only respondents who were homeowners and provided information about their shutter installation status were included in the subsequent analysis. This resulted in total of 339 respondents. There were 227 females (67%), and 112 males (33%) and half of the sample (N = 170, 50.1%) had at least one dependent child. The age of the respondents ranged from 18 to 76 with a mean age of 47.41 (SD = 11.85). A majority of the sample was married (67.8%); 19.2% were partnered, and 7.1% were single. There was a relatively even spread in relation to income and education levels: 31.5% reported their household earnt less than $80000 (AUD) a year, 30.7% reported between $80000 and $125000 (AUD) and 33.7% reported more than $125000; 20.6% reported they completed High School, 34.5% had either a certificate or a diploma and 44.3% had a bachelor degree or higher.

6.3.2 Variables

6.3.2.1 Outcome Variable. Intention to install cyclone shutters or past installation was the mitigation behaviour of interest in this study. Cyclone shutter installation status was chosen as it is one of the only cyclone mitigation behaviours that can be performed by all homeowners. Other recommended structural upgrades can only be installed on specific types of houses. For example, due to code changes in Queensland (location of the study population), most homes built after 1982 have roofs built to withstand cyclonic winds. As such, only houses built before 1982 require complete roof upgrades. Cyclone shutters, on the other hand, are not currently mandated by any legislation in Queensland and can be installed on any house, regardless of age. Thus cyclone shutter installation status was deemed the most appropriate measure of a volitional long-term mitigation behaviour.

Cyclone shutter installation status was assessed using a four-level ordinal variable. Cyclone shutter installation status was created by combining a measure of both behaviour and intentions. First, individuals were asked if they had installed cyclone shutters on their property[5]. Individuals that said no to having installed cyclone shutters were then asked to report how likely they were to install cyclone shutters in the next five years. Intention to install cyclone shutters and cyclone shutter installation were then combined to create the *shutter status* outcome variable. Scores for *shutter status* ranged from one to four with one indicating the respondent is 'extremely unlikely' or 'unlikely' to install shutters and four indicating the responded had already installed shutters. Table 6.1 shows the frequency of responses to *shutter status* variable.

[5] In the survey respondents were asked if cyclone shutters had been installed, not if they had installed the shutters themselves. See question wording in Appendix B.

Table 6.1

Frequency Distribution of Responses to Cyclone Shutter Status

Shutter status	Frequency	Percentage
Extremely unlikely – unlikely	201	59.3
Slightly unlikely – slightly likely	91	26.8
Likely – extremely likely	33	9.7
Already installed	14	4.1

6.3.2.2 Predictor Variables.

6.3.2.2.1 Demographics. Respondents were asked to provide information about their demographic information by responding to closed answer questions. The pattern of responses on these demographic questions was seen in the Participants section above.

6.3.2.2.2 Experience. Cyclone experience was assessed using an ordinal variable. The cyclone experience variable had five levels: no experience; experience but with no damage; experience with minimal damage; experience with moderate damage and experience with high damage. These values were then coded from one to five in the order presented.

6.3.2.2.3 Risk Perception. *Risk perception* was operationalised in a similar manner to past research (Ge et al., 2011; Lindell & Hwang, 2008). *Risk Perception* was scored on a seven-point scale with higher scores indicating a greater perception of risk. *Risk perception* was created by averaging scores on five subscales ($\alpha = .737$). Subscales assessed how likely people thought that a cyclone would cause property damage, disrupt their daily life or negatively affect their mental or physical health.

6.3.2.2.4 Hazard Intrusiveness. The operationalisation of *hazard intrusiveness* was also based on past research (Ge et al., 2011). *Hazard intrusiveness* was assessed by asking respondents how often they thought about and discussed cyclones and cyclone-related safety issues (α =.77).

6.3.2.2.5 Hazard Adjustment Attributes. There were a total of 10 questions used to assess individual perceptions of hazard adjustments. Seven of the questions were adapted from a past study (Terpstra & Lindell, 2013). Three additional items were added to assess new, and potentially independent, constructs: *increases value, visual appeal* and *household efficacy*. *Self-efficacy* was renamed *household efficacy* as it may be that the respondent is not the individual responsible for organising the upgrade to be installed in their household. The description of the variables can be seen in Table 6.2. The grouping of these factors is based on the Principle Components Analysis presented in the Results section. For factors with more than one subscale, the values were summed and averaged.

Table 6.2

Perception of Hazard Adjustments

Items	Higher scores indicate stronger agreement that cyclone shutters…
Shutter efficacy	
Reducing damage	Are effective for reducing property damage and associated costs.
Increasing safety	Are effective for increasing family's safety.
Shutter benefits	
Utility	Are useful for other purposes besides protecting property.
Increases value	Increase property value.
Visual appeal	Cyclone shutters are visually appealing
Resource-related attributes	
Monetary cost	Are expensive to install.
Time & effort	Take a long time and a lot of effort to install.
Knowledge/skill required	Take a lot of skill and knowledge to install.
Cooperation required	Require a lot of help/cooperation from others.
Household efficacy	
Household efficacy	I, or a member of my family, have the ability to organise for shutters to be installed by professionals

6.4 Results

6.4.1 Principal Components Analysis

The number of *hazard adjustment attributes* were reduced using Principal Components Analysis (PCA). Table 6.3 shows the factors (in bold) that were created based on the PCA using Varimax rotation. Two main points of inflection were identified on the scree plot at point five and three (as seen in Figure 6.1). As such, the rotated component matrices were compared for a two-factor solution compared to a four-factor solution. As seen in Table 6.3, the main difference between a two-factor solution and four-factor solution is the separation of the *household efficacy* factor, and the separation of *visual appeal increases value* and *utility* from *reducing damage* and *improving safety*. Based on previous research arguing the conceptual difference between *self-efficacy* and other *hazard adjustment attributes* the four-factor solution was chosen. Moreover, the commonalities of all variables were over .65, and the sample size was over 300 providing further support for the four-factor solution even though this is associated with an eigenvalue less than 1 (Field, 2009).

Figure 6.1

Screen Plot from the Principal Component Analysis

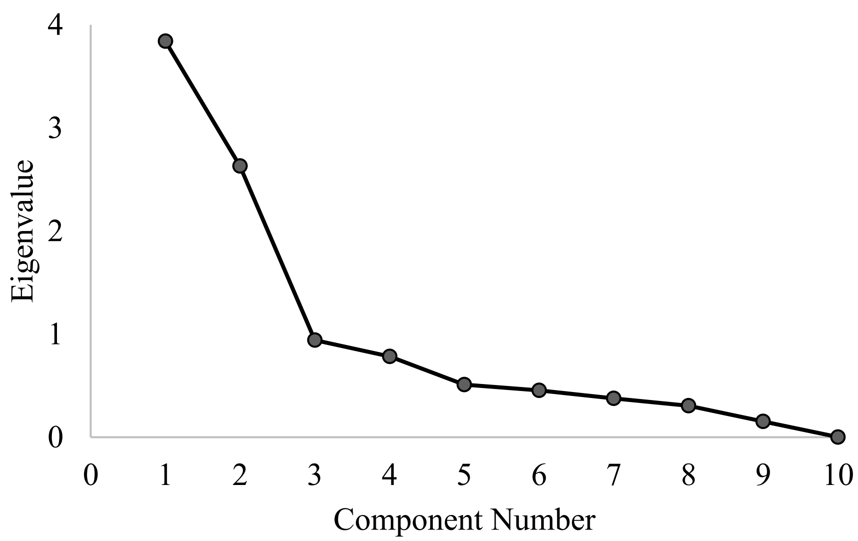


Table 6.3

Rotated Component Matrix for a Two-factor and Four-factor Solution

	Two-Factor Solution		Four-Factor Solution			
	1	2	1	2	3	4
Reducing damage	0.80			0.92		
Increasing safety	0.86			0.89		
Utility	0.81			0.53	0.60	
Increases value	0.77			0.32	0.81	
Monetary cost		0.99	0.99			
Time & effort		0.85	0.85			
Knowledge/skill		0.87	0.87			
Cooperation required		0.81	0.82			
Visual appeal	0.66				0.86	
Household efficacy	0.43					0.97

6.4.2 Correlations

Bivariate correlation coefficients were calculated to identify relationships between all of the variables. As seen in Table 6.5, many demographic factors were associated with *shutter status*: older age, not having a dependent child, more years in their current location, less income and less education. The sex of the respondent and their cyclone experience had no association with *shutter status*. All of the psychological variables assessed were significantly correlated with *shutter status*

Table 6.4

Correlations Between all Variables Assessed

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Shutter Status	1.59	.83	1													
2. Age	47.41	11.85	.16**	1												
3. Female	.67	.47	-.06	-.01	1											
4. Dependent Child	.50	.50	-.16**	-.36**	-.02	1										
5. Years in Location	14.24	12.43	.12*	.23**	-.07	-.11*	1									
6. Education	2.99	1.37	-.17**	-.14**	.01	.06	-.16**	1								
7. Income	3.84	1.20	-.11*	-.35**	-.07	.30**	-.08	.32**	1							
8. Cyclone Experience	2.85	1.05	.05	.05	.07	.04	.20**	-.07	-.08	1						
9. Risk Perception	5.11	1.05	.12*	-.05	.12*	.03	.05	-.16**	-.08	.19**	1					
10. Hazard Intrusiveness	4.17	1.64	.21**	.08	-.11*	.04	.05	-.10	-.06	.19**	.43**	1				
11. Shutter efficacy	4.24	1.34	.35**	.08	-.14*	-.07	.05	-.05	.11*	-.02	.10	.09	1			
12. Shutter benefits	4.31	1.26	.39**	.08	-.10	-.05	.11*	-.18**	-.09	.04	.11*	.17**	.59**	1		
13. Resource related	4.48	1.25	-.17**	-.10	.04	.07	.00	-.03	-.13*	.08	.22**	.10	-.15**	-.18**	1	
14. Household efficacy	5.16	1.71	.17**	-.05	-.18**	.04	.06	.06	.13*	-.10	.03	-.01	.32**	.26**	-.13*	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).
Sample size (N) ranges from 339 to 330 depending on missing data.

6.4.3 Regression

The variables that significantly correlated with *shutter status* were then included in an ordinal hierarchical regression analysis. Three separate models were created: Model 1 only included demographics; Model 2 included risk perception/hazard intrusiveness and Model 3 included the additional perceptual factors. As seen in Table 6.5, Model 3 explained the most variability (30%) and had the strongest predictors of *shutter status*. With all variables included only *hazard intrusiveness, shutter benefits* and *resource-related attributes* were significant predictors of *shutter status*.

Table 6.5

Ordinal Regression Predicting Shutter Status

	Model 1		**Model 2**		**Model 3**	
Variables	**Estimate**	**Sig**	**Estimate**	**Sig**	**Estimate**	**Sig**
Dependent Child	.40	.11	.54*	.04	.45	.10
Age	.02	.07	.02	.13	.02	.17
Years in Location	.01	.51	.01	.59	-.01	.85
Education	-.19*	.03	-.14	.11	-.05	.58
Income	-.02	.82	.01	.99	-.10	.40
Risk Perception			.12	.30	.16	.24
Hazard Intrusiveness			.26**	>.01	.30**	>.01
Shutter efficacy					.19	.14
Shutter benefits					.46**	>.01
Resource related					-.37**	>.01
Household efficacy					.11	.19
Nagelkerke R^2	.07		.14		.31	

6.5 Discussion

This study applied the PADM as a theory for explaining long-term mitigation behaviour. Supporting past research, it was found that psychological factors within the PADM were the strongest predictors of behaviour (Ge et al., 2011). More specifically, the perceived benefits of installing structural upgrades, the perceived costs involved and the degree to which people think and talk about cyclones were the strongest predictors of behaviour. The present study also found that demographic factors did not predict shutter installation status when psychological variables were included in the model. Most of these findings are supported by past research, but this study also identified additional factors that have not been considered in past research. As such, the results have implications for improving the explanatory power of the PADM.

A finding unique to this study was that people who were more likely to install shutters (or had already installed them) perceived more secondary benefits like increased property value, visual appeal and utility for other purposes. After controlling for perceived benefits, perceiving cyclone shutters as effective for reducing damage and increasing safety (the main purpose for shutters) did not significantly predict mitigation intention/behaviour. This result contradicts past flood mitigation research where perceived safety increase was the strongest predictor of mitigation behaviours, above the perceived utility for other purposes (Terpstra & Lindell, 2013). However, these past researchers were only assessing short-term mitigation behaviours as opposed to long-term structural upgrades. The perception that mitigation behaviour has secondary benefits may only be particularly important when adjustments to a property are necessary. Future research should investigate if these secondary benefit factors are as important for structural mitigation for other natural hazards. It may be the case that for costly mitigation measures that require structural changes it is not enough to think that they are effective, they also need to be considered a worthwhile investment.

In addition to perceiving benefits, *resource-related attributes* was also a significant predictor of behaviour. This finding contradicts past research where *resource-related attributes* are either weak or non-significant predictors of mitigation behaviour (Lindell & Prater, 2002; Lindell & Whitney, 2000; Terpstra & Lindell, 2013). The difference between these studies may be due to the type of behaviour. As mentioned in the introduction, cyclone mitigation is objectively more costly compared to flood mitigation and this seems to have an effect on the perceived cost as well. Beyond monetary cost, installing structural upgrades also requires more knowledge/skill, cooperation from others and time/effort, which were all included in the measure of *resource-related attributes*. This finding provides additional support for the theory behind the PADM and highlights the importance of *resource-related attributes* for predicting long-term cyclone mitigation.

The present study also reinforces the importance of including *hazard intrusiveness* as a factor within the PADM. The present study, replicating past research, found that thinking and talking about cyclones was a stronger predictor of mitigation behaviour than *risk perception* (Ge et al., 2011). The theory behind the PADM, however, does not provide an explanation for this finding. One explanation may be that *hazard intrusiveness* is more likely to capture people thinking about cyclones with a protective mindset, whereas *risk perception* may be assessing fear. If so, it is understandable that *risk perception* does not predict behaviour as perceiving too much threat can lead to a non-protective response such as avoidance or denial (Morrison et al., 2012). People who are thinking and talking about cyclones and cyclone mitigation more often may be less likely to think about cyclone damage in a fatalist way. That is, thinking of cyclones as threats whose impacts cannot be avoided. Other researchers have suggested that *hazard intrusiveness* may lead to protective behaviour as it may be indicative of other clinical constructs such as *rumination* and *preoccupation* (Wei & Lindell, 2017). Future research should focus more on *hazard intrusiveness* to further understand its unique influence on mitigation behaviour. In particular, such research should focus on the content of thoughts and discussion regarding cyclones and mitigation.

Understanding the difference between *hazard intrusiveness* and *risk perception* has implications for messaging aimed at promoting mitigation behaviour. For example, instead of informing people about the likelihood and severity of a cyclone (as seen in current messaging), people should be encouraged to think and talk about cyclones, and cyclone mitigation, more regularly. *Hazard intrusiveness* may be particularly important for long-term mitigation when the decision to install such measures is required in the absence of an immediate threat. In other words, thinking about the likelihood and severity of a cyclone once or twice a year may not be salient enough to change behaviour, whereas consistently thinking and talking about cyclones and cyclone mitigation may be the mechanism in which an idea can change into a behaviour. Future research may consider applying a stage model of behavioural change (e.g., The Transtheoretical Model) to investigate how people make decisions over time. This may help to determine when and why *hazard intrusiveness* is important.

One limitation of this study was that only one outcome variable was measured. As such, it is difficult to generalise findings to other mitigation behaviours. Future research should consider investigating other long-term cyclone mitigation adjustments (e.g., roof upgrades). It may also be useful to look at long-term mitigation behaviours in response to other natural hazards (e.g., raising the bottom floor to mitigate food damage).

6.5.1 Implications

For a protective response to occur an individual's attitudes should be congruent with the behaviour. This study shows that there are specific attitudes that relate to long-term cyclone mitigation behaviour. With this knowledge, future messaging to homeowners should focus on changing a few particular attitudes. Specifically, people's attitudes towards cyclone mitigation. Future messaging should, first, demonstrate to people the benefits of cyclone mitigation, such as increased property value, and that these benefits outweigh the costs. Second, people should be encouraged to think and talk about cyclones more often. Risk communication aimed at promoting long-term mitigation should consider ways in which thoughts about cyclones can be less threatening and occur more frequently in everyday life as opposed to being threatening in nature and occurring less often.

The findings also highlight a broader societal barrier. That is until people perceive that the market rewards of long-term mitigation, the uptake of structural upgrades may remain low. If it is not perceived to be economically viable to install upgrades, it is understandable that people will not install them. The government and insurance companies can help in this area by providing incentives to homeowners to install mitigation measure. If there are enough people that install cyclone mitigation, eventually, more people may start to consider upgrades due to social influence. Future programs aimed at promoting cyclone mitigation should consider how to make people become more aware of the mitigation status of the people around them.

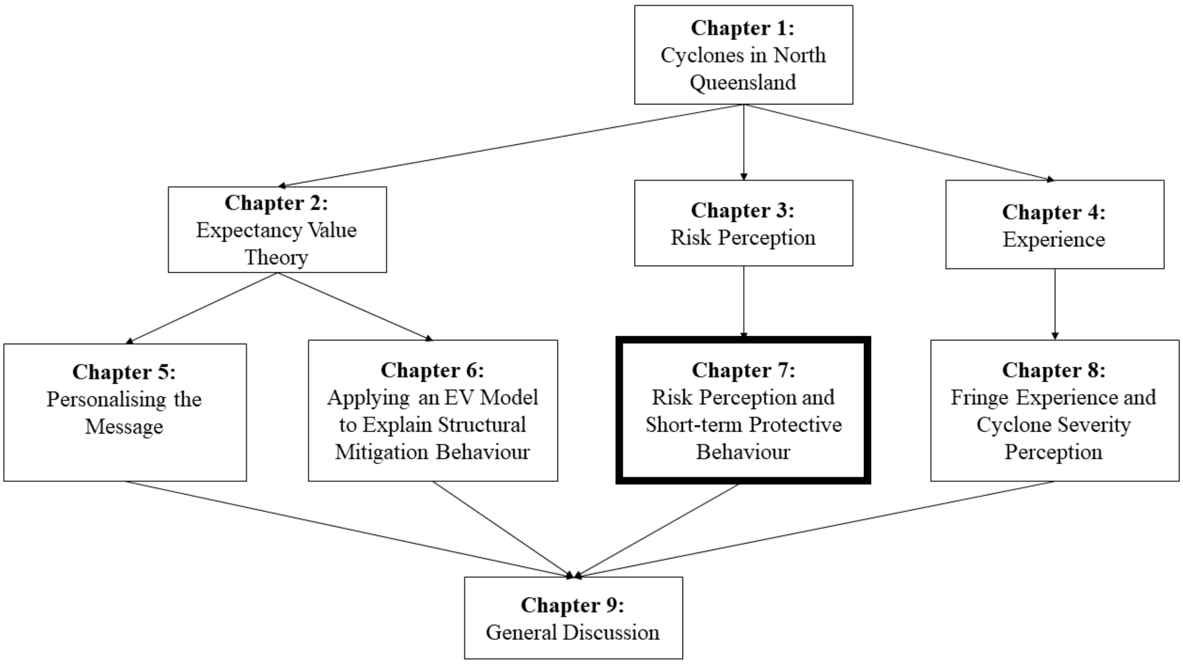
Paper Ends Here

6.6 Summary

This chapter provides further empirical support for the adapted model as outlined in Chapter 2. Supporting one of the hypothesised links in Chapter 2, *hazard intrusiveness* was found to be one of the strongest predictors of structural mitigation behaviour. Future research should explore in more detail why *hazard intrusiveness* is important for explaining structural mitigation behaviour, as there is currently not a strong theoretical explanation for this link in the literature. It was also found that the perceived secondary benefits of structural upgrades (e.g., increased property value) is a stronger predictor of structural mitigation behaviour/intention than the perceived primary benefits (e.g., efficacy for reducing damage). Moreover, the results indicate that higher perceived costs associated with installing structural upgrades (i.e., time, money and knowledge requirement) means that people are less likely to install structural upgrades. The findings suggest that the decision to invest in structural upgrades is primarily motivated by the perceived benefits of upgrade in relation to the cost.

This chapter also found that when controlling for *hazard intrusiveness* and *protective action perceptions, risk perception* did not predict structural mitigation behaviour/intention. This result contradicts the adapted theoretical model, which proposes that when controlling for *protective action perceptions* higher levels of *risk perception* should tend to lead to a greater protective responses. One explanation for this finding could be due to the operationalisation of *risk perception*. The present chapter used the commonly applied cyclone risk perception scale created by Peacock et al. (2005) to assess *risk perception.* However, as argued in Chapter 3, this operationalisation does not control for the influence from objective risk and does not appropriately capture the differences in how people perceive the severity of cyclones (both cognitively and emotionally). The following chapter will test whether a different way of operationalising *risk perception* has a stronger relationship with protective behaviour when controlling for *protective action perceptions* and *hazard intrusiveness*.

Chapter 7: Risk Perception and Short-term Protective Behaviour



7.1 Rationale

Although most EV theories suggest that higher *risk perception* should be associated with a greater protective response (Lindell & Perry, 2012; Rogers, 1975; Witte, 1992), empirical studies have found inconsistent evidence to support this link (Bubeck et al., 2012; Lindell, 2013). The results of the previous chapter provided further evidence that *risk perception* is not always a significant predictor of protective behaviour. As discussed in Chapter 3, an explanation for the inconsistent link between *risk perception* and protective behaviour is the way in which *risk perception* has been conceptualised and/or operationalised in past research. Specifically, few studies acknowledge objective differences in risk and how it might affect *risk perception* and protective behaviour. Past research has also overlooked the importance of emotional appraisal in relation to perceived hazard consequences. The current chapter aims to address these issues.

An additional aim for this chapter is to explore a different type of behavioural response. As discussed in Chapter 1, both general preparedness (e.g., boarding up windows) and structural mitigation (e.g., installing cyclone shutters) are important for reducing cyclone related property damage. While the last two chapters investigated predictors of structural mitigation behaviour, this chapter focuses on short-term protective behaviours such as general preparedness and evacuation intention. The relative importance of psychological factors for predicting long-term and short-term cyclone mitigation behaviour are compared and four main research questions are addressed:

1. Does an adapted EV model explain both evacuation intention and general preparedness intention in response to an imminent cyclone threat?

2. To what extent do changes in objective hazard severity influence protective intention?

3. When controlling for hazard severity, hazard likelihood and protective action perceptions, to what extent does risk perception influence short-term protective intention?

4. Does the anticipated emotional consequences associated with predicted damage influence protective intention?

The subsequent content of this chapter has been submitted as a paper to *Risk Analysis*.

Paper Starts Here

7.2 Introduction

Promoting protective behaviour at the individual level has been shown to reduce natural hazard vulnerability (Pinelli, Torkian, Gurley, Subramanian, & Hamid, 2009; Smith, Henderson, & Ginger, 2015). However, people tend to underprepare for low probability, high consequence events (Scovell, McShane, Swinbourne, & Smith, 2018; Terpstra & Gutteling, 2008). It is, therefore, important to understand why some individuals prepare and others do not. Many researchers have hypothesised that differences in *risk perception* are one of the key determinants of why some people prepare more than others (Bubeck, Botzen, & Aerts, 2012; Meyer & Kunreuther, 2017). Although most relevant psychological theories would support this claim, much of the empirical research has found inconsistent links between *risk perception* and natural hazard preparedness behaviour (Bubeck & Botzen, 2013; Lindell, 2013; Lindell & Whitney, 2000; Siegrist & Gutscher, 2006). This paper will highlight some conceptual and methodological issues seen in past research and propose a new method of testing the link between *risk perception* and protective behaviour. Applying this broader research question to a specific context, this paper will focus on the relationship between *risk perception* and protective behaviour in response to tropical cyclones.

7.2.1 Expectancy Value theories

Most studies investigating natural hazard mitigation behaviour use Expectancy Value (EV) based theories of human behaviour (Bubeck et al., 2012; Lindell & Perry, 2012). Two of the most commonly applied theories in this area are the Protection Motivation Theory (PMT) and the Protective Action Decision Model (PADM). While there are some differences between these theories, they both posit that there are two main psychological factors that explain protective behaviour: perceiving an appropriate level of risk and believing the benefits of a protective response outweigh the cost of performing the response. Each theory labels these factors differently, this paper will refer to them as *risk perception* and *protective action perceptions*. Most importantly, both the PMT and the PADM propose that both *risk perception* and *protective action perceptions* influence protective behaviour.

Studies investigating health related protective behaviours (e.g., smoking cessation) have found that both *risk perception* and *protective action perceptions* are significant predictors of the performance of such behaviours (Floyd, Prentice-Dunn, & Rogers, 2000; Milne, Sheeran, & Orbell, 2000). Such studies also report that *protective action perceptions* tend to be stronger predictors of protective health behaviour than *risk perception* (Floyd et al., 2000; Milne et al., 2000). Similarly, much of the natural hazard literature suggests that *protective action perceptions* are the most important psychological variables in the prediction of mitigation behaviour (Grothmann & Reusswig, 2006; Scovell, McShane, Smith, & Swinbourne, 2019; Terpstra & Lindell, 2013). Moreover, several studies have shown that *risk perception* is only a relatively weak predictor of protective behaviour (Bubeck et al., 2012; Lindell, 2013). Other studies have, in fact, shown that *risk perception* is either a negative or non-significant predictor of behaviour (Bubeck et al., 2012; Lindell, 2013; Lindell & Whitney, 2000; Siegrist & Gutscher, 2006). Considering *risk perception* is an essential component of most EV theories, it is important to highlight some explanations as to why empirical studies have found contradicting results and propose a new method of empirically validating the link between *risk perception* and protective behaviour.

7.2.2 Association between protective behaviour and risk perception

Protective behaviour is desirable because it reduces objective risk. So, while increased risk perception theoretically leads to a protective behaviour, having performed a protective behaviour should lower risk perception. Protective behaviour can, therefore, associate with higher or lower levels of risk perception, depending on the point in time risk perception is assessed in relation to the behaviour. This potential negative feedback between risk perception and protective behaviour has been identified by researchers as a problem that influences the results of cross-sectional research (Bubeck et al., 2012; Weinstein & Nicolich, 1993; Weinstein, Rothman, & Nicolich, 1998). As Bubeck et al. (2012) explains, most studies do not assess risk perception before the performance of a protective behaviour. Instead, studies tend assess risk perception and protective behaviour at the same point in time. Assessing these two factors in this way means that respondents who have performed mitigation behaviours may report lower levels of risk perception even though higher levels of risk perception may have led them to performing the behaviour in the first place. Researchers have recommended that assessing intentions instead of past behaviour should help to address this problem.

Assessing mitigation intentions as opposed to past behaviour is, however, not without its own limitations. Having an intention to perform a mitigation behaviour (e.g., putting up plywood covers before a cyclone) can also lower current levels of risk perception if one believes that a mitigation behaviour is effective (i.e., response efficacy). As explained by Brewer et al. (2004) an individual may report that their risk of experiencing a negative outcome is low (e.g., cyclone-related property damage), but this may be because they plan to prepare adequately, thus reducing their actual risk. Many cross-sectional studies assess risk perception without controlling for the fact that beliefs about the efficacy of an intended response influence risk perception (Brewer et al., 2007). Assessing risk perception in this way is problematic as it does not specifically capture the perceived likelihood and severity of the hazard. Instead, this measure is confounded by the perceived response efficacy of the behaviour. As most EV theories consider perceived response efficacy a separate construct, future studies investigating intentions as an outcome should assess risk perception by asking people to predict the likelihood and severity of damage if they were to perform no protective behaviours.

7.2.3 Not Keeping Hazard Severity Constant

One explanation for the inconsistent link between *risk perception* and protective behaviour is that when assessing *risk perception*, most studies do not keep hazard severity constant. As highlighted by Sjöberg (2000), technical risk estimates influence *risk perception* even though most researchers tend to ignore it. When people are asked to predicted the likelihood of dying from specific diseases, for example, their predictions correlate strongly with the statistical data (Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978). Similarly, EV theories highlight that technical risk estimates influence risk perception, which in turn, influence behaviour (Rogers, 1975; Witte, 1992). While many researchers debate the extent to which risk is both ontologically and epistemologically ‘real’ (see Rosa, 1998), it is a fact that some hazards reliably cause more negative consequences than others. All other things being equal, a Category 5 cyclone, for example, causes more damage, death and negative health outcomes than a Category 1 cyclone. If, therefore, the assumption is granted that most people want to avoid these negative outcomes, then it can be said that a Category 5 cyclone presents a greater risk(assuming the probability of occurrence is the same) than a Category 1 cyclone because negative outcomes are more likely. Most studies, however, tend to assess *risk perception* based on an implicit assumption that technical risk estimates have no influence on *risk perception*.

Consider, for example, the commonly used cyclone *risk perception* scale developed by Peacock, Brody, and Highfield (2005). Using this scale, *risk perception* is assessed based on the perceived likelihood of three outcomes: property damage, work interruption and daily life interruption. The higher the perceived likelihood of these outcomes, the higher the perceived risk. What this scale does not control for, however, is difference in damage potential between cyclones. If, for example, two respondents reported that damage from a future cyclone is ‘not very likely’ but one was thinking of a Category 5 cyclone whereas the other was thinking of a Category 3 cyclone, their scores would incorrectly reflect that they perceive the same level of cyclone risk. In this case, however, it is reasonable to assume that the person who indicated that damage from a Category 5 cyclone is ‘not very likely’ perceives that cyclones, in general, have less damage potential. As such, this scale does not control for differences in the type of cyclone that may come to mind for different people and that this alone would influence responses to the scale items.

There is also a lot of variability in the types of damage that cyclones cause (Boughton et al., 2011; Henderson, Ginger, Leitch, Boughton, & Falck, 2006). Damage can be relatively minor (e.g., a cracked window) or more severe (e.g., destroyed roof). Most risk perception scales, though, do not explicitly acknowledge this difference. While most risk perception scales include an item assessing perceived likelihood of property damage, they do not specify the type of property damage (e.g., Peacock et al., 2005). If two people report that cyclone damage is 'not very likely' but one is thinking of a cracked window whereas the other is thinking of a destroyed roof, their scores would not reflect that they may perceive cyclone risk differently. In such a case, the person who was thinking of roof damage may have reported that a more minor form of damage (e.g., a cracked window) would be 'likely' if told to think of that type of damage. By referencing a specific type of outcome (e.g., damaged roof), the differences in the perceived likelihood of damage should better capture the difference in perceived risk.

Many *risk perception* scales also make it difficult to determine if someone thinks that damage is less likely because they think that cyclones are less likely or because they think that cyclones cause less damage. This raises another problem of confusing the terms *probability* (or *exposure*) and *susceptibility* (or *vulnerability*), since thinking that cyclones are likely in the future is necessary but not sufficient for explaining *perceived susceptibility* to negative consequences. The importance of differentiating between these terms has also been recently discussed by Walpole and Wilson (2020). One can, for example, think that a future Category 5 cyclone is likely but not think that it will cause much damage. Recent research conducted in Australia has shown that when people are asked to predict how much damage a Category 5 cyclone would cause to their property on a 7-point Likert scale, there is a wide range of responses (Scovell et al., 2020). Scovell et al. (2020) found that 35% of respondents reported that damage levels would be "very low" to "medium" and only about 20% reported that it would be “very high”. These findings suggest that people have very different beliefs about the damage potential of severe cyclones. Theoretically, an individual who thinks that a cyclone is likely but not severe would be unlikely to prepare as they would not perceive they are susceptible to negative consequences (Rogers, 1975; Witte, 1992). To properly determine if differences in *perceived susceptibility* predict protective behaviour it is important to also keep the objective probability of the hazard constant. In a cross-sectional survey design, this could be done by asking participants to predict the likelihood of negative outcomes if they were exposed to a hazard (e.g., a Category 5 cyclone). By keeping hazard probability constant, it is possible to assess the degree to which individuals’ *perceived susceptibility* differs in relation to the same hazard and if it has an influence on protective behaviour.

7.2.4 Personal Risk

Another explanation for the inconsistent findings regarding the association between risk perception and protective behaviour is that some studies do not assess risk that is relevant to the individual. Expectancy Value theories suggests that people must perceive they are personally vulnerable to harm before they are motivated to respond protectively (Lindell & Perry, 2012; Rogers, 1975). In other words, the risk is relevant to them. There is, however, a quantifiable difference between how some people rate their personal risk compared to others (Sjöberg, 2000). Generally, people tend to think they are relatively safe from hazards that cause other people harm (Svenson, Fischhoff, & MacGregor, 1985; Weinstein, 1980). This bias of perceiving less personal risk compared to others is known as *optimistic bias* (or *unrealistic optimism*) and has been identified as a barrier to the performance of protective behaviours (Janz & Becker, 1984; Weinstein, Lyon, Rothman, & Cuite, 2000). Even though there is a quantifiable difference between personal risk perception and general risk perception (i.e., risk to others), many studies still assess natural hazard *risk perception* without specifying the individual as the risk target (e.g., Siegrist & Gutscher, 2006; Trumbo et al., 2016). To explain the link between risk perception and protective behaviour, risk perception scales should align with EV based theories and clearly specify the individual as the risk target.

7.2.5 Emotional Risk Perception

Another factor that makes a risk more salient to the individual is the degree to which the risk elicits emotions. Many studies have shown that how people emotionally appraise a risk is a significant predictor of protective behaviour (Demuth, Morss, Lazo, & Trumbo, 2016; Miceli, Sotgiu, & Settanni, 2008; Terpstra, 2011; Trumbo et al., 2016). These studies are informed by theories such as the *affect heuristic* (Slovic, Finucane, Peters, & MacGregor, 2007) and the *risk as feelings hypothesis* (Loewenstein, Weber, Hsee, & Welch, 2001). The *risk as feeling hypothesis*, in particular, explains that there are two types of emotional appraisal that influence decision making: *anticipatory emotions* and *anticipated emotions* (Loewenstein et al., 2001). *Anticipatory emotions* are what one feels in the moment when presented with a risk, whereas *anticipated emotion* is what one expects to feel if the negative outcome was to occur (Loewenstein et al., 2001). Empirical research has since shown that these different types of emotions are quantifiably different constructs (Baumgartner, Pieters & Bagozzi, 2008) and that they differ in the degree to which they influence protective behaviour (Xu & Guo, 2019).

Differentiating between *anticipatory emotions* and *anticipated emotions* is important as emotions can influence decision making in real time (e.g., feeling angry when encouraged to make a fast decision), but at other times emotions may help people to conceptualise the severity of potential outcome (e.g., imagining a feeling of regret after losing a gamble). While Loewenstein et al. (2001) outline that both types of emotions help to explain decision making and behaviour, most studies investigating natural hazard mitigation behaviour have focused on *anticipatory emotions*. That is, these studies ask participants to report the degree to which they feel a specific emotion (in the moment) when thinking about a future hazard (e.g., Demuth et al., 2016; Trumbo et al., 2016). For example, Trumbo et al. (2016) assessed *affective risk perception* by asking respondents to report the extent to which they feel fearful when thinking about the possibility of a major hurricane. Respondents were not asked to report how they feel in when thinking about potential consequences. As such, it is still unclear the extent to which *anticipated emotions* (e.g., how do you expect to feel?) influence protective behaviour for natural hazards.

Most researchers that have studied *anticipated emotions* in relation to decision making and behaviour tend to focus on regret (Loewenstein et al., 2001). While studies researching regret have provided evidence that this particular *anticipated emotion* is a reliable predictor of protective behaviour (Brewer, DeFrank, & Gilkey, 2016), fewer studies have investigated other negatively valanced *anticipated emotions* such as fear, worry or dread. Other empirical research exploring natural hazard mitigation behaviour has shown that people often report negative emotions such as fear, helplessness and uncertainty as a result of experiencing property damage caused by a flood (Siegrist & Gutscher, 2008). In the same study, the respondents who had experienced flood damage also reported that these negative emotional consequences were the worse consequence of experiencing property damage. The same researchers also found that experienced respondents were more likely to report that fear of future flooding was a 'very important' reason why they implemented precautionary measures (Siegrist & Gutscher, 2008). These findings suggest that other negative *anticipated emotions* (e.g., fear) that people commonly associate with negative outcomes (e.g., property damage) may help to explain their protective behaviour.

7.2.6 Current Study

This study, using an experimental survey design, aimed to test how risk perception influences protective behaviour using a new method of assessing risk perception. As mentioned early, this study will focus on protective behaviour in response to cyclone risk as the context to explore this relationship. This study investigated the extent to which changing the objective severity of a hazard (e.g., the cyclone category), while keeping the probability of the hazard constant, has an influence on *risk perception* and preparedness intentions. Hazard probability was kept constant across all conditions to specifically explore the extent to which variations in hazard severity alone influence *risk perception*. This study also examined the relationship between cyclone damage predictions, anticipated negative emotions associated with that damage and protective behaviour. Four main hypotheses were tested:

1. Holding predicted cyclone likelihood constant, increases in objective cyclone intensity (i.e., cyclone category) increases preparedness intention.
2. Holding cyclone intensity and predicted cyclone likelihood constant, high levels of perceived efficacy and lower levels of perceived cost associate with higher levels of preparedness intention.
3. Holding cyclone intensity and predicted cyclone likelihood constant (and perceptions towards efficacy and cost of the preparedness behaviour), higher levels of predicted damage and anticipated negative emotion correlate with higher levels of preparedness intention.
4. Holding predicted cyclone likelihood constant, both predicted damage and anticipated negative emotion mediate the relationship between cyclone intensity and preparedness intention.

7.3 Method

7.3.1 Participants

This study was open to participants who currently live or had lived in North Queensland, Australia (between Port Douglas and Rockhampton). After removing missing data and outliers (discussed further in procedure section), there was a total of 337 respondents, with 269 females and 65 males. The average age of the respondents was 38 years (SD = 16) and ranged from 18 to 79. On average, the respondents had lived in North Queensland for 22 years (SD = 15, ranging from 1 to 69 years). Half of the respondents were homeowners (50%) and most of those homeowners lived in a house (94%) as opposed to a unit or a townhouse. The sample was relatively diverse in relation to education level, income level, and living arrangement (see Table 7.1). As also seen in Table 7.1, most of the respondents were from Townsville, Australia (the largest city in North Queensland).

Table 7.1

The Percentage Distribution (%) of Demographic Factors

Education							**N**
Grade 10 or below	Grade 12	Cert 1-4	Diploma	Bachelor	Postgrad		
6	24	22	16	23	9		337
Income							
$0 -$50,000	$50,000 - $ 100,000	$100,000 - $150,000	$150,000 - $250,000	+$250,000			
26	32	22	17	3			333
Living Arrangement							
Single Occupant	Share House	With Partner (Children)	With Partner (No Children)	Single Parent			
16	18	26	32	8			336
Location							
Townsville	Cairns to Port Douglas	Mackay	Ingham to Innisfail	Burdekin	Whitsunday	Other	
61	9	11	3	2	4	10	326

7.3.2 Measures

All variables were assessed with close-ended questions using an online survey instrument. The order in which the variables are described below follows the order in which the questions were presented in the survey.

7.3.2.1 Demographic Factors. The first questions in the survey assessed demographic factors. Respondents were asked to report their age, gender, living arrangement, income, education, number of years lived in North Queensland, and where they currently lived (or had previously lived) in North Queensland.

7.3.2.2 Experience. Respondents were asked some questions about their experience with cyclones. They were first asked if they had experienced a cyclone with an option to answer 'yes' or 'no'. If the respondent answered 'yes', they were then asked to report their level of *damage experience,* scored on a scale of 0 to 10. There were three anchor points provided on this scale: 0 = no damage, 5 = moderate damage and 10 = complete destruction of house.

7.3.2.3 Hazard Intrusiveness and Knowledge. The survey also assessed *hazard intrusiveness* and *hazard knowledge* as past research has found these variables to be related to protective behaviour (Ge, Peacock, & Lindell, 2011; Lindell & Perry, 2003). Using a similar operationalisation as Ge et al. (2011), both constructs were assessed by asking respondents to rate the extent to which they agreed with specific statements. The extent of agreement was measured with a 7-point Likert scale with high scores indicating more agreement with the statement. Two statements were used to assess *hazard intrusiveness*: one statement related to the frequency of thought about cyclones[6] (i.e., "I think about the potential negative effects from cyclones regularly") and the other related to frequency of talking about cyclones (i.e., "Cyclone related issues are discussed regularly in my household or with other people"). *Hazard knowledge* was assessed using three statements, all asking the individual to rate their own level of knowledge (i.e., subjective knowledge) about three different factors. The first was knowledge about cyclone risks in general. The second, the extent to which cyclones cause property and the final question asked about knowledge pertaining to damage mitigation. The final measure thus assessed how individuals perceived their own levels of knowledge – not how accurate that knowledge was. Scores for both variables were summed and averaged. Both *hazard intrusiveness* ($\alpha = .81$) and *hazard knowledge* ($\alpha = .92$) scales had high levels of reliability.

7.3.2.4 Protective Action Perceptions. Both perceived response efficacy and perceived cost were assessed in relation to both cyclone preparedness behaviours: plywood covers on windows and a water ingress mitigation measure. These preparedness behaviours were selected as their primary use is to mitigate property damage and they can be performed in response to an imminent threat (additional reasons for selecting these measures will be discussed later). A picture of both mitigation measures was provided to respondents. Both perceived response efficacy and cost were assessed by asking respondents to report the extent to which they agreed with specific statements. The extent of agreement was determined by scores on a 7-point Likert scale with higher scores indicating greater agreement. The items used to assess these two factors can be seen in Table 7.2. The same items were used in

[6] The word 'cyclone' was used in the survey as it is the commonly used term when referring to 'tropical cyclones' for the target population.

relation to plywood covers and the water ingress mitigation measure. These were summed and averaged to create four variables: *plywood efficacy* (α = .89), *plywood cost* (α = .86), *water ingress efficacy* (α = .86), *water ingress cost* (α = .90).

Table 7.2

Items used to Assess Perceived Response Efficacy and Perceived Cost

Variable	**Items**
Perceived Response Efficacy	This activity would reduce property damage
	This activity would protect myself and/or my family
Perceived Cost	This activity would take a lot of time
	This activity would take a lot of effort
	This activity would be expensive considering the necessary materials
	This activity would require a lot of skill and/or knowledge
	This activity would require abilities I do not have

7.3.2.5 Cyclone Scenarios. Before responding to the rest of the survey, respondents were asked to imagine they lived in a specific fictional house and location. Respondents were asked to imagine they live in fictional location called ‘Capricornia’. A fictional location was chosen to remove potential biases due to people living in different locations claiming local knowledge or no longer living in North Queensland. Respondents were then asked to imagine they lived in a particular type of house located in Capricornia. A picture of the hypothetical house was provided to respondents (see Figure 7.1). For the remaining questions, respondents were asked to answer as if they lived in this hypothetical house.

Figure 7.1

House Presented to Respondents

Respondents were then presented with one of five hypothetical cyclone scenarios. Respondents were told in every scenario that a cyclone had been identified off the Capricornia coast and is heading for their location. Respondents in all conditions were presented with a map (see Figure 7.2 for an example) and information about the cyclone in the map, such as the expected wind speed. The presented maps were stylised versions of the cyclone track maps usually provided to the public by the Bureau of Meteorology in Australia (e.g., Bureau of Meteorology, 2018a). In all conditions the cyclone was predicted to hit Capricornia in 48 hours and the track line for the cyclone was the same. The respondents were, however, not given any information about the probability of impact or the uncertainty of the forecast as such information is not usually provided by the Bureau of Meteorology in their tack maps (e.g., Bureau of Meteorology, 2018a). These conditions were kept the same to keep the probability and immediacy of the cyclone's impact constant for all conditions. Only the severity of the cyclone was manipulated. The number of respondents in each category condition is shown in Table 7.3.

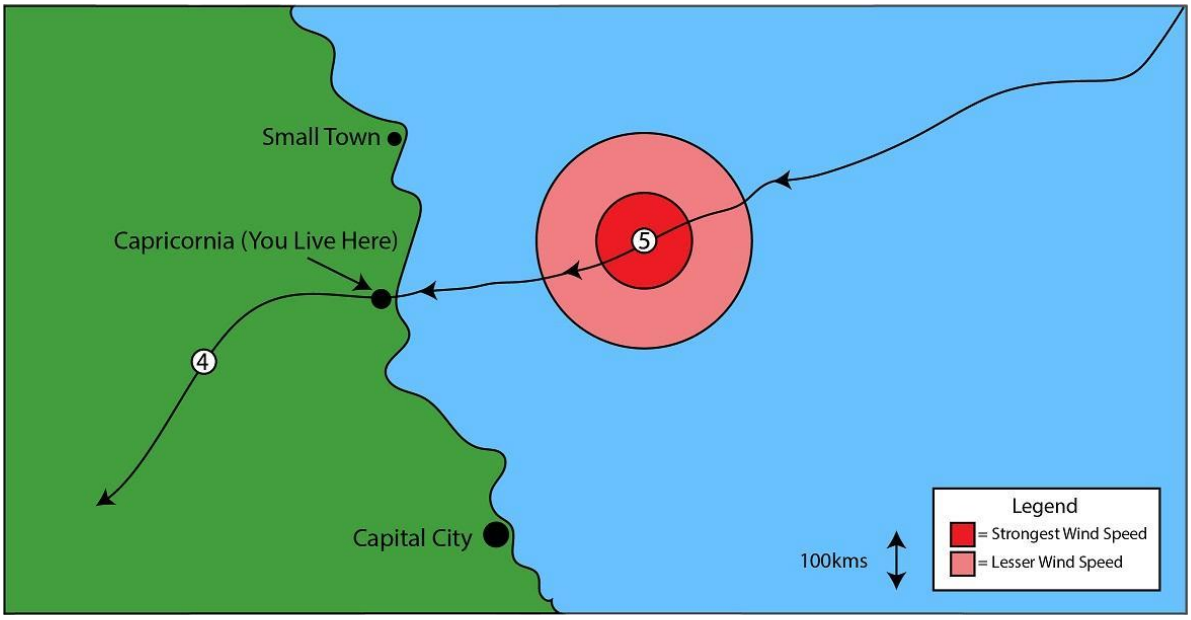
Table 7.3

Number of Respondents in each Category Condition

Category 1	Category 2	Category 3	Category 4	Category 5
54	75	84	61	62

Figure 7.2

Map Presented for the Category 5 Condition



Cyclone severity was manipulated by randomly assigning respondents one of five cyclone scenarios. The five scenarios represented the five different cyclone category classifications in Australia. Like the Saffir-Simpson scale, the Australian scale uses a one to five scale with five being the most severe cyclone. However, there are some differences between the Saffir-Sampson scale and the Australian scale. For instance, Category 1 level wind speeds on the Australian scale would not be considered a Category 1 level hurricane using the Saffir-Sampson scale (Bureau of Meteorology, 2021; Schott et al., 2019). All respondents were also provided information about the potential wind speeds based on the Australian classification system (Bureau of Meteorology, 2018b). For example, if the respondent was presented with the Category 5 condition (seen in Figure 7.2), they were also told that the wind speeds would be over 280 km/h. Only three variables on the map changed depending on the category condition: the cyclone category number (and associated wind speed), the diameter of the outer circle (i.e., lesser wind speed circle) and the diameter of the inner circle (i.e., strongest wind speed circle). As the category number lowered, so too did the diameter of each wind speed circle. When the original map was designed, the Category 5 condition had an outer circle diameter of 36 mm and an inner circle diameter of 16 mm. For each reduction in category number, the outer diameter was reduced by 4mm and the inner circle diameter was reduced by 2 mm. This reduction in diameter roughly equalled 11% for the outer circle and 12.5% for the inner circle.

7.3.2.6 Protective Response Intention. After being presented with the cyclone scenario, respondents were asked how they would respond to this situation. Intentions to perform three types of protective behaviour were used as the dependent variables in this study. *Evacuation intention* was assessed as a dichotomous variable by asking respondents whether they would evacuate or not at the category number presented (0 = no, 1 = yes). The other two protective behaviours were related to damage mitigation: intention to put up plywood covers and intention to perform a water ingress mitigation measure. The water ingress measure involves taping a plastic film to the inside of a window frame to collect any water that enters through the window during a cyclone (Cyclone Testing Station, 2018). The two damage mitigation behaviours were chosen for several reasons. First, research has shown that these behaviours are effective at reducing property damage and, compared to structural upgrades, are relatively inexpensive (see Cyclone Testing Station, 2018 for more information about these measures; Smith et al., 2015). Second, unlike structural upgrades, these mitigation behaviours can also be performed in response to an immediate threat. Finally, past research has shown that most people living in North Queensland tend to perform simpler preparedness behaviours such as cleaning up their yard (Kanakis & McShane, 2016; King, Goudie, & Dominey-Howes, 2006) so assessing these behaviours would return an overwhelmingly positive result regardless of experimental condition. As the two behaviours assessed in this study require more effort to perform, there should be greater variability in responses. *Plywood Intention* and *Water Ingress Intention* were both assessed on 7-point Likert scale with higher scores indicating a greater intention to perform the behaviour.

7.3.2.7 Risk Perception. Risk perception was assessed by assessing both *predicted damage* and *anticipated emotions*. To assess *predicted damage* respondents were asked to report the likelihood that specific components of the house would be damaged if they did not prepare. Five types of property damage were presented: complete roof failure, partial roof failure, damage to house exterior due to flying debris, smashed/cracked windows, damage to house interior due to water ingress. These types of outcomes were chosen as they differ in severity and relate to many structural components of a house. Respondents were asked to report the likelihood that each type of damage would occur on the 7-point Likert scale with high scores indicating a higher likelihood. Scores on the scales were summed and averaged to create the *predicted damage* variable ($\alpha = .92$).

Respondents were also asked to report the types of emotional responses they would anticipate in relation to the *predicted damage* if they did not prepare. Four types of negative emotional states were presented to the respondents: fearful, worried, full of dread and depressed. These four emotions were chosen based on research indicating that they tend to be associated with thoughts about natural hazards (Demuth et al., 2016; Trumbo et al., 2016). Respondents were asked to report the extent to which they agree they would experience these emotions before, during or after the cyclone (if they did not prepare) on a 7-point Likert scale (high scores indicated stronger agreement that they would experience the emotion). The temporal component was added to the question as some emotions may be more likely to be felt leading up to (e.g., worry) or during a cyclone (e.g., fear) and yet they can all be anticipated. Scores on these items were summed and averaged to create the *anticipated emotion* variable (α = .85).

7.3.3 Procedure

Most of the respondents completed the survey online using the Qualtrics platform. Respondents were mainly recruited via snowball sampling through Facebook. A Facebook page was created for the study, which had a link to the survey and some additional information about the study. A link to the survey and the Facebook page was posted in several Facebook groups relevant to people living in North Queensland. Links were posted to community noticeboard groups (e.g., Townsville Community Noticeboard), disaster information groups (e.g., North Queensland Disaster Watch) and weather groups (e.g., Wally's Weather). Seven of the respondents completed a paper version of the survey. These participants were recruited at an event called Disaster Ready Day held in Townsville on the 3rd of November 2019. Some respondents were also psychology undergraduate students who were given credit points for participating in the study.

All data screening and analysis was conducted in R. Initial scatter plots indicated linear relationships between the variables of interest. Missing data was imputed (where possible) using the 'mice' package in R (Buuren & Groothuis-Oudshoorn, 2010). Before missing data was removed/imputed there were 502 respondents (122 were students). However, 43 respondents opened the online survey without starting it and were, therefore, removed from the analysis. Data was imputed for non-demographic continuous variables if the variable had less than 5% of data missing and the participant did not respond to less than 5% of the questions (Schafer, 1999) as the analysis used in this study is sensitive to outliers (Kline, 2015). In other words, data was imputed for row and columns that had less than 5% of the data missing. After cases with high amounts of missing data were removed and data was imputed, the sample sized reduced to 357.

Data was then screened for outliers. Outliers were determined by first calculating Mahalanobis distance values for each case. Based on a chi-squared distribution, cases that had a Mahalanobis distance value above a cut-off of $p < .001$ were removed. After removing outliers, the sample sized reduced to 337. Assumptions of normality and heterogeneity/homogeneity of variance were tested by using all the assessed variables as predictors of random number variable in linear regression model. The regression analysis revealed no violations of normality and heterogeneity/homogeneity of variance.

7.4 Results

7.4.1 Hypothesis 1

The first hypothesis was tested by examining the degree to which evacuation and preparedness intention differed based on the *cyclone category* condition. Table 5 shows the number and percentage of respondents who reported they would evacuate (or not) depending on the *cyclone category* presented. As shown in Table 7.5, a majority of respondents reported they would evacuate before a Category 5 cyclone (84%) whereas the majority said they would not evacuate before a Category 1 cyclone (94%). A chi-square test of independence indicated that there was a significant association between *evacuation intention* and *cyclone category* ($\chi^2(4) = 90.68$, $p < .001$), with increasing category being associated with larger proportions of respondents endorsing evacuation. Table 7.6 shows the mean levels of preparedness intention for all category conditions. Two separate one-way analyses of variance indicated that there was a significant difference between the mean levels for *plywood intention* ($F(4,331) = 8.31$, $p < .001$) and *water ingress intention* ($F(4,331) = 3.66$, $p < .01$) based on the category conditions presented. A pairwise comparison using a Bonferroni correction revealed a significant difference between *plywood intention* for the Category 1 condition compared to every other condition ($p < .01$). There was not, however, a significant difference in *plywood intention* between Categories 2 through 5. For *water ingress intention*, the only significant difference was between the Category 1 and Category 5 conditions ($p < .01$).

Table 7.4

Number (%) of Respondents who Reported they would Evacuate (or not) in each Cyclone Category Condition

Evacuation	Category 1	Category 2	Category 3	Category 4	Category 5
No	51 (94)	55 (73)	44 (52)	22 (36)	10 (16)
Yes	3 (6)	20 (27)	40 (48)	39 (64)	52 (84)

Table 7.5

Mean (SDs) of Preparedness Intention for each Cyclone Category Condition

Preparedness	Category 1	Category 2	Category 3	Category 4	Category 5
Plywood Intention	3.35 (2.15)	4.77 (1.97)	4.58 (2.05)	4.84 (2.21)	5.45 (1.62)
Water Ingress Intention	3.50 (2.24)	4.35 (2.20)	3.88 (2.14)	4.43 (2.37)	4.90 (2.03)

7.4.2 Hypothesis 2 & 3

To examine univariate relationships between all variables, a partial correlation analysis was conducted with *cyclone category* as the covariate. A partial correlation was used to examine the relationship between all variables while keeping the *cyclone category* constant. To be used as a covariate in this analysis, the *cyclone category* variable was treated as an interval scale variable. Conceptually, this is appropriate as increases in cyclone category are approximately linear in relation to increases in wind speed (Bureau of Meteorology, 2021). Furthermore, treating an ordinal variable as continuous is considered suitable when the variable has at least five levels (Rhemtulla, Brosseau-Liard, & Savalei, 2012). Results of the partial correlation analysis are shown in Table 7.6.

Table 7.6

Partial Correlation between all Variables used in Analysis (Controlling for Category Condition)

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Plywood Intention	4.64	2.09	-																	
2. Ingress Intention	4.21	2.22	.61**	-																
3. Evacuate	.46	.50	.16**	.11	-															
4. Age	37.93	15.69	-.25**	-27**	-.18**	-														
5. Female	.81	.40	-.03	.04	-.01	.05	-													
6. Years in North Queensland	22.28	15.36	-.18**	-25**	-.11*	.48**	.03	-												
7. Education	3.53	1.45	-.20**	-.13*	-.09	.28**	.07	.03	-											
8. Income	2.39	1.14	-.20**	-.18**	-.03	.11*	-.03	.13*	.23**	-										
9. Homeowner	.50	.50	-.23**	-.24**	-.09	.53**	.04	.38**	.20**	.40**	-									
10. Damage Experience	2.72	2.48	-.05	-.11*	-.03	.07	-.01	.21**	-.11	.05	.02	-								
11. Hazard Knowledge	6.24	.96	-.03	-.15**	-.11*	.34**	-.01	.35**	.03	.19**	.23**	.26**	*.92*							
12. Hazard Intrusiveness	4.24	1.61	.02	.01	.06	.35**	-.10	.16**	.03	.12*	.20**	.21**	.39**	*.81*						
13. Predicted Damage	5.85	1.14	.27**	.23**	.20**	.00	.15**	-.06	-.02	-.02	-.05	.01	.11*	.08	*.92*					
14. Anticipated Emotion	5.18	1.37	.36**	.35**	.17**	-.16**	.16**	-.07	-.05	-.08	-.15**	-.01	-.08	.07	.49**	*.85*				
15. Plywood Efficacy	5.18	1.16	.34**	.22**	.11	-.12*	-.08	-.15**	-.08	-.10	-.07	-.05	.08	.13*	-.01	.06	*.89*			
16. Plywood Cost	4.58	1.31	-.36**	-.24**	-.09	.39**	.12*	.25**	.18**	.16**	.25**	.11*	.11*	.14**	-.01	-.07	-.21**	*.86*		
17. Water Ingress Efficacy	3.78	1.51	.14**	.45**	-.04	-.13*	.04	-.19**	-.04	.03	-.05	-.07	-.05	.07	.00	.09	.28**	-.03	*.86*	
18. Water Ingress Cost	3.07	1.30	-.24**	-.18*	-.17**	.31**	.02	.18**	.06	.09	.18**	.04	.06	.05	-.07	-.10*	-.24**	.56**	.19**	*.90*

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). The numbers in *italics* are the internal consistency reliability coefficients (α) for the multi-item variables.

As seen in Table 7.6, *predicted damage* and *anticipated emotion* were significantly correlated with an increase in preparedness and evacuation intention. The perceived efficacy and cost of the preparedness behaviours was also significantly associated with an increase in preparedness intention. *Hazard intrusiveness* was not significantly associated with any of the protective behaviours and greater perceived *hazard knowledge* was associated with less intention to evacuate and put up the water ingress mitigation measure. *Damage experience* was negatively correlated with *ingress intention* and did not correlate with either *plywood intention* or *evacuation intention.* Age, years in North Queensland, not being a homeowner, income and education were negatively associated with both preparedness behaviours; only age and years in North Queensland were negatively associated with *evacuation intention*. Gender was not associated with performance of any of the protective behaviours. It should also be noted that due to the number of correlations conducted in this study, weak correlations should be interpreted with caution.

To further examine how the statistically significant psychological factors predicted protective behaviour, three hierarchical regression models were calculated. First, a hierarchical logistic regression model was calculated to test if the risk perception factors were significant predictors of *evacuation intention*. Independent variables were added in three blocks. *Cyclone category* was added in the first block. In the second block, age and years in North Queensland were added to the model as covariates. These two demographic variables were chosen as they were significantly correlated with evacuation intention. The risk perception factors (*predicted damage* and *anticipated emotion*) were added in the final block.

Results of the logistic regression analysis (Table 7.7) show that *cyclone category* was a strong predictor of evacuation intention. Results of Model 1 indicate that differences in *cyclone category* alone explain 34% of the variability in *evacuation intention*. While age was also a significant predictor of evacuation intention, the addition of both demographic factors only added an increase in 4% of explained variability. Model 3 showed that *predicted damage* was a significant predictor of *evacuation intention*, but *anticipated emotion* was not. *Cyclone category* remained the strongest predictor of *evacuation intention* in the final model.

Table 7.7

Results of a Logistic Regression Analysis Predicting Evacuation Intention

Variable	**Model 1**		**Model 2**		**Model 3**	
	Estimate	**Odds Ratio**	**Estimate**	**Odds Ratio**	**Estimate**	**Odds Ratio**
Cyclone Category	.96**	2.61	1.00**	2.73	.82**	2.27
Age			-.02*	.98	-.03*	.97
Years in Location			-.01	.99	-.00	1.00
Predicted Damage					.54**	1.72
Anticipated Emotion					.10	1.11
Intercept	-3.10**		-2.20**		-5.35**	
Model Fit	$\chi^2(1)$=99.68**		$\chi^2(3)$=110.40**		$\chi^2(5)$=128.52**	
Nagelkerke R^2	.34		.38		.43	

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Two hierarchical linear regression analyses were then conducted to test if the risk perception factors were significant predictors of the preparedness behaviours. Similar to the previous analysis, variables were added to the model in blocks. For these analyses, however, two addition demographic factors (education and income) were added to the second block as they were also correlated with both preparedness behaviours. The perceived efficacy and cost associated with the preparedness behaviours were also added to these models as additional covariates before the risk perception variables were added. Table 7.9 and Table 7.10 show the results of the regression models predicting *plywood intention* and *ingress intention*.

Table 7.8

Results of a Hierarchical Linear Regression Analysis Predicting Plywood Intention

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	β	**β**	**β**	**β**
Cyclone Category	.26**	.25**	.24**	.05
Age		-.17**	-.06	-.04
Education		-.10	-.08	-.08
Income		-.12*	-.07	-.06
Homeowner		-.06	-.07	-.03
Plywood Efficacy			.26**	.25**
Plywood Cost			-.24**	-.24**
Predicted Damage				.17**
Anticipated Emotion				.26**
Intercept	3.42**	4.97**	3.43**	.69
Model Fit	F(1,334)=23.6**	F(5,326)=12.74**	F(7,324)=19.1**	F(9,322)=23.8**
Adjusted R^2	.06	.15	.28	.38

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 7.9

Results of a Hierarchical Linear Regression Analysis Predicting Water Ingress Intention

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	β	**β**	**β**	**β**
Cyclone Category	.17**	.18**	.20**	.06
Age		-.21**	-.08	-.09
Education		-.02	-.02	-.02
Income		-.14*	-.13	-.12
Homeowner		-.06	-.07	-.04
Water Ingress Efficacy			.47**	.45**
Water Ingress Cost			-.21**	-.18**
Predicted Damage				.13*
Anticipated Emotion				.21**
Intercept	3.38**	4.74**	2.34**	-.06
Model Fit	F(1,334)=9.45**	F(5,326)=9.36**	F(7,324)=23.7**	F(9,322)=24.75**
Adjusted R^2	.02	.11	.32	.39

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

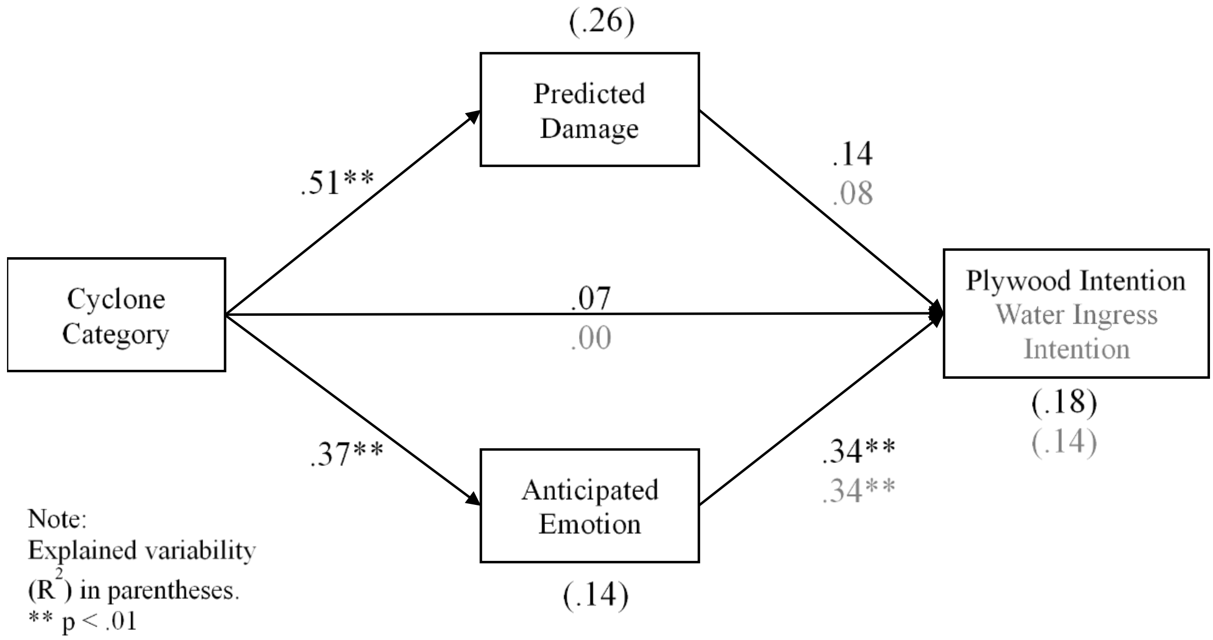
As seen in Tables 7.8 and 7.9, the *cyclone category* condition alone explained a relatively small amount of variability in preparedness intention (Adjusted R^2 of .06 for *plywood intention* and .02 for *ingress intention*). It was found that perceived efficacy and perceived cost were significant predictors of both preparedness behaviours in the final models. The variables *predicted damage* and *anticipated emotion* were also significant predictors of preparedness intention, but *anticipated emotion* was a slightly stronger predictor in the two regression models. When *anticipated emotion* and *predicted damage* were added to the final models, *cyclone category* was no longer a significant predictor of preparedness intentions.

7.4.3 Hypothesis 4

The results of the linear regression models suggest that *predicted damage* and *anticipated emotion* mediates the relationship between *cyclone category* and preparedness intention. As such, a path analysis model was tested to confirm this mediation effect. The path model was tested for *plywood intention* and *ingress intention* using the 'lavaan' package in R. The model in Figure 7.3 was tested using 1000 bootstrapped samples. Figure 3 shows the standardised coefficients linking each path and the amount of variability explained by each component of the model. The coefficients and variability explained in each model was the same except for the path between *predicted damage* and preparedness intention. Figure 3 represents the path coefficient and variability explained for the *ingress intention* model in grey and the *plywood intention* model in black. Overall, the results of the path models show that while *cyclone category* had a stronger influence on *predicted damage* than on *anticipated emotion*, *anticipated emotion* had a stronger influence on preparedness intention. Furthermore, the models suggest mediation as there was no significant direct effect. Results revealed a significant indirect effect through *anticipated emotion* ($p < .001$) but the indirect effect through *predicted damage* was not significant for both models.

Figure 7.3

The Standardised Coefficients Linking Each Path



7.5 Discussion

This study aimed to determine if *risk perception* predicts cyclone mitigation intention when controlling for cyclone intensity and *protective action perceptions*. The results suggest that when keeping these variables constant, the *predicted damage* if no action is taken and *anticipated emotion* associated with that outcome are both significant predictors of preparedness intention. The findings also show that these *risk perception* variables mediate the relationship between cyclone intensity and preparedness behaviour. Cyclone evacuation intention, on the other hand, was found to be primarily influenced by objective cyclone severity. *Predicted damage* was also a significant predictor of evacuation intention but *anticipated emotion* was not. One explanation for this finding is that damage related consequences (including anticipated negative emotions) have less of an influence on evaluation intentions than other considerations like predicted casualties (Huang et al., 2017).

One of the most important findings from the present study was the strength of the relationship between *risk perception* variables and preparedness intention. Much of the past research has found *risk perception* is a relatively weak predictor of protective behaviour when controlling for *protective action perceptions* (Bubeck et al., 2012; Bubeck, Botzen, Kreibich, & Aerts, 2013; Grothmann & Reusswig, 2006; Terpstra & Lindell, 2013). *Protective action perceptions* (or *coping appraisals*) are also found to be consistently stronger predictors of health-related protective behaviours compared to *risk perception* (Floyd et al., 2000; Milne et al., 2000). The results of the present study contradict these findings. The results, instead, suggest that *risk perception* and *protective action perceptions* influence protective behaviour to a similar extent. Controlling for the influence from hazard severity and probability of exposure, referencing the individual as the risk target, including and emotional risk perception component, and specifying damage outcomes in relation to not performing a protective behaviour all likely contributed to this stronger *risk perception* effect.

Another possible explanation for the stronger effect is that the present study assessed intentions instead of behaviour, which tends to provide stronger correlations (Bubeck et al., 2012). Though other studies have also included both *risk perception* and *protective action perceptions* as predictors of preparedness intentions and found that *risk perception* had a relatively weak effect compared to *protective action perceptions* (Poussin et al., 2014; Scovell et al., 2021; Terpstra & Lindell, 2013). For example, one study, using similar hierarchical regression models, found that *risk perception* only explained an additional 2-4% of variability in flood preparedness intentions beyond *protective action perceptions* (Terpstra & Lindell, 2013), whereas the present study found that *risk perception* variables explained an additional 7-10% of the variability. It is, therefore, unlikely that most of additional explained variability in intention from *risk perception* in this study is due to measuring intentions instead of past behaviour.

7.5.1 Controlling Hazard Severity and Probability of Exposure

Controlling for hazard severity and probability of exposure is one explanation for the stronger relationship between *risk perception* and protective behaviour in the present study. This study shows that increases in cyclone intensity (a strong predictor of cyclone severity) increases the extent to which people predict they will experience negative consequences (i.e., damage and negative emotions). As such, future research should consider controlling for hazard severity and probability of exposure when investigating the link between *risk perception* and protective behaviour. Controlling such factors it particularly important for explaining short-term protective behaviour (e.g., household preparedness and evacuation) as Hazard severity seems to have a particularly strong influence on behaviour aimed at mitigating potential harm to the individual (e.g., evacuation intention). Future research may wish to explore this relationship further, especially in relation to hazards that primarily cause harm to the individual as opposed to their assets.

Another useful contribution from the present study is that specific property damage outcomes were referenced to assess *risk perception*. Though, the results suggest it may be appropriate to just reference one type of damage (e.g., roof damage) as there was strong intercorrelations between the five items used to assess predicted damage. Future researcher should at least reference one specific property damage outcome when assessing cyclone *risk perception* so that all participants are thinking about the same outcome.

7.5.2 Anticipated Negative Emotion

The findings suggest that *anticipated emotion* associated with *predicted damage* is a strong driver of preparedness behaviour. The results also show that while these constructs are related, people's *anticipated emotion* is not entirely dependent on *predicted damage*. Furthermore, the mediation model indicated that cyclone intensity has a direct influence on *anticipated emotion* when controlling for *predicted damage*. This finding supports past research proposing that *risk perception* is best theorised as a dual-process phenomenon in a natural hazard context (Demuth et al., 2016; Miceli et al., 2008; Trumbo et al., 2016). More research is, however, needed to determine the extent which affect and cognitive processes influence appraisal of *anticipated emotion*. Some researchers, for example, would argue that *anticipated emotion* is dependent on cognitive appraisal (e.g., Lazarus, 1991), whereas others claim that emotions can arise without cognitive appraisal (e.g., Zajonc, 1980). Future research should also investigate if *anticipated emotion* and *anticipatory emotions* can be differentiated in a natural hazard context and if the constructs have different effects on protective behaviour as found in other research (Baumgartner et al., 2008; Xu & Guo, 2019).

Interestingly, though, *anticipated emotion* was not associated with evacuation intention. This result may have been due to how *anticipated emotion* was assessed. In the present study, respondents were asked to anticipate the extent to which they would feel specific emotions in relation to damage they predicted. Respondents who said they would evacuate may have anticipated fewer, or less intense, negative emotions as they knew they would not be in their homes to witness the damage. The finding suggests that *anticipated emotion* is highly dependent on the specificity of the outcome.

The importance of *anticipated emotion* has significant implications for the application of EV theories. The theory behind the Protection Motivation Theory and associated models explicitly state that people are primarily motivated to avoid physical harm as opposed to avoiding negative emotions. Both Rogers (1975, 1983) and Witte (1992) claim that while emotion is associated with the appraisal of a threat (they both explicitly reference fear), emotion does not directly influence protective behaviour. The findings of the present study suggest that both predicted harm (i.e., predicted property damage) and anticipated negative emotion, whilst related, independently predict protective motivation.

It may, however, be the case that *anticipated emotion* is only important for explaining protective behaviour in response to hazards that do not present a clear threat to people's health or safety. Natural hazards are different from health-related threats in this regard as natural hazards much less frequently cause death and/or physical harm in developed countries. A hazard such as smoking, on the other hand, is directly associated with physical harm. *Anticipated emotion* may only be related to protective behaviour when it acts as proxy for other negative outcomes that people find difficult to associate with physical harm (e.g., inability to work or monetary loss). Future research is needed to explore the extent to which *anticipated emotion* differs from other *risk perception* concepts in different contexts. There may, in fact, be more conceptual overlap between negative emotion and physical harm than acknowledged by traditional EV theories. The degree to which someone expects to feel fear in response to a predicted outcome may, for example, be a form of *perceived severity* similar to the expectation that a hazard can cause death or physical harm. Put simply, anticipated negative emotion *is* a type of perceived harm that a rational actor should want to avoid.

7.5.3 Demographic Factors and Experience

In accordance with past research, demographic factors in this study had minimal influence on protective behaviour compared to psychological factors (Lindell, 2013; Terpstra & Lindell, 2013). One finding that was surprising, however, was the non-significant relationship between being a homeowner and preparedness intention in both linear regression models. It would have been expected that homeowners would be more concerned about the damage that cyclones can cause to property. One explanation for this finding is that homeowners in this study found it difficult to imagine what they would do, or what damage they expect, if they were living in a different house. Another explanation is homeowners, compared to renters, had thought more about the costs involved with preparing their house, which, in turn, reduced their intention to prepare. The significant positive correlation between homeowners and *perceived costs* supports this latter explanation.

Another surprising result was that damage experience was unrelated to both *risk perception* variables and intention to perform most protective behaviours. This finding contradicts much of the past research, which suggests that natural hazard experience increases future protective behaviour and the relationship is mediated, at least partially, by an increase in *risk perception* (Demuth et al., 2016; Lindell & Hwang, 2008; Mishra & Suar, 2007). One explanation for the inconsistent findings may be due to differences in the recency of damage experience. As identified in other research, the effect that experience has on *risk perception* and future protective behaviour seems to fade over time (Burger & Palmer, 1992; Sattler, Kaiser, & Hittner, 2000; Trumbo, Meyer, Marlatt, Peek, & Morrissey, 2014). In the present study, most of the respondents were from Townsville, a location that has not been directly hit by a severe cyclone since 1971. As such, even though the respondents may have experienced property damage in the past, the memory may no longer be salient enough to increase their *risk perception* and preparedness intention.

Another explanation for the non-significant relationship between experience, *risk perception* and protective behaviour is the way in which experience was operationalised. In the present study, experience was operationalised as a subjective assessment of the severity of past damage. As found by other researchers, negative emotional experience with natural hazards seems to have the greatest effect on *risk perception* and future protective behaviour (Demuth et al., 2016; Siegel, Shoaf, Afifi, & Bourque, 2003; Siegrist & Gutscher, 2008; Zaalberg, Midden, Meijnders, & McCalley, 2009). The findings of the present study also support this link between negative emotions, *risk perception* and protective behaviour. It may be the case that people with damage experience in this study did not experience many negative emotional knock-on effects. Conversely, those with cyclone experience that did not cause property damage may still have experienced negative emotional consequences. The moderate correlation between *predicted damage* and *anticipated emotion* suggests that people do not always associate more damage with more negative emotional consequences. To appropriately assess the link between experience and cyclone protective behaviour it may be important to assess people's emotional experience in relation to past property damage.

7.5.4 Limitations

This study had some limitations that may have affected the findings. One limitation is that respondents may have found it difficult to imagine living in a different type of house. If, instead, some respondents were thinking about their own house, when asked to predict damage, they may have either underestimated or overestimated it based the appraised strength of their own house. Another limitation with the study design was that the size of the cyclone increased linearly with the category condition. Research has shown that while storm size and cyclone category tend to be positively related, they do not always follow linear relationship (Song et al., 2020). While both variables increase the destructive potential of a cyclone (thus increasing hazard severity), storm size and cyclone category may have different effects on *risk perception* and mitigation intention. It is, therefore, difficult to determine the extent to which each variable influenced *risk perception* and preparedness intention using this methodology. A similar limitation arises due to treating cyclone categories as an interval variable. Research has shown that cyclone category does not increase linearly with respect to damage (Murnane & Elsner, 2012; Pielke et al., 2008). However, it is unlikely that this had an influence on the findings as most people are unaware of this non-linear association (Stewart, 2011). Some other limitations of this study are the items used to assess psychological factors. More recent research suggests that experience is best conceptualised as a multidimensional construct (Demuth, 2018). Demuth (2018) specifically shows the importance of capturing negative emotions as part of natural hazard experience. Had a more complete measure of experience been used, it may have been a stronger predictor of cyclone protective behaviour. Similarly, the measure of knowledge used was not a measure of objective knowledge. It is well-known psychological phenomenon that subjective knowledge is not linearly associated with objective knowledge (Dunning, 2011). Future research should consider developing an objective knowledge scale to test how that may influence protective behaviour and other psychological factors. In summary, while these constructs could have been measured more appropriately, investigating the influence of experience and knowledge on protective behaviour were not primary aims of the present study.

This study also had limitations due to the sample. The first sample-based limitation was that some of the sample were students whom were given credit points for participating, which may have biased some responses. However, this relatively small proportion of students did not seem to influence the overall representativeness of the sample as diversity in age, income and the proportion of homeowners was similar to population level statistics (see Australian Bureau of Statistics, 2019). The second sample-based limitation was the use of a convivence sample, which also limits generalisability. However, even studies that use probability sampling techniques (e.g., random number dialling) can have low response rates in this area of research (Lindell & Perry, 2000). It is, therefore, difficult to determine the extent to which self-selection influences the findings even in probability-based samples. As also highlighted by Lindell and Perry (2000), and Lindell (2013), demographic characteristics tend to correlate weakly with psychological variables in this area of research (as also found in the present study). As such, it is reasonable to assume that an overrepresentation of some demographic characteristics would only influence the results of this study to the extent that demographic variables correlate with the psychological variables of interest. For instance, while females were overrepresented in this study, it is unlikely that more a more diverse sample with respect to gender would influence the main findings as gender was not correlated with most variables in this study. Future research should, however, aim to replicate these findings with a larger, more diverse sample.

7.5.5 Implications

Beyond its theoretical implications, the findings of this study can also inform risk communication messaging to improve cyclone preparedness. One recommendation is that risk communication messaging should aim to promote both *risk perception* and *protective action perceptions.* Informing people about their house's vulnerability to cyclone damage and the commonly experienced negative emotions associated with property damage may be one way of increasing risk perception. It is, however, important that the information addresses a property's *vulnerability* rather than giving a concrete damage prediction as such information may cause a boomerang effect if the predicted level of damage does not occur (Bryne & Hart, 2009). To influence *protective action perceptions*, people should be shown that the efficacy of preparedness behaviour outweighs the cost. An internet (or smartphone) based application is one method of disseminating such information. Such an application could provide people with risk information that is relevant to their house based on known variables that influence risk (e.g., house age, location). The same application could reduce *perceived cost* by providing tutorials on how to perform preparedness behaviours (e.g., putting plywood up on windows) and increased *perceived efficacy* by showing how the mitigation measure reduces damage.

Perhaps the most consequential discovery from this research, though, was the strength of the association found between *risk perception* and protective behaviour. Overall, the findings provide support for theoretical models that specify the importance of *risk perception* for explaining protective behaviour (Rogers, 1975, 1983; Witte, 1992). Moreover, the results suggest that the weak and/or inconsistent links between *risk perception* and protective behaviour, as found in past empirical research, may be due to the fact that most studies do not control for hazard severity. Future research should attempt to replicate these findings in response to other hazards, with larger and more diverse samples, and in different geographical locations.

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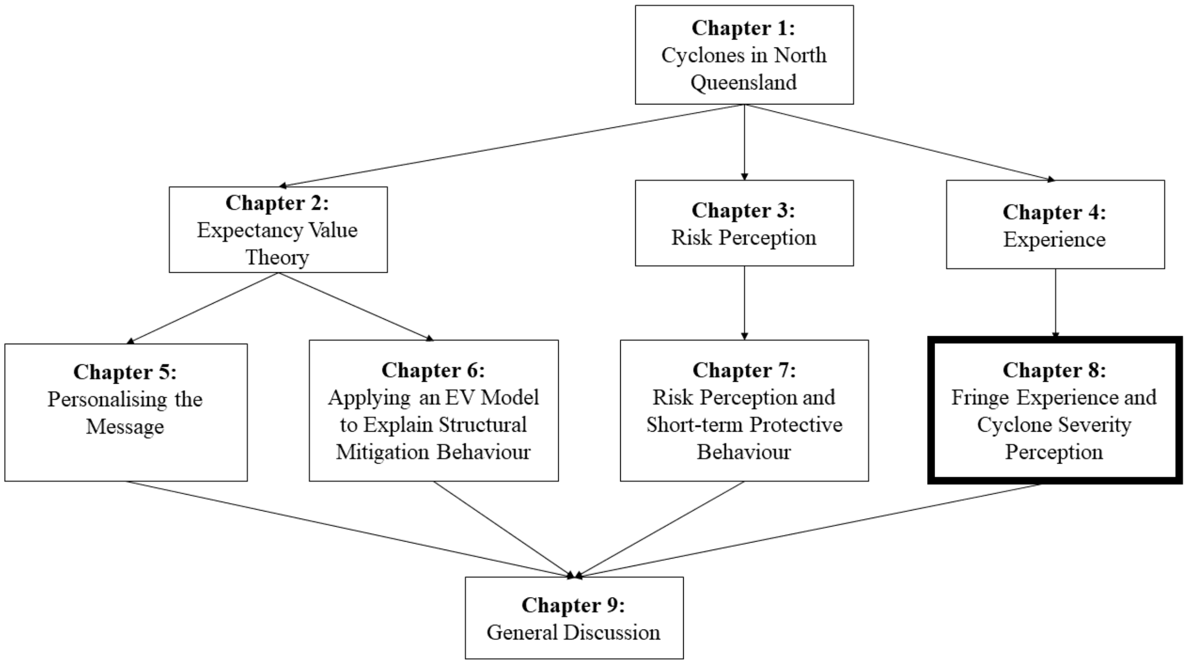
7.6 Summary

The results of the present chapter provide additional support for the adapted EV model outlined in Chapter 2. The present study's findings show that the adapted EV model can explain both long-term and short-term cyclone mitigation behaviour. As discussed in the previous two chapters, it was found that *protective action perceptions* were some of the strongest predictors of general preparedness behaviour. As hypothesised, *risk perception* significantly increased short-term protective intentions when controlling for hazard severity and probability. Moreover, the ability to associate negative emotions with predicted damage was demonstrated to be a relatively strong predictor of preparedness intentions. Unlike the findings in Chapter 7, however, *hazard intrusiveness* was unrelated to protective intention in the present study. The conflicting results provide further evidence that increased thinking and talking about a hazard may only lead to protective behaviour when a protective response is required in the absence of an immediate threat (i.e., long-term mitigation behaviour). Rather it is the heightened *risk perception* is what leads to protective behaviour when a hazard is imminent. The following chapter will explore the link between *risk perception* and a specific type of cyclone experience.

Chapter 8: Fringe Experience and Cyclone Severity Perception



8.1 Rationale

So far, Chapters 6 and 7 have shown that experience with cyclone related property damage does not appear to have a direct influence on cyclone mitigation behaviour. There is, however, some evidence to suggest that damage experience may, indirectly, influence mitigation behaviour through its effect on risk perception. Chapter 5, for example, identified that people in the 'proactive' cluster group (the group that had the highest intention to install shutters) were more likely to have experienced damage. Similarly, Chapter 6 showed that risk perception was significantly correlated with damage experience. In Chapters 5-7 though, only one type of experience had been assessed: the extent of property damage experienced. The aim of the present chapter was to explore a different type of experience and how it influences risk perception.

As outlined in Chapter 4, there are a range of different types of experience that have been shown to influence risk perception in a variety of different ways. Studies have shown that experience with near misses tend to reduce future concern about hazards whereas direct experience with damage tends to increase future risk perception. No studies to date, however, have attempted to empirically investigate the link between fringe experience and subsequent risk perception. As highlighted by Jarrell et al. (1992), most people who have experienced a cyclone have likely only experienced the fringe effects of the storm. As such, it is important to explore how this common experience influences people's cyclone risk perception. The present chapter addressed two main research questions:

1. Do people who have experienced the fringe effects from a cyclone overestimate how severe that cyclone was in their region?
2. Do people who overestimated the severity of their cyclone experience perceive future cyclones as being less severe?

The subsequent content of this chapter has been published as a paper in Disaster Prevention and Management as the following citation:

Scovell, M.D., McShane, C.J., Swinbourne, A.L., and Smith, D.J. (2020) How Fringe Cyclone Experience affects Predictions of Damage Severity. *Disaster Prevention and Management,* ahead-of-print, https://doi.org/10.1108/DPM-07-2019-0228

Paper Starts Here

8.2 Introduction

Tropical cyclones (aka hurricanes, typhoons) cause extreme economic losses and adverse public health outcomes on an annual basis worldwide (Shultz et al., 2005; Pielke et al., 2008). In Australia, the losses from cyclones and non-synoptic storms are larger than those from other natural hazards (Insurance Council Australia, 2014). Given the potential economic losses and threats to human life (Shultz et al., 2005) people living in high-risk areas are encouraged to act protectively in response to cyclone threats. Examples of protective behaviour include evacuation and mitigation strategies, both short-term and long-term (depending on the severity of the threat). Unfortunately, evidence suggests that people living in high-risk areas often do not prepare effectively or evacuate when instructed to do so (Baker, 1991; Grothmann and Reusswig, 2006).

North Queensland is one area of Australia that is highly vulnerable to cyclones (Bureau of Meteorology, 2008). Despite the regularity of cyclone activity in the region, there is a proportion of the population which do not perform even simple preparatory behaviours such as trimming tree branches and having an emergency kit (Kanakis and McShane, 2016). Furthermore, many homeowners in North Queensland report that they are unlikely to invest in any structural upgrades (e.g., cyclone shutters) in the future (Scovell et al., 2018). This paper will use residents of Cairns and Townsville as a case study to investigate why some people in regions like North Queensland are underprepared. People of Cairns and Townsville have been chosen for this study as they are the two most populated cities in North Queensland and they both have a unique history with cyclones.

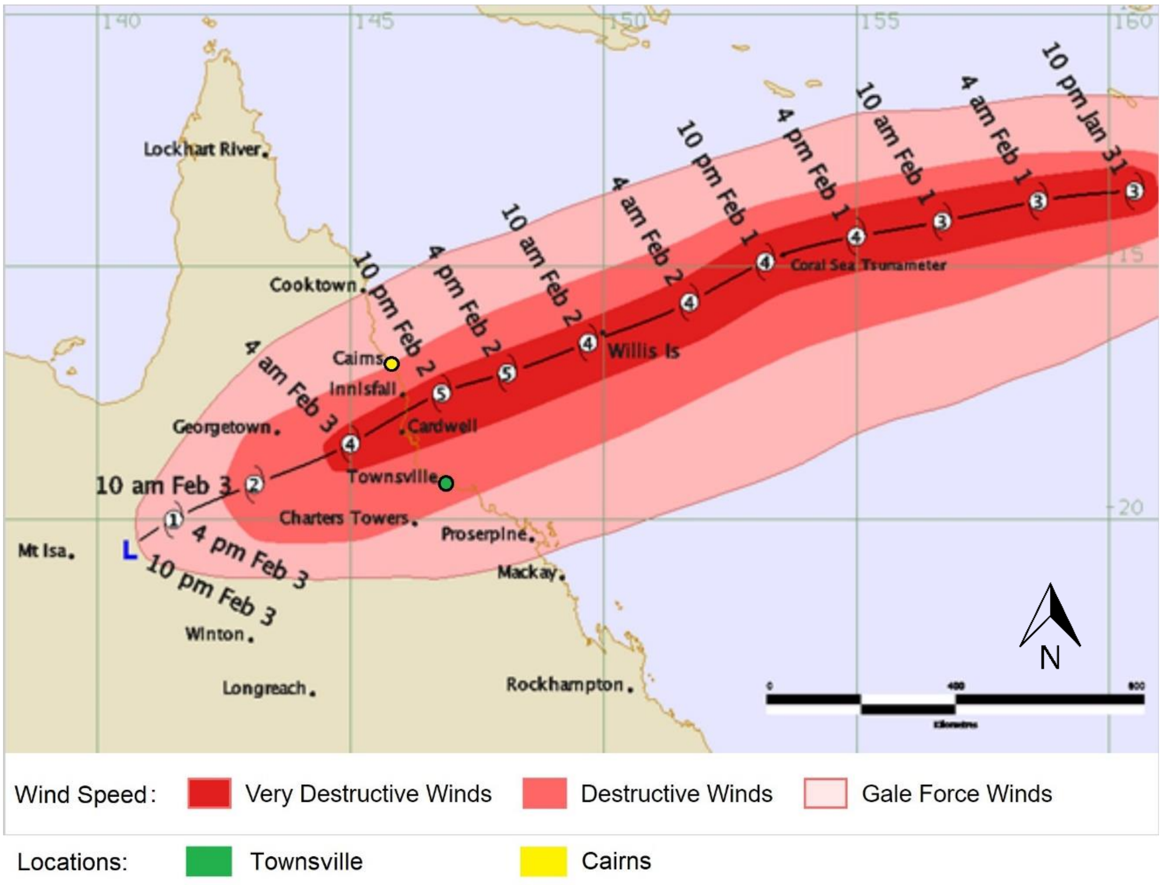
While Cairns and Townsville are both situated in a high-risk area, neither location has directly experienced a severe tropical cyclone (category 3 or above[7]) since 1971 (Bureau of Meteorology, 2018a). However, these cities have experienced the fringe effects of severe cyclones. In 2006, Cyclone Larry (category 5) made landfall close to Innisfail, approximately 90kms south of Cairns (Henderson et al., 2006). Although not hit directly, the Cairns Airport still recorded wind speeds equivalent to a category 1 cyclone (Callaghan, 2006). In 2011, Cyclone Yasi (category 5) crossed the Queensland coast near Mission Beach, approximately halfway between Cairns and Townsville (see Figure 8.1). Although the eye of the storm did

[7] Category levels on the Australian tropical cyclone intensity scale are referenced throughout this paper unless stated otherwise.

not pass through either city, Townsville experienced category 2 wind speeds and Cairns experienced category 1 wind speeds (Smith et al., 2015). These wind speeds still resulted in many residents experiencing minor property damage in both Cairns and Townsville (Smith and Henderson, 2015).

Figure 8.1

Cyclone Yasi's Track and Intensity Information (adapted from Bureau of Meteorology, 2018b)



Although they experienced lesser winds, it is important to consider how people of Cairns and Townsville remember their experience with Cyclone Yasi. Many residents still experienced property damage and others would have seen significant damage to signs, trees, caravans and crops (Bureau of Meteorology, 2018c). As most residents would not have first-hand experience with a more severe cyclone, they do not have an adequate reference point to determine the severity of what they witnessed. Common sources of cyclone information do not explicitly provide a useful reference point either. For example, cyclone track maps (e.g., Figure 8.1) do not show wind speeds/category levels at specific locations. As such, it is difficult for people to determine the severity of the wind speeds that they experienced. Without this information, people are at risk of incorrectly recalling the severity of their experience. If people, for example, overestimate their past experience they could potentially underestimate future cyclone severity.

8.3 Background

8.3.1 The Importance of Accurately Perceiving Risk

There is a range of factors that may explain whether people prepare for a cyclone. Many of the factors that may facilitate or impeded preparedness behaviour are external and, therefore, outside of the individual's control (Moore et al., 2004; Wisner et al., 2012). At the individual level, however, research has shown that how people think about a hazard is a reliable predictor of how they will respond (Floyd et al., 2000; Milne et al., 2000). Many behaviour change theories specify that perceiving a salient level of risk is one of the essential cognitive factors that leads to protective behaviour (Rogers, 1975; Witte, 1992). The Extended Parallel Process Model (EPPM), in particular, specifies that when people perceive that they can do something to reduce a risk (i.e., perceived efficacy), the degree of perceived risk is what determines the magnitude of the response (Witte, 1992). Put simply, the greater the perceived risk, the greater the protective response. However, people do not always perceive risks in the same way. For example, experts perceive risk differently compared to the general public (Peacock et al., 2005). Risk perception is also influenced by a range of well-researched cognitive biases (Finucane et al., 2000; Keller et al., 2006; Loewenstein et al., 2001; Tversky and Kahneman, 1974) as well as people's culture, beliefs and values (Bontempo et al., 1997; Sjöberg and Wåhlberg, 2002; Slimak and Dietz, 2006). As the performance of protective responses is dependent on the individual actually perceiving risk, rather than the presence of objective risk, it is important to understand how individuals perceive risk.

Risk perception is often defined as having two components: perceived probability and perceived severity (Breakwell, 2014). The theory behind most health psychology models also reflects the distinction between perceived probability and perceived severity (Rogers, 1975; Witte, 1992; Janz and Becker, 1984). However, many studies investigating mitigation behaviour towards natural hazards only consider perceived probability when assessing risk perception(Bubeck et al., 2012). Only assessing perceived probability may explain why many studies have found no association between risk perception and the performance of protective behaviours (Bubeck et al., 2012). What seems to be particularly important for explaining people's mitigation behaviour is the perceived severity of consequences as a result of a natural hazard (Sjöberg, 1999). Therefore, understanding the way perceived severity differs to the objective severity of a cyclone is essential for identifying why people respond to the threat of a cyclone in different ways. Understanding how people perceive cyclone severity is particularly important when the objective severity is relatively ambiguous. For cyclones, this is often the case.

It is, however, also important to note wind speed is not the only factor that determines risk. For example, two people exposed to the same wind speed may experience very different consequences. As such, the degree to which a cyclone may cause negative consequences for an individual is depended on their relative vulnerability to the hazard (Cardona et al., 2012). Put simply, exposure does not equal risk. Research does, however, show that, on average, as wind speed increases so too does the damage potential (Murnane and Elsner, 2012), which can lead to death, physical harm and negative mental health outcomes (Bourque et al., 2006). As such, this paper will define the cyclone category (i.e., wind speed) as the objective severity of the cyclone as it correlates with the damage potential of the cyclone.

8.3.2 Experience

Research suggests experience with natural hazards promotes future performance of protective behaviours and that this relationship is, at least partially, mediated by risk perception (Becker et al., 2017; Lindell and Hwang, 2008; Weinstein, 1989). In other words, experience is argued to promote protective behaviour via experience increasing perceived risk. There are however inconsistencies in the literature as some studies have found that experience is associated with a decrease in the performance of subsequent protective behaviour (Rincon et al., 2001). The inconsistencies suggest that not all hazard experience is the same and that the type of experience (e.g., property damage vs no property damage) determines the potential change in risk perception. If someone has experienced damage in the past it is understandable that their first-hand experience would increase their perception of cyclone severity. What may not have the same effect on behaviour is experience with near misses or, in this case, with the fringe effects of a cyclone. Baker (1991) describes this outcome as a “false experience”. Having a “false experience” is an important distinction as experience may either be beneficial or detrimental for future protective behaviour depending on the type of experience. Exposure to the risk of events without experiencing the full impact of the event may result in people becoming overconfident and no longer perceiving risk (Svenson, 1981; Johnson et al., 1993; Perry and Lindell, 1990). In the context of the current study, people living in Cairns or Townsville could potentially become overconfident as they have had significant experience with near misses in the past. In other words, they have significant exposure to “false experiences”.

To determine if experience influences perceived cyclone severity, Morss and Hayden (2010) conducted a qualitative study. In this study, 49 participants were interviewed after experiencing a Saffir-Simpson Category 2 Hurricane (equivalent to a Category 4 Cyclone in Australia). In the interviews, they were asked to reflect on the extent of the damage caused by

Hurricane Iyke and asked if they would have predicted that extent of damage before the hurricane. Of the sample interviewed, only 4% experienced no damage. This is in contrast with the perceptions held before the event. Just over 20% reported that prior to the event they did not think they would experience any damage. The evidence suggests that this discrepancy in expectations was due to inaccurate estimates of event severity. One respondent specifically stated that she did not think a Category 2 Hurricane could cause so much damage. When interviewed, 40% of the respondents said they would be more scared about future hurricanes (Morss and Hayden, 2010). The finding suggests that before experiencing an event, people tend to underestimate cyclone damage potential. However, perceived cyclone severity appeared to increase after exposure to an event that was worse than expected. As this study investigated direct experience with high category cyclones, it is still unclear how individuals perceive cyclone severity changes after an experience with near misses or fringe events.

The potential influence on perceived threat severity from “false experience”, in the form of near misses, has since been tested in an experimental study. In this study, participants were given risk information about an upcoming hurricane in a computer-based game-like simulation (Meyer et al., 2013). Participants were shown the predicted track and likely severity of an impending hurricane. They then had to decide whether to prepare or not prepare based on that information. The researchers found that people with more hurricane experience were more likely to postpone their preparedness behaviours than those with less hurricane experience. The authors suggest that an explanation for this effect was that most of the sample had a very specific type of experience: most of the respondents only experienced the fringe effects of a strong cyclone. Despite only experiencing the fringe of a hurricane, these respondents may have felt they had experienced a hurricane at its destructive peak. As a result, these respondents may have developed a “false perception” of how they should respond as they perceive their preparations were sufficient for the last hurricane. Meyers et al.

(2013) experimental findings offer insight into what may occur in Cairns and Townsville as many residents may not have experienced the destructive potential of a severe cyclone but may think they have.

8.3.3 Perception of Cyclone Severity

Regardless of the influence of experience, research suggests that certain aspects of cyclone risk may be underestimated more than others (Pennings and Grossman, 2008; Meyer et al., 2013). While people seem to be able to interpret cyclone probability information, they may not have the ability to appropriately conceptualise cyclone severity (Pennings and Grossman, 2008). Researchers investigating real-time behaviour in response to the 2012 Atlantic Hurricane Season found that people tended to overestimate hurricane likelihood but they were not as concerned about the potential damage (Meyer et al., 2014). One explanation for this finding is that cyclone severity information is relatively ambiguous, often represented by a category number. People are then expected to interpret that number and respond appropriately. This is argued to result in protective behaviour that is dependent on their interpretation. For example, one person may decide that a Category 3 Cyclone is severe enough to require evacuation while the other may decide that no preparation is necessary.

One study experimentally investigated how exposure to cyclone level wind speeds influences risk perception (Duzgun et al., 2012). In this study, participants were given appropriate protective gear and asked to stand inside a wind tunnel. They were then exposed to 10, 20, 30, 40, 50 and 60 mph winds at 20-second intervals. The researchers found that participants were able to accurately predict slower wind speeds but as wind speeds increased, participants started to overestimate wind speeds. The fastest wind speed shown in this study was equivalent to a Category 2 Cyclone wind speed. At this speed, participants reported, on average, that they thought the speed was equal to a Category 3 Cyclone (Duzgun et al., 2012).

The researchers also found that the degree of overestimation increased risk perception (operationalised as the estimate of personal injury on a 10-point scale). It was also found that past experience moderated the degree of overestimation: no hurricane experience resulted in more overestimation whereas experience with 10 or more hurricanes resulted in more accurate predictions of wind speed (Duzgun et al., 2012). These findings suggest that experience with multiple cyclones seems to make estimates of wind speed more accurate when watching wind speed in real time. It is unclear, however, how these perceptions of wind speed and risk perception change over time and if the same effect occurs with people who have had minimal experience or only experience with fringe effects.

Another qualitative study also supports the finding that people tend to overestimate wind speeds. Miller et al. (2016) compared human assessments of wind speed and wind speeds measured by weather stations. The researchers found that people tend to overestimate wind gust factors by approximately a third. The researchers suggested fear may have a mediating effect on assessments of wind speed (Miller et al., 2016). A well tested psychological model, the Extended Parallel Process Model (EPPM), would also support the effect that fear has on perceived threat (Witte, 1992). For instance, according to the EPPM framework, high levels of fear results in people perceiving the threat to be a larger and less manageable threat than it may be. Fear may help to explain why people who have only experienced low category cyclones may overestimate how severe the cyclone was. Even lower category cyclones can cause potentially frightening outcomes (e.g., loss of power and fallen trees/street signs). Without broader experiences of cyclonic events, the individual only has one reference point. If this reference point is a low category but fear-provoking event, it is not surprising they would overestimate the severity. People with only fringe cyclone experience would be particularly vulnerable to overestimating the severity, especially if they felt fearful without exposure to the full extent of the storm.

8.4 The Present Study

Findings from past research suggest that people tend to underestimate cyclone severity and that experience can change how people perceive cyclones. The current study aimed to clarify the link between fringe cyclone experience and perceived cyclone severity. As such, this paper investigated two main hypotheses:

H1: People who have experienced the fringe effects from a severe cyclone will overestimate how severe that cyclone was in their region.

H2: People who overestimated the severity of their cyclone experience will perceive high category cyclones as being less severe than the events are. Such individuals will predict less damage from severe cyclones in the future.

To test these hypotheses, people living in North Queensland were recruited to complete a survey. The purpose of this survey was to assess the degree to which people overestimate cyclones and how this affects their perception of cyclone severity. This study was part of a larger research project conducted in North Queensland but for the present study, only respondents from Cairns and Townsville who experienced Cyclone Yasi were used in the subsequent analysis. This particular subsample was used due to their unique experience with near misses and their relatively recent experience with the fringe effects from Cyclone Yasi.

8.5 Method

8.5.1 Participants

The study was available to complete between the 30th of June, 2017 and the 19th of November, 2017. A total of 155 respondents from Cairns or Townsville reported having experienced Cyclone Yasi. There were 14 males and 38 females from Cairns and 38 males and 65 females from Townsville. The average age of the respondents was 45.9 years

(SD=13.6 years) with a range of 19 to 76 years. The average number of years living in their current location was 18.2 years (SD=11.8 years) with a range of 7 to 65 years. Most frequently respondents reported that they were married (58%), were homeowners (79%) and just over half of the sample (60%) did not have any dependent children. The demographic characteristics were similar for both Townsville and Cairns samples. Figure 8.1 shows the study locations in relation to the Cyclone Yasi track map. In in Figure 8.1 Cairns is represented by a yellow dot and Townsville by a green dot.

8.5.2 Measures

8.5.2.1 **Demographics.** Respondents were asked to provide information regarding their age in years, their sex, marital status and the region in which they live. They were also specifically asked how many years they had lived in their current location and how many dependent children they had by recording any number. Finally, they were asked if they owned a home in North Queensland (answering yes or no).

8.5.2.2 Experience. Respondents were asked to answer yes or no as to whether they had experienced Cyclone Yasi. They were subsequently asked if they experienced property damage due to Yasi (yes or no). The questionnaire also asked respondents to report the category level winds they believed they experienced due to Cyclone Yasi (per the Bureau of Meteorology Tropical Cyclone Category System, 1 to 5 scale).

8.5.2.3 Predicted Damage Severity. Predicted cyclone damage potential was assessed by asking respondents to predict the extent of property damage they would expect in relation to three cyclone events: a category 1-2 cyclone, a category 3-4 cyclone and a category 5 cyclone. Respondents were asked to imagine that the hypothetical event would occur in the next week to avoid them considering the mitigating effects from future property upgrades in their predictions of damage. However, they were asked to assume that they would have performed their usual level of household preparedness. Responses to the three cyclone scenarios were assessed on a seven-point scale (1-7) with seven indicating ‘very high’ damage and one indicating ‘very low’ damage.

8.5.2.4 Procedure. Ethics for this study was obtained through the James Cook University Human Research Ethics Committee**.** The survey was available online using the Qualtrics online platform. The survey was first disseminated via social media platforms such as Facebook and Twitter through the researcher’s networks. A Facebook page was also created that provided information about the study and a link to the survey. There was also additional media exposure that informed people in North Queensland about the study. Radio and TV interviews and newspaper articles informed people about the survey and provided links to the survey via the Facebook page. Information sheets were presented to the respondents as part of the online survey before starting the questionnaire. The questionnaire took approximately 20 minutes for respondents to complete.

8.6 Results

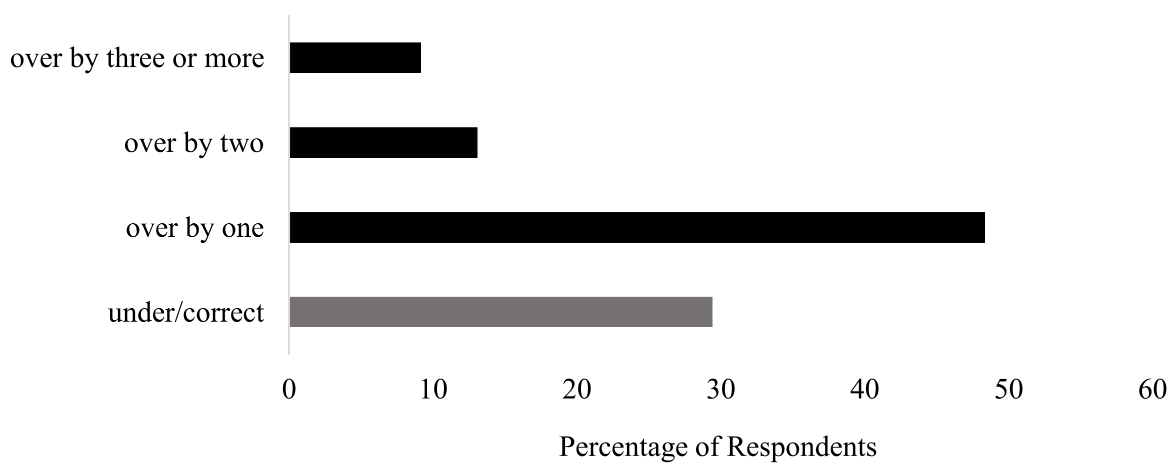
The methodology of this paper was built on the assumption of ontological realism. This ontological position assumes that there are genuine differences between people in terms of how they view the world. These differences can, therefore, be captured. The way in which these differing perceptions are assessed, however, are influenced by the theoretical perspective and measurement method chosen by the researchers. As such, the results should be interpreted from the perspective of epistemological relativism. In other words, the results of this paper should be interpreted in the context of the theoretical framework applied.

8.6.1 H1: Wind Estimates

To assess the accuracy of wind speed estimates made by participants, objective measures of Cyclone Yasi's wind speed category were subtracted from each participant's estimate of the wind speed category. Objective wind speed categories were based on analysis by the Cyclone Testing Station (Boughton et al., 2011). It was found that, in Cairns and Townsville, people estimated Yasi's wind speeds with the following spread of accuracy: three people underestimated, 42 people accurately estimated, 74 people overestimated by one category, 20 people overestimated by two categories, 10 people overestimated by three categories and four overestimated by four categories. Due to the small number of people who underestimated Yasi's wind speed, these people were grouped with the individuals who accurately predicted wind speed for subsequent analysis. The people who overestimated by four categories were also grouped with people who overestimated by three for the same reason. Figure 8.2 shows the four wind speed error margin groups created and the percentage of respondents in each group. Overall, 70% of people overestimated Cyclone Yasi's wind speed by at least one category.

Figure 8.2

The Error Margin (in cyclone categories) of Cyclone Yasi's Recalled Wind Speed



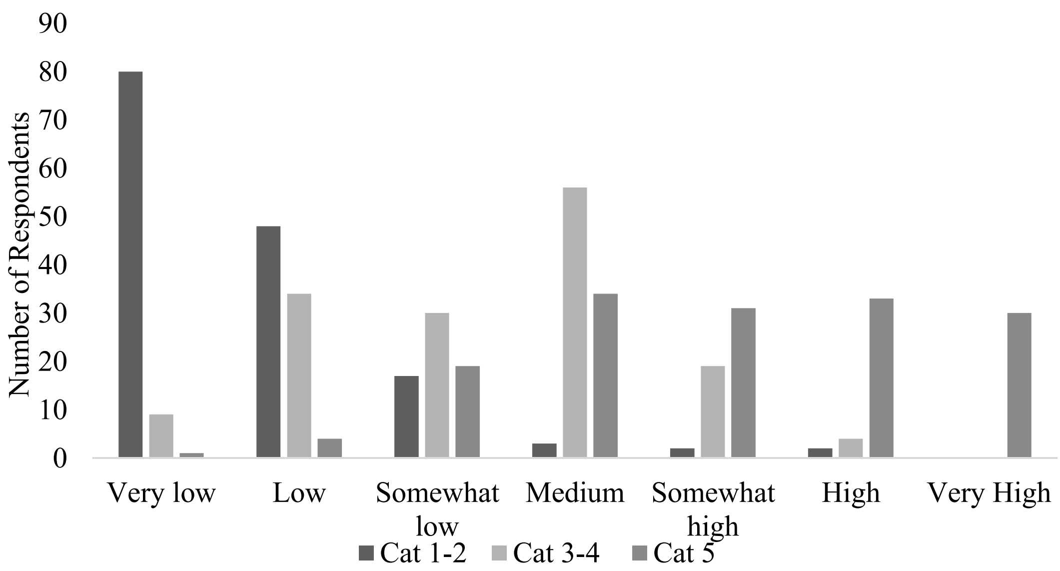
A chi-square test of independence was then used to identify if there was any different between locations and their wind speed error margin. Results showed that there was a pattern between wind speed error rate and whether the respondent lived in Townsville or Cairns (χ^2=16.29, p =.001). It was found that people from Townsville were more likely to overestimate by one category compared to people from Cairns. Conversely, people from Cairns were more likely to overestimate by two categories, or by three or more categories, than were people from Townsville. The percentage of respondents accurately categorising Cyclone Yasi's wind speed was similar between the locations.

8.6.2 H2: Predictions of damage and influence of wind speed error rate

As seen in Figure 8.3, most people indicated that property damage from a Category 1-2 cyclone would be 'very low' or 'low'. Category 3-4 damage was predicted as more severe with people most commonly selecting medium level damage. For Category 5, the estimates commonly ranged from 'medium' to 'very high'. The responses to these questions were treated as continuous variables for the subsequent analyses.

Figure 8.3

Frequency Distribution of Damage Expected Relative to Cyclone Category



One-way analysis of variance (ANOVA) was used to determine if the wind speed error margin influenced respondents' damage predictions. Three separate ANOVAs were conducted using the same independent variable (i.e., wind speed error margin). For the first analysis, the dependent variable was the predicted damage in relation to a Category 1-2 cyclone. The results showed that there was no significant difference between damage predictions depending on the wind speed error margin. Similarly, the second analysis revealed that there was no significant difference between damage predictions for future Category 3-4 cyclones. There was, however, a significant difference between predictions of Category 5 damage with a moderate effect size ($F_{3,147}$=5.43, p=.001, η^2=.10). Furthermore, Tukey post hoc tests indicated that people who overestimated Yasi's wind speed by at least three categories expected the least damage (medium level damage, M=3.93, SD=1.54) whereas people who accurately estimated or underestimated Cyclone Yasi's wind speed expected the most (between somewhat high and high damage, M=5.44, SD=1.34). The difference between these means was significant (p=.003). There was also a significant difference between people who overestimated by one category and people who overestimated by three categories or more (p=.017).

One additional ANOVA was calculated to determine if wind speed error margin still had an influence on predicted Category 5 cyclone damage when controlling for damage experience. As such, damage experience from Cycone Yasi was added to the previous analysis as a two-level idependent variable: no damage (n=74) and damage (n=80). Results showed that both wind speed error margin ($F_{3,142}$=4.70, p=.004, η^2=.09) and damage experience ($F_{1,142}$=5.86, p=.017, η^2=.04) significantly influenced perceived severity. There was, however, no signficiant interaction effect. Pairwise comparisons showed that people with damage experience predicted higher levels of damage (M=5.11, SE=.21) compared to those without damage experience (M=4.43, SE=.19).

8.7 Discussion

As evaluating cyclone risk has been argued to depend on experience (Keller et al., 2006; Weinstein, 1989; Sattler et al., 2000), this article aimed to understand how people in cyclone-prone regions recall the severity of past events and how this subsequently influenced future risk perception and mitigation intentions. This research isolated two regions which have a unique experience with frequent near misses and fringe events (Bureau of Meteorology, 2018a). It was found that people did tend to overestimate past cyclone severity, which had an influence on future cyclone severity perception. Explanations for these findings and resulting implications for cyclone risk reduction and future research will be discussed.

8.7.1 Wind Speed Estimates

The first hypothesis examined whether people who have had recent experience with a fringe event would overestimate the wind speed they experienced. Results supported this hypothesis as most people (70%) in Cairns and Townsville overestimated the wind speed experienced in their location by at least one category level. Another surprising result was the degree to which people overestimated wind speeds: about a quarter of the respondents overestimated the wind speed by at least two categories. This level of overestimation is the difference between an Australian Classification Category 2 Cyclone and a Category 4 Cyclone, which have vastly different wind speeds and damage potential (Bureau of Meteorology, 2018c). The observed overestimation of the category level experienced is consistent with past research (Morss and Hayden, 2010). The overestimation of wind speed identified in the current study shows a disconnection between objective measures of wind speed and individual recollection of cyclone severity.

This research also found that the degree of overestimation was influenced by location. It was found that Townsville residents were more likely to overestimate Cyclone Yasi's wind speed by one category whereas Cairns residents were more likely to overestimate Yasi's wind speed by two or more categories. This result indicates that even though Cairns experienced lower level category winds, respondents in either location thought they experienced similar wind speeds. One explanation for this result is that most people have limited access to information regarding the wind speed of a recent cyclone. For example, the Bureau of Meteorology (Australia's meteorology organisation) only provides information about the maximum category and the cyclone's tracking map (Bureau of Meteorology, 2018b). The Bureau does not provide information about wind speeds in specific towns and cities. Most people, therefore, must make an estimate of the wind speeds they experienced in their location based on this information alone. This may help to explain why past research found that people who had only experienced the fringe effects of severe cyclones were more likely to postpone preparedness behaviour (Meyer et al., 2013). In the Meyer et al., (2013) study the participants may have become complacent as they thought they had experienced a more severe cyclone than they actually did. These participants may not have realised that they experienced lesser winds than those reported by the weather authorities.

8.7.2 Damage Predictions

The second aim of the study was to identify whether there was a link between perceived cyclone severity experience and future assessments of damage potential. It was hypothesised that overestimating past cyclone wind speed would decrease estimates of future cyclone damage. The hypothesis was partially supported as respondents who overestimated Cyclone Yasi's wind speed to a greater extent predicted less damage from a future Category 5 Cyclone. There was, however, no significant difference in predictions for category 3-4 events and category 1-2 events. The low variability in terms of expected damage could explain why there was no significant difference in damage predictions for low category cyclones. That is, most respondents predicted lower level damage from a Category 1-2

Cyclone regardless of their experience. Low variability is unsurprising considering most people who had experienced Cyclone Yasi (a Category 1 for Cairns and a Category 2 for Townsville) thought they experienced a higher category cyclone than what was measured in their location. As such, predictions of future damage would be less or similar to the damage they received from Yasi, which for half of the sample, was minimal. In other words, consistently low damage predictions make sense in that most of the respondents thought they had experienced a more severe cyclone.

There was slightly higher variability in predictions about category 3-4 damage but the difference in responses was still not significant. One explanation for this finding is that even respondents who accurately estimated Cyclone Yasi's severity (e.g., Townsville residents who thought it was a category 2) may not have thought that a category 3-4 could cause more damage. For example, experiencing no damage from a Category 2 Cyclone may lead an individual to think that a Category 3-4 Cyclone would only cause minimal damage. This explanation is consistent with the results as about half of the respondents predicted 'somewhat low' or less damage for a Category 3-4 Cyclone. Although overestimating past cyclone wind speed did not influence severity predictions for a Category 3-4 Cyclone, the lower levels of prediction about category 3-4 level property damage does still represent an overall underestimation of the damage potential. Nearby regions that experienced category 3-4 level winds in their area saw significant and widespread property damage. Considering the fact that a Category 3-4 Cyclone can cause such widespread damage, the findings of this study show that in the aggregate people seem to be underestimating the damage potential of Category 1-4 Cyclones, regardless of their perceived experience with stronger winds. These findings support the obesevations made by Meyer et al. (2014) that people tend to underestimate the damage potential of cyclones.

Despite the lack of association between perceived wind speeds and predicted damage for Category 1-4 Cyclones, the hypothesis was partially supported when it came to Category 5 damage predictions. It was found that people who had overestimated Cyclone Yasi's wind speed category tended to underestimate future damage from a Category 5 Cyclone. More specifically, the results showed that people who overestimated Cyclone Yasi by three or more categories predicted less damage compared to those who accurately predicted or overestimated by one category. There was, however, no significant difference in damage estimates between people who accurately estimated and those that overestimated by one or two categories. The higher amount of variability in responses for predictions about category 5 damage could explain this finding. The high variability suggests that there is uncertainty about the severity of a Category 5 Cyclone. The uncertainty is expected considering most of the respondents had not experienced a Category 5 Cyclone, but some respondents thought they had (or a least close to a Category 5). As mentioned before, the wide variety of damage predictions for Category 5 Cyclones is concerning since even modern structures (built to engineering cyclone code) start to fail at this category (Henderson and Ginger, 2008).

8.7.3 Limitations

This study is not without limitations. The first is that the sample is self-selected as participants had the ability to choose whether or not they wanted to participate in the study. However, past research has found that online self-selected samples are at least as diverse as traditional sampling techniques used in psychology research (Gosling et al., 2004). The present study supports this claim as the sample was relatively diverse in relation to most demographic factors (e.g., average age is 45.6 years and ranges from 19 to 76). Because the sample was self-selected it is also reasonable to assume that people who were, on average, more informed about cyclones may have been more likely to participate. If anything, the sample in this study would be more informed about what Cyclone Yasi's category was in their location and, therefore, more likely to report the category correctly. As such, even though this sample is self-selected it is likely the results would be replicated with larger and more diverse sample.

The second limitation is that this study did not investigate the relationship between perceived severity and protective behaviour (e.g., evacuation or household preparedness). As such, it cannot be confirmed that a decrease in perceived severity of future property damage based on overestimating past wind speed categories necessarily leads to less protective behaviour. While past research does suggest that perceived severity of consequences is an important predictor of protective behaviour (Semenza et al., 2011; Sheeran et al., 2014; Sjöberg, 1999), there are a range of other factors that also explain protective behaviour. For example, the perceived efficacy of a protective behaviour and perceived self-efficacy have shown to be particularly strong predictors of protective behaviour (Kanakis & McShane, 2016; Terpstra & Lindell, 2013). People are also influenced by social factors like community participation and trust in authorities (Paton et al., 2010). Although it was beyond the scope of this study, future research should consider investigating how perceived severity of future damage influences protective behaviour while controlling for the influence from other psychological and social factors.

8.7.4 Recommendations

The results suggest that it may be useful to communicate to people the extent to which cyclone intensity differs based on location. Explaining the difference in cyclone intensity may be particularly important for people who have experienced the fringe effects of cyclones who tend to overestimate cyclone intensity in their location. Currently, there is a lack of precision in the way that such information is disseminated. Generally, the public is told where the cyclone made landfall and the category level of the highest wind speeds. People are not provided with wind speeds that are specific to their location. As such, a clear implication from this research is that people should be able to access location specific information about the wind speed, and corresponding category level during and after a cyclone event. This information will help them to comprehend the damage potential associated with specific wind speeds/category levels. While other external factors may still impede an individual's protective behaviour, this information will help to empower people by giving them the requisite knowledge to make informed decisions about their own cyclone risk.

The findings of this research also have implications outside of Australia. Although other countries use different cyclone classification systems, most countries still communicate wind speed using a graded classification system (e.g., Category 1 to Category 5). Even countries that refer to cyclones as 'hurricanes' or 'typhoons' still use graded wind speed classifications. In these countries it is still important for residents in cyclone-prone areas to be able to access location specific information about an incoming or past cyclone. One method of disseminating such information may be through a website or smartphone application run by the government or disaster management coordinators. A smartphone application, for example, would be able to provide location specific information about past and incoming cyclones based on an address specified by the user. Regardless of dissemination method used, the key is to give people an accurate reference point relative to their personal experience so they can better conceptualise the damage potential of future cyclones.

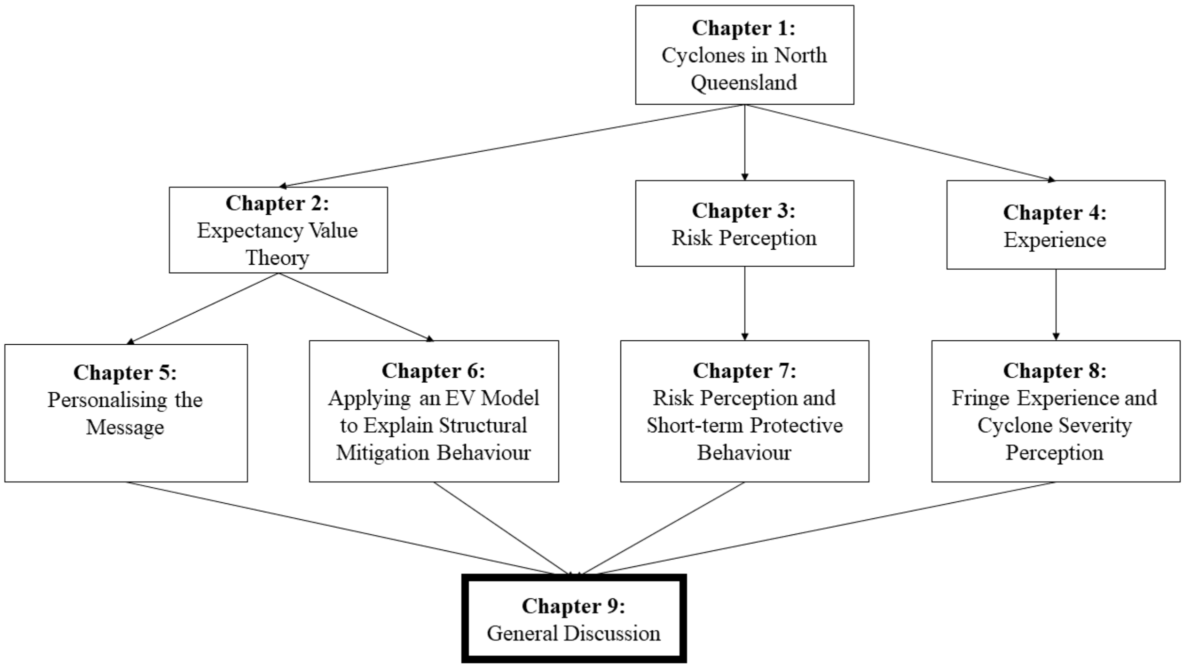
Paper Ends Here

8.8 Summary

In the context of the overall thesis, results of this paper indicate that the link between experience and risk perception is dependent on the type of experience. Further supporting the claims made by other researchers (e.g., Demuth et al., 2016; Weinstein, 1989), the results indicate that researchers need to be precise in how they are conceptualizing and operationalizing experience. As found in the present study, people who have had fringe experience tend to overestimate the severity of the cyclone they have experienced. Furthermore, the more people overestimated the severity of their past experience the more they tended to perceive that future severe cyclones will cause low levels of damage. These results provide further evidence that certain types of experience lower risk perception as opposed to increasing it as most theories suggest. The findings are also consistent with research showing that people can develop a ‘normalisation bias’ after natural hazard experience in that they tend to predict that future impacts will be similar to what they have experienced in the past (Johnston et al., 1999; Mileti & O’Brien, 1993). Acknowledging that fringe experience can influence risk perception helps to explain the inconsistent relationship between experience, risk perception and protective behaviour identified in past natural hazard research.

The findings from this also suggest that more location-specific information regarding cyclone intensity may help people to appraise future cyclone severity more accurately. Location-specific information regarding cyclone wind speed and impacts could be provided to people after an event (when accurate information becomes available) so they can link their subjective experience with wind speed information. Such information could be disseminated via smartphone applications or natural disaster information websites. Providing location-specific wind speed information may help to reduce the extent to which people underestimate the severity of future cyclones and, therefore, increase levels of both general preparedness and structural mitigation behaviour.

Chapter 9: General Discussion



The overall aim of this research project was to understand the psychological factors that influence cyclone mitigation behaviour. Based on a review of the literature (Chapters 1-4), several research questions were formulated and answered in the study chapters (Chapters 5-8). This final discussion chapter summarises the research and reviews how previous chapters collectively address the broader aim of the project. This final chapter will start by reviewing the main findings of the project and their role in explaining how and why people prepare for cyclones. The subsequent sections will highlight the main findings from Chapters 5-8 and how they relate to each chapter's research questions. The present chapter will end with a discussion of the broader limitations of the project and highlight the main theoretical and practical implications from this research.

9.1 Summary of Research

To understand the psychology behind cyclone mitigation behaviour, it was first important to differentiate between the different types of cyclone mitigation behaviour. As discussed in Chapter 1, one of the worst consequences from cyclones is the wind-related property damage. Therefore, the research was focused on mitigation behaviours aimed at reducing wind-related damage. Chapter 1 explained that effectively reducing wind-related property damage requires both structural upgrades (e.g., installing cyclone shutters) and general preparedness (e.g., cleaning up yard). While these behaviours differ in the time and cost required to perform them, they both have been shown to reduce damage. Subsequent chapters were thus focused on reviewing psychological theory that could explain both types of cyclone mitigation behaviour.

9.1.1 ***Expectancy Value Theory***

There are a range of psychological factors that have been shown to influence natural hazard mitigation behaviour (Bubeck et al., 2012; Ejeta, Ardalan, & Paton, 2015; Lindell, 2013). However, few studies have investigated psychological factors that predict cyclone related structural mitigation behaviour. Chapter 2 established that Expectancy Value theories such as the Protection Motivation Theory (PMT) and Protective Action Decision Model (PADM) can help to explain protective behaviour for other natural hazards (e.g., flood and earthquake). Complete versions of these theories, that assess both *risk perception* and *protective action perceptions*, had yet to be applied to explain structural mitigation behaviour in response to cyclones. The central research aim for this project was to test whether an EV theory could explain this unique form of protective behaviour.

Chapter 5 was the first attempt at applying an EV theory to explain cyclone related structural mitigation behaviour. The study reported in this chapter was exploratory in nature since such a model had yet to be applied in this context. Supporting past research, it was found that the *perceived efficacy* of cyclone shutters was one of the strongest predictors of behaviour. However, in contrast to past research, the *perceived cost* associated with installing cyclone shutters was also found to be a strong predictor of behaviour. *Risk perception,* while a significant predictor, had less of an influence on mitigation behaviour. Perceived *visual appeal* of cyclone shutters was also an important psychological factor in predicting behavioural intention; a variable that had not been considered in past empirical studies.

The second research question in Chapter 5 was whether specific patterns of cognition lead to mitigation behaviour. This research question was primarily informed by the theoretical foundation of the Extended Parallel Process Model (EPPM). It was found that when respondents were clustered based on *risk perception*, *perceived efficacy*, *perceived cost* and *visual appeal*, only one cluster group was significantly more likely to have installed cyclone shutters (or have intentions to do so in the future) in comparison to the other cluster groups. In support of the EPPM, it was found that this 'proactive' group had the highest level of both *risk perception* and *perceived efficacy*. The findings supported a central claim made by Witte (1992) that protective response is stronger when both *risk perception* and *perceived efficacy* are relatively high.

Another finding that warrants discussion is the link between *risk perception* and mitigation behaviour. While *risk perception* helped to differentiate cluster groups in Chapter 5, it was a relatively weak predictor of mitigation behaviour. There are at least two explanations for this result. One explanation is that the 'sufficient level' of *risk perception* that leads to a mitigation behaviour (in accordance with the EPPM) may be relatively low. The other explanation is that the *risk perception* measure used in this study did not appropriately capture the strongest psychological driver of protective behaviour. Past research suggests that *hazard intrusiveness* (a construct that covaries with *risk perception)* is a stronger predictor of mitigation behaviour in studies where it has been assessed (Lindell, 2013). Subsequent analysis showed that when *hazard intrusiveness* and *risk perception* are included in a regression model, only *hazard intrusiveness* is a significant predictor of structural mitigation behaviour.

While Chapter 5 reported that an EV theory can explain cyclone related structural mitigation behaviour, this study did not address all the knowledge gaps identified in the literature. It was also unclear from Chapter 5 the extent to which both experience and demographic factors directly influence protective behaviour. Finally, there is debate amongst researchers regarding the overlap and differences between the factors that make up *protective action perceptions* and how they relate to structural mitigation. As such, Chapter 6 aimed to answer the remaining unanswered research questions relating to the application of an EV theory to explain structural mitigation behaviour.

The first research question Chapter 6 addressed was the relative importance of psychological factors compared to demographic and experience factors for explaining structural mitigation behaviour. Chapter 6 used shutter status (a combined measure of behaviour and intention) as the outcome variable in the analyses. Experience with property damage and all the demographic factors had no significant influence on shutter status when controlling for psychological factors. This finding partially supported past research showing that demographic factors are inconsistent predictors of mitigation behaviour (Bubeck et al., 2012; Lindell, 2013). In contrast to past research, damage experience did not appear to have an influence on mitigation behaviour.

While psychological factors were more important than demographic and experience factors for explaining shutter status, some psychological factors were also more important than others. Addressing the second research question, the results showed that perceptions towards the mitigation measure (i.e., efficacy and cost) had a stronger influence on behaviour than perceptions towards the hazard (i.e., intrusiveness and risk perception). This finding also supports past research showing that *protective action perceptions* (or *coping appraisal*) are stronger predictors of mitigation behaviour than *risk perception* (Floyd et al., 2000; Grothmann & Reusswig, 2006; Milne et al., 2000; Terpstra & Lindell, 2013).

Contrary to past research, perceptions about the cost of cyclone shutters were one of the strongest predictors of behaviour. In other research investigating mitigation behaviour for different natural hazards, perceptions about cost tend to be weak or non-significant predictors of behaviour (Lindell & Prater, 2002; Lindell & Whitney, 2000; Terpstra & Lindell, 2013). It was, however, hypothesised that because cyclone shutters are more costly to install (in terms of time, effort and money) compared to mitigation behaviours for other natural hazards (e.g., having an emergency kit or using sandbags), *perceived cost* would be a significant predictor of cyclone mitigation behaviour. The results supported this hypothesis and suggest that the relationship between *perceived cost* and protective behaviour is dependent on the type of behaviour. Put simply, *perceived cost* only seems to influence protective behaviour when the behaviour is objectively costly.

Another research question addressed in Chapter 6 was the extent to which *hazard intrusiveness* had an influence on cyclone mitigation behaviour. As explained in Chapter 2, this construct has not been included in many empirical studies. The studies that have included *hazard intrusiveness*, though, have found it to be a consistent predictor of behaviour (Lindell, 2013). Supporting past research, the results of Chapter 6 showed that *hazard intrusiveness* was a significant predictor of structural mitigation behaviour, but *risk perception* was not. The findings suggest that the extent to which people think and talk about a hazard should be considered in future theoretical models.

It is was also unclear from past research how *protective action perception* variables should be categorised within an EV framework for explaining structural mitigation behaviour. Chapter 6 aimed to address this knowledge gap. By assessing additional factors relating to the overall utility of a structural upgrade (i.e., perceived visual appeal and property value increase) it was found that people tend to think about the benefits and efficacy of a structural upgrade differently. In other words, the *perceived efficacy* (i.e., the degree to which harm and damage can be mitigated) and the *perceived benefits* (i.e., the additional benefits beyond damage reduction) can be considered separate constructs. Perhaps most surprisingly, it was found that when *perceived efficacy* and *perceived benefits* were included in a regression model, only *perceived benefits* was a significant predictor of behaviour. This finding has significant practical and theoretical implications, which will be discussed further in the implications section.

This research project also aimed to examine the extent to which the adapted EV theory can explain short-term cyclone preparedness behaviour. As opposed to Chapters 5 and 6, which focused on structural mitigation behaviour, Chapter 7 explored two categories of short-term protective behaviour: general preparedness and evacuation. Supporting the first two studies, it was found that *protective action perceptions* were strong predictors of intentions to perform two preparedness behaviours (plywood covering on windows and a water ingress mitigation measure). More specifically, it was found that *perceived efficacy* and *perceived cost* were both strong predictors of general preparedness behaviour. The findings suggest that perceiving that the benefits of a protective response outweigh the costs is one of the strongest psychological predictors of both structural upgrades and general preparedness for cyclones.

9.1.2 ***Risk Perception***

Another aim of this research project was to further explore the relationship between *risk perception* and cyclone mitigation behaviour. It was argued that the inconsistent link found in past research between *risk perception* and protective behaviour for natural hazards can partially be explained by the way in which *risk perception* has been conceptualised and operationalised. This research project aimed to address this problem by investigating a new method of assessing *risk perception*.

It was proposed that one way to improve the assessment of *risk perception* was to control for objective risk. This claim was investigated empirically by controlling several variables that determine objective damage risk: property type, cyclone probability and proximity to the eye of the cyclone. When keeping these variables constant, it was found that increases in cyclone severity (operationalised by cyclone category number) significantly increased *risk perception*, which, in turn increased short-term protective behaviour. The strength of the relationship between *risk perception* and protective behaviour provides a strong case for the importance of controlling variables that determine objective risk, which has not been done in past research.

Beyond showing the importance of controlling objective risk, it was also found that an emotional component of *risk perception* helps to explain preparedness intention. The reviewed literature showed that many researchers are starting to conceptualise *risk perception* as a dual-process phenomenon in contrast to traditional EV theories that conceptualise *risk perception* as purely cognitive. In accordance with this dual-process perspective of *risk perception*, Chapter 7 assessed two components of *risk perception*: *predicted damage* and *anticipated emotion*. The emotional component of *risk perception* was, however, operationalised differently to past research. Empirical studies in this field usually assess emotional *risk perception* by asking people to report how they feel about a future cyclone in the moment (e.g., To what extent do you feel anxious when thinking about a future cyclone?). Instead of using this operationalisation, respondents were asked to anticipate the extent to which they would feel a range of negative emotions in relation to a predicted damage outcome (e.g., a destroyed roof). It was subsequently found that *anticipated emotion* was one of the strongest predictors of both preparedness behaviours.

The results also indicated that differences in how people perceive cyclone severity (i.e., the predicted damage potential) helps to determine their evacuation and preparedness intention. The predicted damage potential was, in turn, associated with the cyclone category number. The findings suggest that people rely on category numbers to determine the severity of a cyclone. While the cyclone category and level of predicted damage were related, the results also show that people predict different amounts of damage when presented with the same category cyclone. It was, however, unclear from this research why two people presented with the same category can predict different levels of damage. One possible explanation is the variability in people's experience with past cyclones and how this influences the conceptualisation of the damage potential of future cyclones.

9.1.3 ***Experience***

While *risk perception* and natural hazard experience tend to be related, the association seems to be dependent on the type of experience. One type of experience that has received minimal attention in past research is fringe experience. Fringe experience, as defined in this thesis, is experience with the fringe effects of a cyclone (i.e., lesser wind speed). An example of fringe experience in a cyclone context is being exposed to what is defined by authorities as a 'Category 5 cyclone', but only witnessing Category 1 level wind speeds due to the distance from the eye of the storm. When considering cyclone experience, fringe experience is common as, probabilistically speaking, people are rarely exposed to the eye of the storm (Jarrell et al., 1992). Although other researchers have speculated that fringe experience might influence risk perception (Meyer, Broad, Orlove, & Petrovic, 2013), the association had yet to be empirically investigated.

It was subsequently found that most respondents overestimated the cyclone category they had experienced during Cyclone Yasi. Moreover, the more people overestimated their cyclone experience, the less damage they expected from a future Category 5 cyclones (even when controlling for the extent of damage experienced). Overall, the findings support the claims that the link between experience and *risk perception* is dependent on the type of experience. Fringe cyclone experience, one type of cyclone experience, seems to lower *risk perception*.

The association between cyclone experience, *risk perception* and mitigation behaviour was also examined in other chapters. However, a more general measure of cyclone experience was used in Chapters 5, 6 and 7. Namely, experience with property damage. As supported by past research, the current project found inconsistent links between damage experience, risk perception and protective behaviour (Baker, 1991; Dow & Cutter, 1998; Lindell, 2013; Siegrist & Gutscher, 2006; Weinstein, 1989). The extent to which an individual had experienced damage had no direct correlation with either structural mitigation behaviour or preparedness behaviour. Moreover, damage experience was only weakly correlated with *risk perception* in Chapter 6 and was not significantly correlated with either *predicted damage* and *anticipated emotion* in Chapter 7.

Differences in study samples provides one explanation for why damage experience only influenced *risk perception* in Chapter 6. Chapter 7, compared to Chapter 6, had a higher proportion of people from Townsville, whom have not had direct experience with a severe cyclone since Cyclone Althea in 1971 (Bureau of Meteorology, 1972). Conversely, the sample in Chapter 6 had a higher proportion of people from areas such as Airlie Beach, Tully and Rockhampton; locations that have had more recent direct experience with severe cyclones (Bureau of Meteorology, 2018a). As the influence that experience has on *risk perception* tends to fade over time (Meyer et al., 2013; Trumbo et al., 2014), a higher proportion of respondents without recent experience with a severe cyclone may explain why damage experience did not influence risk perception in Chapter 7. Another explanation for the inconsistent link between *risk perception* experience comes from Chapter 8: respondents in the Chapter 7 sample may have had more experience with the fringe effects from Cyclone

Yasi and as a result, had lower *risk perception*. Regardless of the cause, the results of this project consistently show that the link between experience, *risk perception* and mitigation behaviour is dependent on the type of experience.

Damage experience also had no influence on anticipated negative emotions. This finding, at first, seems to contradict past research showing that damage experience helps people to conceptualise the negative emotional consequences of a natural hazards (Siegrist & Gutscher, 2008). One explanation for this result is that in the Siegrist and Gutscher (2008) study, respondents were categorised as experienced if the cost of repairing their house was over $833USD. In the same study, the median level of damage to house and contents for the experienced group was $65,000USD, a relatively high amount of damage in the context of cyclone-related property damage (Smith & Henderson, 2015). While it is difficult to directly compare subjective and objective levels of reported damage, it seems clear that there was a higher proportion of respondents in the Siegrist and Gutscher (2008) study that had experienced high levels of damage. The comparison in levels of damage experience between these studies suggests that only higher levels of property damage many cause negative emotional consequences that are salient enough to increase the anticipated negative emotions associated with future natural hazards.

9.1.4 ***Demographic Factors***

In addition to psychological and experience factors, demographic factors were assessed in most studies. A consistent finding throughout the research project was that when controlling for psychological factors, demographic factors were not significantly associated with structural upgrade or general preparedness intention, a result supported by past research (Bubeck et al., 2012; Lindell & Perry, 2012; Terpstra & Lindell, 2013). There were, however, some significant univariate correlations between demographic factors, psychological factors and mitigation behaviour. Moreover, the results indicate that some demographic factors were significantly associated with psychological personas, which, in turn, were related to mitigation intention. Overall, the findings suggest that demographic factors can have an indirect influence on mitigation behaviour due to their effect on psychological factors.

One surprising and consistent finding was the negative influence that higher levels of income and education had on both types of cyclone mitigation intention. While this effect was no longer present when controlling for psychological factors, the finding warrants further investigation due to the potential mediation effects. One explanation for the relationship between education, income and mitigation intention is that people with higher incomes and more formal education may be more likely to own newer houses and, therefore, less likely to think they need to make structural upgrades. People from this demographic may, for example, think cyclones are just as likely and severe as others but because they live in a newer house, they do no predict that it is as susceptible to damage than older houses. There is some evidence to support this explanation as there was a significant negative correlation between education level and *risk perception* seen in Chapter 6. More research, however, is needed to properly explore the connection between income, education, psychological variables and cyclone mitigation behaviour.

9.2 Limitations

This research had limitations that future research should aim to address. Most of the limitations are specific to each study and have already been discussed in the results chapters. There are, however, some broader limitations that pertain to the whole project. The first is that all the studies in the project were based on a cross-sectional survey design. Therefore, like other studies of this nature, causal inferences cannot be derived from the results. Experimentally investigating how people respond to cyclones in real time is difficult for obvious reasons but future researchers may benefit from using emergent technology like virtual reality (VR). This medium has the potential to make cyclone-like scenarios without exposing people to cyclones.

Another limitation of this research project is that only a limited number of cyclone mitigation behaviours were assessed as outcome variables. As such, it cannot be said that the same psychological factors that predict intentions to install cyclone shutters also predict intentions to install roof upgrades. Future research should consider using a similar research design to determine if the same psychological factors also predict the uptake of other structural upgrades. A study focusing on roof upgrades would be particularly useful as the damage associated with substandard roofing leads to significant financial and personal losses.

The emphasis on using intentions as the main outcome variable in this research project presents an additional limitation. While intentions tend to be strong predictors of behaviour in most contexts (Ajzen, 1991), other research has shown that intentions do not always lead to behaviour (Sheeran, 2002; Sheeran & Webb, 2016). As there are also limitations to assessing past behaviour instead of intention as discussed throughout this thesis (i.e., feedback loop and rarely performed behaviours), future research may benefit from considering *implementation intentions* as an additional outcome variable. *Implementation intentions*, as opposed to intentions, clearly specify the conditions under which a behaviour will be performed and have shown to be strong predictors of behaviour (Gollwitzer, 1999; Gollwitzer & Sheeran, 2006). For example, an *implementation intention* to install cyclone shutters could be that an individual has selected an appropriate builder and determined when they will contact them to install the shutters. Including such an outcome variable in future research should provide greater insights into the additional factors that may inhibit someone from translating intention into behaviour.

The way in which *risk perception* was conceptualised and operationalised also differed between the studies. The difference in the assessment of *risk perception* makes it difficult to directly compare the associations between *risk perception* and mitigation intention. In Chapter 6, which focused on structural mitigation as the outcome variable, *risk perception* was assessed using a commonly applied scale. Chapter 7, though, used a different conceptualisation and operationalisation of *risk perception* because of the weak link between *risk perception* and mitigation behaviour identified in Chapter 6. However, as *risk perception* was not assessed in the same way in these chapters, it is difficult to confidently claim that *risk perception* is only important for explaining short-term protective behaviour. It is possible that if *risk perception* was assessed the same way in Chapter 6 as it was in Chapter 7, it may have also been a significant predictor of structural mitigation behaviour. Moreover, it may have been a stronger predictor of structural mitigation behaviour than *hazard intrusiveness*, as it was in Chapter 7.

The focus on using an EV theory to explain human behaviour also meant that other potential antecedents of cyclone mitigation behaviour may have been overlooked. Past research has, for example, found that other social factors such as community participation and social connectedness can influence natural hazard preparedness (Kanakis & McShane, 2016; Paton et al., 2008, 2010). Other research has also found social norms (i.e., perceived social expectations) can also have a significant influence on preparedness (McIvor & Paton, 2007; Najafi et al., 2017). The extent to which social factors influence or interact with psychological factors such as *risk perception* and *protective action perceptions* should be explored in future research.

9.3 Theoretical Implications and Future Research

Although the research project had limitations, it still makes several valuable contributions to many areas of psychological theory. This research project has several implications for the formulation of EV models when applied in a natural hazard context. First, the results show the link between psychological factors and protective behaviour is dependent on the type of behaviour. That is, different psychological factors predict long-term behaviour compared to short-term behaviour. One clear implication is that theoretical models should be adjusted to include relevant explanatory variables based on the context in which they are applied. The more precise a model becomes, the less likely it is to explain other types of behaviour. If, for example, the conceptualisation of variables with the PMT or PADM were followed dogmatically in this research project, important explanatory variables such as the *hazard intrusiveness* and *perceived benefits* would have been overlooked.

Regardless of the theoretical model used, *hazard intrusiveness* should be considered as an explanatory variable when investigating long-term protective behaviour. As long-term protective behaviours do not need to be performed in response to an immediate hazard, thinking and talking about a hazard seems to more important than thinking that a hazard is likely to cause negative consequences (i.e., *risk perception*). As such, future research investigating the psychological factors that influence household adjustments for other natural hazards should assess *hazard intrusiveness*. Although not tested in this research project, *hazard intrusiveness* may also help to explain other long-term focused protective behaviours. Future research should also explore in more detail the extent to which there is a conceptual difference between *hazard intrusiveness* and *critical awareness*, whether this difference can be measured, and if the constructs have different effects on natural hazard preparedness.

As explained by Weinstein (1988), it is an oversimplification to suggest that a one-time appraisal of the risk and benefits associated with a behaviour will lead to a protective response in all contexts. Many health protective behaviours, for example, need to be performed many times (e.g., resisting the urge to smoke, eating health food) to obtain long-term benefits. It is unlikely that an individual will perform a mental cost benefit analysis every time they chose to perform these types of behaviours. These repetitive, long-term focused health behaviours are like structural mitigation behaviour in that they must be performed in the absence of an immediate threat. It may be the case that *hazard intrusiveness* also helps to explain long-term focused health protective behaviours.

Theoretical models should also be updated to include broader aspects of perceived efficacy. In the current research project, the secondary benefits associated with a structural upgrade was one of the strongest predictors of mitigation intention. These secondary benefits, however, are not usually considered with traditional EV models as they are not associated with reducing harm. The PMT and EPPM, for example, explicitly reference *response efficacy* as the perceived efficacy of a protective behaviour for reducing harm (Rogers, 1975, 1983; Witte, 1992). Similarly, studies that reference *outcome expectancy,* instead of *response efficacy,* also tend to assess it as the perceived efficacy of a behaviour for reducing damage (Johnston et al., 2005; Paton, 2003; Paton et al., 2005). The findings suggest that, regardless of the terminology used, studies using EV theories should consider both perceived efficacy and secondary benefits . Assessing perceived secondary benefits may help to explain a range of other protective behaviours in response to natural and health-related hazards. For example, protective behaviour for flooding can require adjustments to property (e.g., raising the ground floor), that could increase overall value and visual appeal of a property. In a health behaviour context, smoking cessation, for example, can save people money, which may be a driver of protective behaviour.

For both long-term and short-term mitigation behaviours, perceived cost was shown to be a reliable explanatory variable. The results provide evidence that perceived cost should be considered in all EV models. Theories that do not currently specify the importance of perceived cost (e.g., the EPPM) should consider including it in the model. It is also evident that people tend to think about different types of costs in the same way. In this research project, the perceived cost in terms of money, effort, time and knowledge/skill requirement were highly correlated.

The concept of *self-efficacy* was found to be best conceptualised and operationalised as a type of response cost in this research (i.e., a knowledge and skill requirement). Both chapter 6 and chapter 7 showed that the perceived knowledge and skill required to perform a behaviour was highly correlated with other costs like money, time and effort. It seems when a protective behaviour is dependent on knowledge or skill, as in the case of cyclone mitigation, considering *self-efficacy* as a cost of knowledge and skill that needs to be acquired is most appropriate. Overall, operationalising *self-efficacy* as a cost supports the utility of the Protective Action Decision Model for explaining mitigation behaviour that requires knowledge/skill as *self-efficacy* is not explicitly referenced within in the model (Lindell & Perry, 2012). When applying a model to explain simpler mitigation behaviours it may, however, be more appropriate to use a more traditional measure of *self-efficacy* as outlined by the PMT and the EPPM.

This research project also provided significant theoretical contributions to *risk perception* research. Supporting the claim made by other research (Sjöberg, 2000), this project showed that objective risk effects *risk perception*. Future research should control the influence from objective risk as much as possible to accurately determine the link between *risk perception* and protective behaviour. Controlling the severity of the hazard has shown to be particularly important. Cyclones, like other natural hazards, differ greatly in terms of their damage potential. Future studies interested in other natural hazards, such as flood or earthquakes, should be clear about referencing the severity of the hazard. In the case of floods, this could involve referencing the depth of water, or in the case of earthquakes, specifying the magnitude (e.g., Richter scale).

Moreover, studies should reference specific outcomes when assessing *risk perception*. For example, instead of assessing 'the perceived likelihood of damage', it may be more appropriate to assess 'the perceive likelihood of a destroyed roof' to keep the severity of the impact constant. Similar question phrasing could also be used to assess *risk perception* towards other natural hazards (e.g., 'flooding in house at least a foot deep' instead of 'likelihood of flooding'). Researchers in other fields that are interested in the link between *risk perception* and proactive behaviour should also consider referencing a specific outcome. Studies investigating health protective behaviour, for example, tend to assess *risk perception* by asking people to determine the likelihood of developing a specific disease and how serious they perceive the disease to be. Some diseases, however, while given the same name, differ greater in their ability to cause death or harm. Skin cancer, for example, is blanket term that is used to describe a spectrum of cancers, only some of which are deadly (Cancer Council Australia, 2020). Most skin cancers that people develop are not deadly and are easily treatable. Yet many researchers assess *risk perception* in relation to skin cancer do not reference as specific type of skin cancer (Bränström, Kristjansson, & Ullén, 2005; de Vries, van Osch, Eijmael, Smerecnik, & Candel, 2012). Future research may find that the link between *risk perception* and protective behaviour becomes clearer when a more specific outcome is referenced. Future research should compare these methods of assessing *risk perception* and see if it has a different influence on protective behaviour.

In addition to referencing outcomes, this research project showed that *anticipated emotion* in relation to damage was found to be a significant predictor of preparedness intention. To date, researchers in a natural hazard context have tended to only investigate *anticipatory emotion* as driver of mitigation behaviour (Demuth et al., 2016; Miceli et al., 2008; Trumbo et al., 2016). The current research project, instead, assessed a range of *anticipated emotions* such as fear, worry and dread. This result shows that the extent to which people anticipate they will feel these negative emotions in relation to a predicted outcome can help to explain protective behaviour. While other researchers have focused on the importance of affect in *risk perception* (e.g., Demuth et al., 2016; Trumbo et al., 2016), the link between *predicted damage* and *anticipated emotion* in this study suggests that emotional appraisal is, to some extent, driven by cognitive appraisal. Future research is, however, needed to determine the extent to which cognitive and affective processes determine *anticipated emotions*. Moreover, future research should continue to assess various types of *anticipated emotions* beyond regret.

Finally, the results show that experience can influence psychological factors and protective behaviour, but the relationship is dependent on the type of experience. This research project found that the extent to which someone has experienced cyclone damage has no direct influence on mitigation intention. However, experience with the fringe effects of a cyclone tends to decrease perceived cyclone severity. It is, therefore, an oversimplification for any theoretical model to predict that experience increases or decreases future preparedness. Theories that aim to predict the relationship between experience, psychological factors and protective behaviour need to be clear about the type of experience they are assessing. Future research should consider comparing different types of natural hazard experience and how they influence psychological factors and protective behaviour.

9.4 Practical Implications

Beyond the theoretical contributions, this research project provides evidence for a range of practical implications. More specifically, the findings can improve both risk communication messaging and policy aimed at promoting cyclone mitigation behaviour. Improvements to messaging and policy also have implications for the broader disaster risk reduction strategies (e.g., Sendai Framework for Disaster Risk Reduction) as the changes would help to address some of the behavioural barriers to cyclone mitigation behaviour. Some of the recommendations in these areas will be discussed below.

9.4.1 Messaging

As discussed earlier, the ways in which people think about cyclones and protective behaviour helps to explain their mitigation intention. One important step in promoting cyclone mitigation behaviour is to, therefore, encourage people to think about cyclones and protective behaviour in a way that is more likely to result in mitigation behaviour. Risk communication messaging building on empirically validated behaviour change theory is one evidence-based method for promoting protective behaviour for natural hazards (Kievik & Gutteling, 2011; Mulilis & Lippa, 1990). Although, as this research project has shown, not all psychological factors relate to different types of cyclone mitigation behaviour in the same way. As such, the content of an effective message needs to be dependent on the desired action. This section will highlight how the content of a message should change depending on whether the desired action is structural upgrades as opposed to general preparedness.

9.4.1.1 Structural Mitigation. For structural upgrades, messaging should not focus on increasing *risk perception*, which is the focus of most messages aimed at promoting protective behaviour. Instead, messaging aimed at promoting structural mitigation behaviour should encourage people to think and talk about cyclones more often. That is, these messages should aim to increase *hazard intrusiveness.* As discussed earlier, structural upgrades must be installed in the absence of an immediate threat and there is no deadline for their installation. Messaging that is aimed at increasing the frequency in which the thoughts of cyclones intrude on people's everyday life may be one way of encouraging mitigation behaviour. Currently, local government in areas such as Townsville tend to concentrate cyclone messaging to the start of the cyclone season. To promote structural upgrades, local governments should, instead, consider shifting their focus to promoting intermittent awareness of cyclones throughout the year.

It was also clear from this research that people who are more likely to invest in a structural upgrade tend to think that the upgrade has more secondary benefits beyond damage reduction. It is, therefore, important for messaging to clarify the secondary benefits of structural upgrades. Many homeowners many not be aware of the secondary benefits that structural upgrades can provide. Homeowners can, for example, be informed that a new roof can provide better insulation that helps to regulate house temperature (Ong, 2011). Similarly, messaging could explain that cyclone shutters and doors/window screens provide additional home security in addition to protecting openings during a cyclone (Cozens & Davies, 2013). Messaging that focuses on the secondary benefits may be one way to encourage people to install these upgrades as the results from this project suggest that primary benefits (i.e., reduced cyclone damage) has less of an influence on structural mitigation behaviour.

9.4.1.2 General Preparedness. Messaging aimed at promoting short-term preparedness or evacuation behaviour should have a slightly different focus compared to structural mitigation. As supported by Chapter 7, the perceived efficacy and cost of performing preparedness behaviours are significant predictors of behaviour. As preparedness behaviours are not permanent adjustments to a house, they do not have utility for other purposes or add value to a property. As such, the emphasis should be on promoting how effective the measure is for reducing damage. This is where showing homeowners how these preparedness measures mitigate damage may help to encourage behaviour.

While preparedness behaviour such as putting up plywood on windows are cheaper than installing cyclone shutters, the findings suggest that perceived cost still reduces the likelihood of cyclone preparation. One component of perceived cost that could be minimised with an appropriate intervention is the perceived lack of knowledge and skill. As most general preparedness behaviours can be performed by the homeowner, video tutorials that provide instructions on how to put up plywood covers, for example, may help many homeowners overcome their perceived lack of skill or knowledge. Such videos could easily be embedded into a smartphone-based application aimed at promoting cyclone preparedness.

9.4.2 Community Engagement

Promoting community engagement can also help to increase preparedness behaviour (Paton & Tedim, 2013; Paton, 2019). As other researchers have highlighted, community engagement may increase how often people think and talk about cyclones (i.e. increase *hazard intrusiveness*), which in turn, may increase future preparedness (Paton, 2019; Paton et al., 2005, 2006; Paton & Buergelt, 2012). Community engagement events may be particularly useful for promoting structural mitigation because of the effect on *hazard intrusiveness*, which was shown to be strong predictor of such behaviour. Such events also provide an opportunity to show homeowners that the benefits of mitigation behaviours outweigh the cost, thus influencing other important drivers of cyclone mitigation: the perceived efficacy, benefits and cost of the behaviour.

9.4.3 Policy

Another way to promote the installation of structural upgrades is to make changes to current policy. One barrier that effective policy can potentially overcome is the high upfront monetary cost associated with structural upgrades. While structural upgrades are cost effective at a population level, the price of structural upgrades is still too high for many homeowners. Completely upgrading a roof, for example, can cost around $AUS 30,000. At this price it is an economically rational decision for a homeowner not to upgrade their roof if they do not plan on living in their house for an extended period. What may encourage the uptake of more expensive structural upgrades like roof upgrades are financial incentives that minimise the upfront costs.

There are many examples of government funded programs for promoting structural upgrades in the United States that Australia may consider adopting. A study in the US found that most homeowners were interested in a range of incentive programs such as low interest loans, reduced insurance premiums and reduced property tax (Ge et al., 2011). Moreover, the same researchers found that most homeowners would be interested in a home inspection program, which assesses their house's vulnerability to cyclone damage. A government funded inspection program may be another method of motivating structural upgrades as it makes cyclone risk clear to the individual, removes ambiguity in relation to what upgrades should be installed and provides a relatively low-cost cue to action. This recommendation is supported by other research, which has shown that preparation increases when people become more aware of their house's natural hazard vulnerability (McRae et al., 2018).

Past research has shown that perceived social norms also influence preparedness behaviour (Najafi et al., 2017; Paton, 2003). Encouraging upgrades through effective policy may, therefore, change social norms and increase the perceived market value of structural upgrades. As identified by the current research project, people are more likely to install structural upgrades if they perceive them as a worthwhile investment. If having cyclone shutters on a property, for example, becomes more common in cyclone-prone regions, people may start to believe that houses without them as less valuable. This belief, in turn, may encourage more investment in structural upgrades.

9.5 Conclusion

This research project has shown that *how* people think about cyclones and mitigation behaviour helps to explain *why* they prepare for cyclones. More broadly, this research project addressed several gaps in current knowledge regarding the psychological factors that influence protective behaviours for natural hazards. Overall, the findings make significant contributions to various areas of psychological theory and provide evidence for the formulation of effective policy changes and risk communication messaging. While reducing vulnerability to cyclone-related property damage is a complex problem that will require additional research, this research project shows that understanding how people think is an important step towards increasing resilience to cyclones.

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Appendices

Appendix A: Information Sheet (for Chapters 5, 6 & 8)

JAMES COOK UNIVERSITY
AUSTRALIA

INFORMATION SHEET

PROJECT TITLE: **"An Investigation of the Factors that Influence Cyclone Mitigation Behaviour"**

Hi, my name is Mitchell Scovell and I am a postgraduate research student at James Cook University. I would like to invite you to take part in my research project investigating cyclone mitigation behaviours. In this research, I am interested in understanding more about the factors that influence specific behaviours aimed at reducing cyclone related property damage.

The study is also being conducted by Dr Connar McShane, Dr Anne Swinbourne and Dr Daniel Smith and will contribute to my Thesis for my PhD at James Cook University. This research will also contribute to a research grant I am involved in with the JCU Cyclone Testing Station funded by Suncorp Group Limited.

If you would like to participate in this study, you will be invited to fill out a questionnaire. With your consent, the questionnaire will enquire about your perceptions of cyclone threats, your perceptions relating to specific mitigation behaviours as well as what mitigation behaviours you have performed in the past or intend to perform in the future. The questionnaire should only take approximately 15 minutes of your time.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. By completing this questionnaire you are consenting to participate in this study.

The data from the study will be used in research publications and reports as part of my PhD Research and the research grant funded by Suncorp Group Limited. Your responses will be anonymous and you will be completely unidentifiable in these reports and publications.

Thank you for your interest in completing this questionnaire and contributing to my Research Project! Your time is greatly appreciated. If you know of anyone else that would be interested in participating, could you please let them know about this study.

If you have any questions about the study, please contact **Mitchell Scovell or Connar McShane**.

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If you have any concerns regarding the ethical conduct of the study, please contact:
Human Ethics, Research Office
James Cook University, Townsville, Qld, 4811
Phone: (07) 4781 5011 (ethics@jcu.edu.au)

Cairns - Townsville - Brisbane – Singapore
CRICOS Provider Code 00117J

Appendix B: Survey (for Chapters 5, 6 & 8)

Cyclone Mitigation Questionnaire: What do you do to prepare for a cyclone?

First, we would like you to tell us some general things about yourself.

What is your age in years?

____

Sex (please circle)?

Male *Female*

How many dependent children do you have?

____

What is your current marital status (please circle)?

Single *Partnered* *Married*

Widowed *Divorced* *Separated*

What is your average household income per year?

0 -22000
22 – 50000
50 – 80000
80 – 125000
125000 – 260000
260000+

Where in the North Queensland Region do you live (e.g., Townsville, Cairns etc.)?

____

How many years have you lived in your current city?

____

How long have you lived in North Qld?

____

What is your highest level of education achieved?

Grade 9 or below
Grade 10
Grade 12
Certificate I-IV
Diploma
Bachelor's Degree
Postgraduate Degree (Masters/PhD)

The next part of this questionnaire will ask you about your experiences with previous cyclones.

Have you ever experienced a cyclone before?

No (skip to page 3) *Yes*

How many?

____

Did you have a role in your household's preparation activities for one of these past experiences?

No *Yes*

Did you experience Cyclone Yasi?

No *Yes*

What are some of the previous cyclones you have experienced? (provide the names if you can recall them)

____

Has your property received damage from a previous cyclone?

No *Yes*

On a scale from 1 to 5, how would you rate the damage your property has received from all previous cyclones (if applicable)?

Minimal damage 1	*2*	*Moderate damage 3*	*4*	*Extensive damage 5*

On a scale from 1 to 5, how would you rate the level of property damage sustained as a result of Cyclone Yasi (if applicable)?

Minimal damage 1	*2*	*Moderate damage 3*	*4*	*Extensive damage 5*

When thinking about Cyclone Yasi, or another cyclone event, do you remember feeling any of the following feelings? Rate your level of these feelings with a tick on the scales below.

	None	**Low**	**Moderate**	**High**
Stressed	☐	☐	☐	☐
Fearful	☐	☐	☐	☐
Helpless	☐	☐	☐	☐
Depressed	☐	☐	☐	☐
Dread	☐	☐	☐	☐

Based on what you can remember about Cyclone Yasi, what was the highest category winds **that your city experienced due to Cyclone Yasi (tick the box that applies)?**

	Category	**Wind Gusts over flat land**	**Beaufort Scale**	**Damage Potential**
☐	**Five** *(severe tropical cyclone)*	More than 280 km/h	12 (Hurricane)	Extremely dangerous with widespread destruction.
☐	**Four** *(severe tropical cyclone)*	225 – 279 km/h	12 (Hurricane)	Significant roofing loss and structural damage.
☐	**Three** *(severe tropical cyclone)*	165 – 224 km/h	12 (Hurricane)	Some roof and structural damage.
☐	**Two** *(tropical cyclone)*	125 – 164 km/h	10 & 11 (Storm and violent storm)	Minor house damage.
☐	**One** *(tropical cyclone)*	90 – 125 km/h	8 & 9 (Gales and strong gales)	Negligible house damage.

People have different kinds of *emotional responses* to the threat of a cyclone. In thinking about the possibility of your location being hit by a major cyclone with the potential for widespread damage, how strongly would you disagree or agree with the following statements?

Thinking about the possibility of a major cyclone makes me feel…

	Strongly Disagree	Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Agree	Strongly Agree
Fearful	☐	☐	☐	☐	☐	☐	☐
Worried	☐	☐	☐	☐	☐	☐	☐
Depressed	☐	☐	☐	☐	☐	☐	☐
Dread	☐	☐	☐	☐	☐	☐	☐

People *understand* cyclones in different ways. In thinking about the nature of cyclones generally, how strongly would you disagree or agree with the following?

	Strongly Disagree	Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Agree	Strongly Agree
I think that cyclones may cause catastrophic destruction.	☐	☐	☐	☐	☐	☐	☐
I think that cyclones may cause widespread death.	☐	☐	☐	☐	☐	☐	☐
I think cyclones pose great financial threat.	☐	☐	☐	☐	☐	☐	☐
I think cyclones pose a threat to future generations.	☐	☐	☐	☐	☐	☐	☐

If a cyclone was to occur in your area, how likely would it be that each of the following would occur?

	Extremely Unlikely	Unlikely	Somewhat Unlikely	Neutral	Somewhat Likely	Likely	Extremely Likely
Your property has been damaged	☐	☐	☐	☐	☐	☐	☐
Your, or a member of your household's, daily life is disturbed	☐	☐	☐	☐	☐	☐	☐
You, or a member of your household, are prevented from going to work or doing their job	☐	☐	☐	☐	☐	☐	☐
Your, or a member of your household's, mental health is negatively affected	☐	☐	☐	☐	☐	☐	☐
Your, or a member of your household's, physical health is negatively affected	☐	☐	☐	☐	☐	☐	☐

How strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Agree	Strongly Agree
I am knowledgeable about cyclone risks (to be able to make informed preparation decisions)	☐	☐	☐	☐	☐	☐	☐
I am knowledgeable about the types of property damage that can be caused by a cyclone	☐	☐	☐	☐	☐	☐	☐
I am knowledgeable about what I can do to reduce cyclone related property damage	☐	☐	☐	☐	☐	☐	☐
I think about the potential negative effects from cyclones regularly	☐	☐	☐	☐	☐	☐	☐
Cyclone related issues are discussed regularly in my household	☐	☐	☐	☐	☐	☐	☐

How likely do you believe each of the following cyclone events are to occur in the next 5 years?

	Extremely Unlikely	Unlikely	Somewhat Unlikely	Unsure	Somewhat Likely	Likely	Extremely Likely
Your city will experience a Category 1 (or above) cyclone	☐	☐	☐	☐	☐	☐	☐
Your city will experience a Category 3 (or above) cyclone	☐	☐	☐	☐	☐	☐	☐
Your city will experience a Category 5 cyclone	☐	☐	☐	☐	☐	☐	☐

If the following cyclone events were to occur next week what level of property damage would you expect to

	Very Low	Low	Somewhat Low	Medium	Somewhat High	High	Very High
A Category 1-2 cyclone	☐	☐	☐	☐	☐	☐	☐
A Category 3-4 cyclone	☐	☐	☐	☐	☐	☐	☐
A Category 5 cyclone	☐	☐	☐	☐	☐	☐	☐

receive? (Assume you will perform your usual amount of household preparedness)

If a severe cyclone was to occur in the next five years, what do you believe is the likelihood that the government would provide financial assistance to homeowners who have received property damage?

Extremely Unlikely	Unlikely	Somewhat Unlikely	Unsure	Somewhat Likely	Likely	Extremely Likely
☐	☐	☐	☐	☐	☐	☐

Since living in North Queensland, have you actively looked for information regarding what you can do to reduce cyclone related property damage?

No *Yes*

The list below includes sources where you may seek information about an upcoming cyclone. Please indicate the frequency in which you have (or intend to) access/contact the following sources for information about an upcoming cyclone event. For example, if you contact a family member hourly for information about a current cyclone, select the 'hourly' column. (Please tick one box per row if applicable)

	Daily	Every few hours	Hourly	N/A
Phone or visit a family member				
Watch television updates				
Listen to radio updates				
Read the newspaper				
Visit the Bureau of Meteorology website				
Phone or visit the neighbours				
Visit the Council website				
Phone or visit SES members				
Phone or visit the police				
Social media updates from official organisations (e.g., SES, BOM, QLD police)				
Social media updates from unofficial group pages (e.g. friends, local groups, etc)				
Other (please write and rank) ________________				

Do you own a property in NQ?

No (skip to page 13)   *Yes*

Do you live in that property?

No   *Yes*

How many years have you lived in/owned your current property? ______

For how many years do you plan on living in/owning your current property?

0-1   *1-2*   *3-4*   *4-5*   *5+*

The following questions will ask you about the property you own in NQ (if you own more than one, answer the questions with only one of the properties in mind). We're interested in the types of building upgrades that are installed on your property.

Property Information	**No**	**Yes**	**Unsure**
Did you build/use a building contractor to build the house you own in North QLD?	☐	☐	☐
Was your house built before 1982?	☐	☐	☐
Was your house built before 2012?	☐	☐	☐
Do you have a shed?	☐	☐	☐

Please indicate which of the following are installed on your house/property and when the item/s were installed.

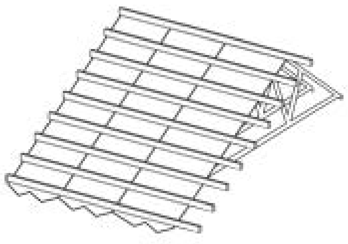
Property Upgrade	Not installed	Installed when house was built	Already installed when I purchased the house	Installed after house was built/purchased	Unsure	N/A
Deadlocks on external doors	☐	☐	☐	☐	☐	☐
Metal screens on all glass areas 	☐	☐	☐	☐	☐	☐
Cyclone shutters (as shown below or other similar window protection) 	☐	☐	☐	☐	☐	☐

What was the main reason for installing the upgrades above? (if applicable)

Property Upgrade	**Security**	**Cyclone Protection**	**Other**
Deadlocks on external doors	☐	☐	☐
Metal screens on all glass areas 	☐	☐	☐
Cyclone shutters (as shown below or other similar window protection) 	☐	☐	☐

Please indicate which of the following are installed on your house/property and when the item/s were installed.

Property Upgrade	Not installed	Installed when house was built	Already installed when I purchased the house	Installed after house was built/purchased	Unsure	N/A
Roller door bracing for cyclones (pre 2012 homes) 	☐	☐	☐	☐	☐	☐
Shed anchored to a concrete slab (if you have a shed)	☐	☐	☐	☐	☐	☐
Shed designed for high wind rating/ reinforced with cyclone kit (if you have a shed)  Typical cyclone rated shed knee bracket (left) and apex bracket (right)	☐	☐	☐	☐	☐	☐

Roof upgrades (pre 1982 homes)	Not installed	Installed when house was built	Already installed when I purchased the house	Installed after house was built/purchased	Unsure	N/A
Complete replacement (not only the replacement of the external cladding but also the upgrade of batten to rafter attachments, and upgrading tie-downs from rafter or truss to the top plate of the wall framing)	☐	☐	☐	☐	☐	☐
Strapping upgrades  Example of nailed strapping for batten to rafter connection	☐	☐	☐	☐	☐	☐
Roof over-batten system  Typical over-batten install per HB132.2 Structural Upgrading of Older Houses handbook	☐	☐	☐	☐	☐	☐
Sarking(layer of protection placed underneath roof tiles or sheeting to help prevent wind driven rain and dust from entering the home) 	☐	☐	☐	☐	☐	☐

The following questions ask about the upgrade items mentioned above. Please keep these items in mind when answering the following questions.

Have any of your friends, family or neighbours installed any of these upgrade items?

Yes *No* *Unsure*

Did you implement any of these upgrade items due to incentive from insurers?

Yes *No* *N/A*

Did you implement any of these upgrade items due to an incentive or encouragement from anyone else?

Yes *No* *N/A*

If so, who?

____

How likely is it that you will install the following upgrades in the next 5 years? (**If you are not a homeowner**, think of how likely you would be to install these upgrades if you were to buy a house without these items already installed)
Do not tick a box if you have already installed this upgrade.

Property Upgrade	**Extremely unlikely**	**Moderately unlikely**	**Slightly unlikely**	**likely nor unlikely**	**Slightly likely**	**Moderately likely**	**Extremely likely**
Complete roof replacement	☐	☐	☐	☐	☐	☐	☐
Upgraded roof structural connections during roof replacement (pre-1982 homes)	☐	☐	☐	☐	☐	☐	☐
Deadlocks on external doors	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters	☐	☐	☐	☐	☐	☐	☐
Metal screens on all glass areas	☐	☐	☐	☐	☐	☐	☐
Roller door bracing	☐	☐	☐	☐	☐	☐	☐
Shed anchored to a concrete slab	☐	☐	☐	☐	☐	☐	☐
Shed designed for high wind rating/reinforced with cyclone kit	☐	☐	☐	☐	☐	☐	☐

Please indicate how strongly you agree with the following statements.

	Strongly Disagree	Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Agree	Strongly Agree
Cyclone shutters are effective for reducing damage and financial consequences of cyclones to my property and belongings	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters are effective for my family's safety during a cyclone	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters are useful for other purposes besides preventing cyclone damage	☐	☐	☐	☐	☐	☐	☐
Installing cyclone shutters increases property value	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters are expensive to install considering my income and other expenses	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters take a lot of time and effort to install considering my free time	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters are difficult to get installed considering the knowledge and skill that is required	☐	☐	☐	☐	☐	☐	☐
It would require a lot of help/cooperation from others (family, friends, neighbours or government) to install cyclone shutters	☐	☐	☐	☐	☐	☐	☐
I, or a member of my family, have the ability to install cyclone shutters	☐	☐	☐	☐	☐	☐	☐
Cyclone shutters are visually appealing	☐	☐	☐	☐	☐	☐	☐

Skip this page if you did not experience Cyclone Debbie or Cyclone Yasi.

From the list below, please indicate which of the following activities you perform at the start of the cyclone season. Please indicate the activities you performed before Cyclone Yasi and Cyclone Debbie.

	Cyclone Yasi			Cyclone Debbie		
Preparation Activities	**Yes**	**No**	**N/A**	**Yes**	**No**	**N/A**
Trim treetops and branches	☐	☐	☐	☐	☐	☐
Check property for rust, rotten timber, termite infestations and loose fittings	☐	☐	☐	☐	☐	☐
Check that the walls, roof and eaves of your home are secure	☐	☐	☐	☐	☐	☐
Check fencing is not loose or damaged	☐	☐	☐	☐	☐	☐
Clean gutters and downpipes	☐	☐	☐	☐	☐	☐

From the list below, please indicate which of the following activities you perform when a cyclone watch/warning has been issued. Please indicate the activities you performed before the Cyclone Yasi and Cyclone Debbie.

	Cyclone Yasi			Cyclone Debbie		
Preparation Activities	**Yes**	**No**	**N/A**	**Yes**	**No**	**N/A**
Trim treetops and branches	☐	☐	☐	☐	☐	☐
Check fencing is not loose or damaged	☐	☐	☐	☐	☐	☐
Clean gutters and downpipes	☐	☐	☐	☐	☐	☐
Put plywood up on glass windows/doors	☐	☐	☐	☐	☐	☐
Secure outdoor furniture and garden items	☐	☐	☐	☐	☐	☐
Clear yard of any loose items	☐	☐	☐	☐	☐	☐
Remove shade sails	☐	☐	☐	☐	☐	☐

Did you prepare for Cyclone Yasi differently as opposed to Cyclone Debbie?

____

____

From the list below, please indicate how likely you are to perform the following activities during the next cyclone season/when a cyclone warning/watch is issued.

	Extremely unlikely	**Moderately unlikely**	**Slightly unlikely**	**likely nor unlikely**	**Slightly likely**	**Moderately likely**	**Extremely likely**
Trim treetops and branches	☐	☐	☐	☐	☐	☐	☐
Check property for rust, rotten timber, termite infestations and loose fittings	☐	☐	☐	☐	☐	☐	☐
Check that the walls, roof and eaves of your home are secure	☐	☐	☐	☐	☐	☐	☐
Check fencing is not loose or damaged	☐	☐	☐	☐	☐	☐	☐
Clean gutters and downpipes	☐	☐	☐	☐	☐	☐	☐
Put plywood up on glass windows/doors	☐	☐	☐	☐	☐	☐	☐
Secure outdoor furniture and garden items	☐	☐	☐	☐	☐	☐	☐
Clear yard of any loose items	☐	☐	☐	☐	☐	☐	☐
Remove shade sails							

Thinking about both structural upgrades and preparedness activities, what factors are the most important to you when preparing for a cyclone? **Please number items from most important to least important.**

__ that preparations increase my (and my family's) safety during a cyclone
__ that preparations limit the financial impact and damage to my property and belongings
__ that preparations are also useful for events other than cyclones
__ that preparations are cheap
__ that preparations take little time and effort
__ that preparations require little knowledge and skills
__ that preparations require little help and cooperation from others
__ that preparations are recognised by my insurer

Answer the following questions if you are a homeowner

How much does your current insurance premium cost p.a?

____

Assume that it will cost $3000 (including labour) to install cyclone shutters on all of your windows. How much reimbursement would you require to go ahead with the purchase?

A $__ reduction on your premium p.a. over 5 years (some paperwork involved).

____

An $__ government rebate (some paperwork involved)

____

END OF QUESTIONNAIRE

Thank you very much for participating in this study! Your time and effort has been greatly appreciated.

Appendix C: Information Sheet (for Chapter 7)

JAMES COOK UNIVERSITY
AUSTRALIA

INFORMATION SHEET

PROJECT TITLE: **"Investigating North Queenslanders' Perception of Cyclone Severity"**

Hi, my name is Mitchell Scovell and I'm a postgraduate research student at James Cook University. I would like to invite you to take part in my research project looking at how people think about and prepare for cyclones.

The study is also being conducted by Dr Connar McShane, Dr Anne Swinbourne and Dr Daniel Smith and will contribute to my PhD thesis at James Cook University.

Participation in this study is open to anyone who currently lives, or has lived, in coastal North Queensland (between Rockhampton and Port Douglas). If you choose to participate in this study, you will be asked to imagine you own a home in a fictional location called 'Capricornia'. You will then be informed that a cyclone is heading towards your house and given an option to respond. This hypothetical scenario will be followed by some brief questions asking about how you chose to respond and why. Completing this survey should only take about 15 minutes.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. If completing the survey online, you can stop taking the survey by closing your internet browser. By completing this survey, you are consenting to participate in this study.

The data from the study will be used in research publications and reports as part of my PhD research. Your responses will be anonymous, and you will be completely unidentifiable in these reports and publications.

Thank you for your interest in completing this study and contributing to my research! Your time is greatly appreciated. If you know of anyone else that would be interested in participating, could you please let them know about this study.

If you would like to access the study you can do so via this link "https://jcuchs.qualtrics.com/jfe/form/SV_9nWcgcaerZZ9kEt" or via the public Facebook page "@CyclonePerceptionStudy". You do not have to use Facebook yourself to access the page.

If you have any questions about the study, please contact Mitchell Scovell or Anne Swinbourne.

Principal Investigator: Mitchell Scovell
College: Healthcare Sciences
James Cook University
Phone:
Email: mitchell.scovell@my.jcu.edu.au

Supervisor: Anne Swinbourne
College: Healthcare Sciences
James Cook University
Phone:
Email: anne.swinbourne@jcu.edu.au

If you have any concerns regarding the ethical conduct of the study, please contact:
Human Ethics, Research Office
James Cook University, Townsville, Qld, 4811
Phone: (07) 4781 5011 (ethics@jcu.edu.au)

Appendix D: Survey (for Chapter 7)

Cyclone Perception Survey: How do you respond when a cyclone is approaching?

What is your current age in years?

____

What is your gender?

- O Male
- O Female
- O Other

Which of the following best describes your living arrangement?

- O I live by myself with no dependent children
- O I live with a romantic partner (i.e., de facto/married) with no dependent children
- O I live with a romantic partner (i.e., de facto/married) with at least one dependent child
- O I live with at least one other adult (i.e., house/room mate) in a share house with no dependent children
- O I am a single parent with at least one dependent child

What is your highest level of formal education?

- O Grade 10 or below
- O Grade 12
- O Certificate I-IV
- O Diploma
- O Bachelor's Degree
- O Postgraduate degree (Masters/PhD)

What is your household's yearly income (before tax)?

- O $0 - $50,000
- O $50,000 - $100,000
- O $100,000 - $150,000
- O $150,000 - $250,000
- O +$250,000

Do you own the property you live in? (e.g., house or apartment/unit)

- O Yes
- O No

Which of the follow best describes your property type?

- O House
- O Apartment/Unit
- O Townhouse

When was your house built?

- O After 1980
- O Before 1980
- O Not sure

Where in North Queensland do you currently live? If you do not currently live in North Queensland please select the place in North Queensland where you lived the longest.

- O Port Douglas
- O Cairns
- O Innisfail
- O Tully
- O Cardwell
- O Ingham
- O Townsville
- O Burdekin
- O Bowen
- O Proserpine
- O Mackay
- O Rockhampton
- O Other (please type) ____________________

What is your postcode?

____

How many years have you lived in North Queensland? (please write answer to the nearest whole number)

____

To what extent do you agree with the following statements?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
I am knowledgeable about cyclone risks (to be able to make informed preparation decisions)	O	O	O	O	O	O	O
I am knowledgeable about the types of property damage that can be caused by a cyclone	O	O	O	O	O	O	O
I am knowledgeable about what I can do to reduce cyclone related property damage	O	O	O	O	O	O	O
I think about the potential negative effects from cyclones regularly	O	O	O	O	O	O	O
Cyclone related issues are discussed regularly in my household or with other people	O	O	O	O	O	O	O
It is likely that my city/town will experience a direct hit from a cyclone in the next 5 years	O	O	O	O	O	O	O
It is likely that a new house (built to North Queensland code) would withstand a direct hit from a category 5 cyclone	O	O	O	O	O	O	O
Cyclones often miss my city/town	O	O	O	O	O	O	O

Have you experienced a cyclone?

O Yes

O No ***(If No Please Skip to Page 8)***

What extent of property damage have you experienced due to a cyclone on a scale of 0 to 10? If you have not experienced property damage, please circle 0.

No damage					Moderate damage					Complete destruction of house
0	1	2	3	4	5	6	7	8	9	10

Did you experience property damage due to the recent Townsville flood?

O Yes

O No

Did evacuate your home due to the recent Townsville flood?

O Yes

O No

Did you personally witness cyclone level wind speeds from Cyclone Yasi?

O Yes

O No ***(If No Please Skip to Page 8)***

Where were you living when you experienced Cyclone Yasi?

____

What extent of property damage did you experience due to Cyclone Yasi on a scale of 0 to 10? If you have not experienced property damage, please circle 0.

No damage					Moderate damage					Complete destruction of house
0	1	2	3	4	5	6	7	8	9	10

From what you remember about Cyclone Yasi, what was the highest category winds that your city/town experienced due to Cyclone Yasi?

- O Category 1
- O Category 2
- O Category 3
- O Category 4
- O Category 5

Are you aware of the following cyclone preparedness activities? If so, please indicate if you have performed them in the past.

	Aware of the activity	Aware of the activity and I have performed it in the past	Not aware of the activity
Tidy yard and secure outdoor furniture	O	O	O
Trim tree branches	O	O	O
Clean gutters	O	O	O
Put ply-wood up on windows	O	O	O
Tape windows with a cross pattern	O	O	O
Cover the inside of windows with plastic and tape the seams	O	O	O

The picture below shows an attempt to protect against cyclone related property damage. In this photo the property owner has covered their windows with plywood.

To what extent do you agree with the following statements when considering the cyclone protection activity presented above (putting plywood up on windows)?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
this activity would reduce property damage	O	O	O	O	O	O	O
this activity would protect myself and/or my family	O	O	O	O	O	O	O
this activity would take a lot of time	O	O	O	O	O	O	O
this activity would take a lot of effort	O	O	O	O	O	O	O
this activity would be expensive considering the necessary materials	O	O	O	O	O	O	O
this activity would require a lot of skill and/or knowledge	O	O	O	O	O	O	O
this activity would require abilities I do not have	O	O	O	O	O	O	O

The picture below shows an attempt to protect against cyclone related property damage. In this photo the property owner has covered the inside of their window with plastic and taped the seams.

To what extent do you agree with the following statements when considering the cyclone protection activity presented above (plastic covering on this inside of window)?

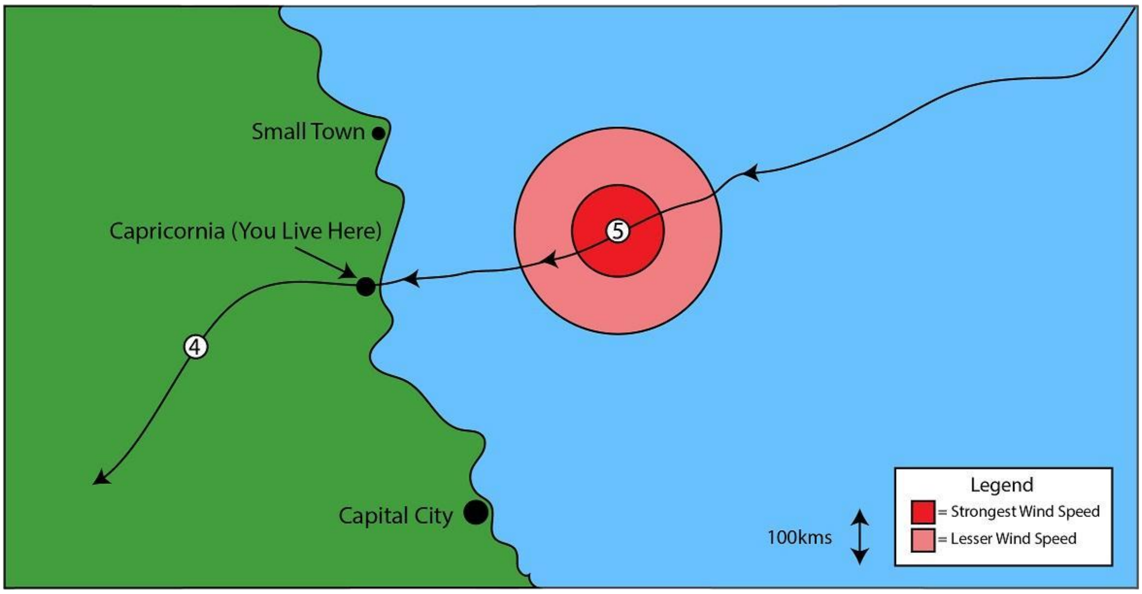
	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
this activity would reduce property damage	O	O	O	O	O	O	O
this activity would protect myself and/or my family	O	O	O	O	O	O	O
this activity would take a lot of time	O	O	O	O	O	O	O
this activity would take a lot of effort	O	O	O	O	O	O	O
this activity would be expensive considering the necessary materials	O	O	O	O	O	O	O
this activity would require a lot of skill and/or knowledge	O	O	O	O	O	O	O
this activity would require abilities I do not have	O	O	O	O	O	O	O

The rest of the study requires you to use your imagination a little. From now on, please answer questions as if you own and live in the house pictured below. The house pictured below was built in 1972. The roof has not been upgraded since construction. As such, this house is more vulnerable to cyclone related property damage compared to newer housing.

Participants were given one of the five following conditions at random

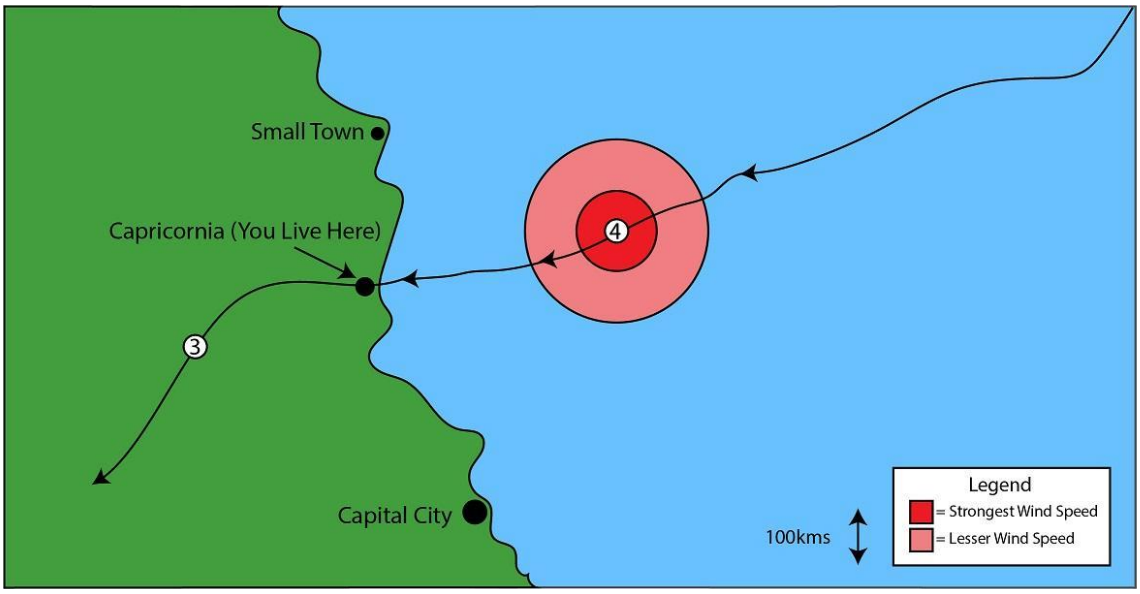
CATEGORY 5 CONDITION

The map below shows a portion of the state of 'Tropicana'. You currently live in the city of 'Capricornia', which is roughly 400kms north of 'Capital City' and 300kms south of 'Small Town'. The map below also shows the track of a hypothetical cyclone, which is predicted to hit your city. In Capricornia it is currently 8am, Saturday morning. Based on its current track the cyclone is expected to hit Capricornia in 48 hours (8am, Monday morning). It is currently tracking as a Category 5 and it is not expected to weaken until it passes Capricornia. The strongest wind gusts from this cyclone are expected to be more than 280 km/h.



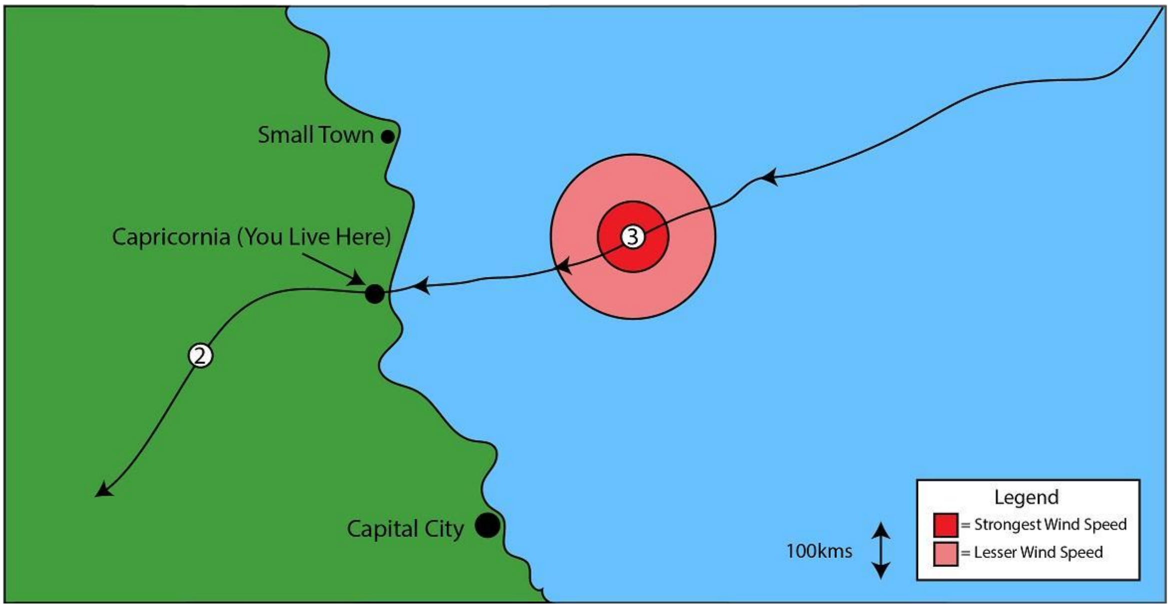
CATEGORY 4 CONDITION

The map below shows a portion of the state of 'Tropicana'. You currently live in the city of 'Capricornia', which is roughly 400kms north of 'Capital City' and 300kms south of 'Small Town'. The map below also shows the track of a hypothetical cyclone, which is predicted to hit your city. In Capricornia it is currently 8am, Saturday morning. Based on its current track the cyclone is expected to hit Capricornia in 48 hours (8am, Monday morning). It is currently tracking as a Category 4 and it is not expected to weaken until it passes Capricornia. The strongest wind gusts from this cyclone are expected to be between 225 - 279 km/h.



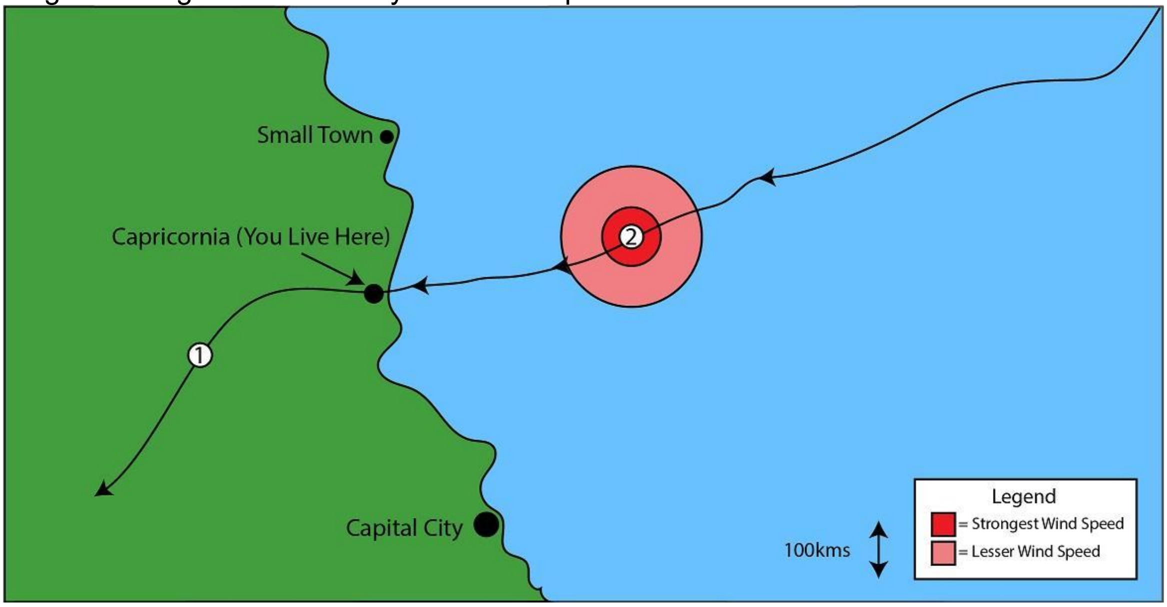
CATEGORY 3 CONDITION

The map below shows a portion of the state of 'Tropicana'. You currently live in the city of 'Capricornia', which is roughly 400kms north of 'Capital City' and 300kms south of 'Small Town'. The map below also shows the track of a hypothetical cyclone, which is predicted to hit your city. In Capricornia it is currently 8am, Saturday morning. Based on its current track the cyclone is expected to hit Capricornia in 48 hours (8am, Monday morning). It is currently tracking as a Category 3 and it is not expected to weaken until it passes Capricornia. The strongest wind gusts from this cyclone are expected to be between 165 - 224 km/h



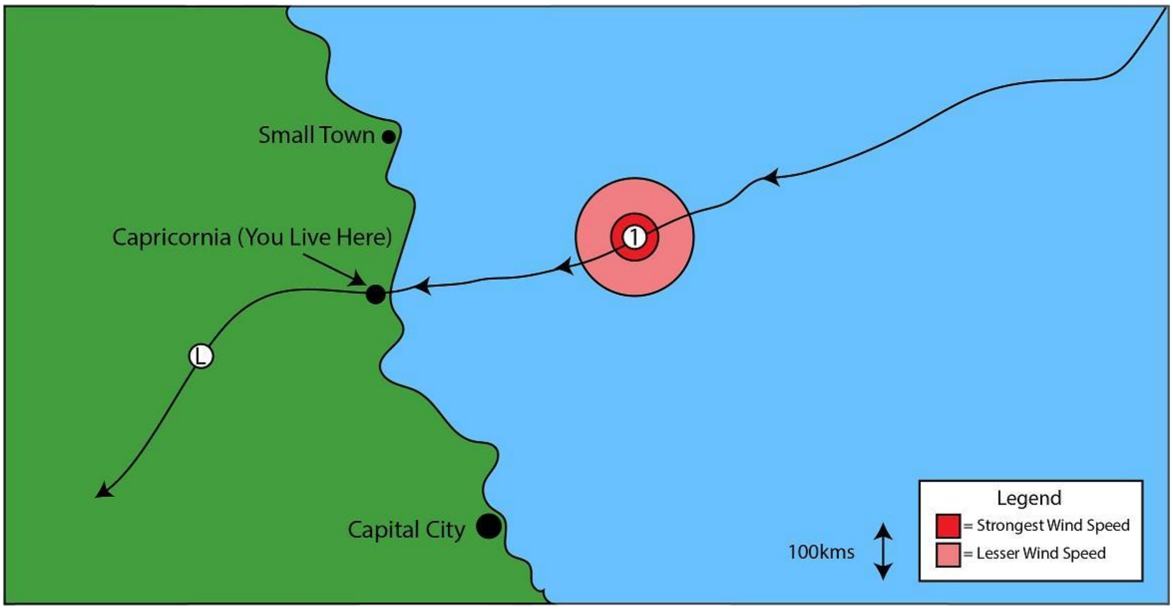
CATEGORY 2 CONDITION

The map below shows a portion of the state of 'Tropicana'. You currently live in the city of 'Capricornia', which is roughly 400kms north of 'Capital City' and 300kms south of 'Small Town'. The map below also shows the track of a hypothetical cyclone, which is predicted to hit your city. In Capricornia it is currently 8am, Saturday morning. Based on its current track the cyclone is expected to hit Capricornia in 48 hours (8am, Monday morning). It is currently tracking as a Category 2 and it is not expected to weaken until it passes Capricornia. The strongest wind gusts from this cyclone are expected to be between 125 - 164 km/h.



CATEGORY 1 CONDITION

The map below shows a portion of the state of 'Tropicana'. You currently live in the city of 'Capricornia', which is roughly 400kms north of 'Capital City' and 300kms south of 'Small Town'. The map below also shows the track of a hypothetical cyclone, which is predicted to hit your city. In Capricornia it is currently 8am, Saturday morning. Based on its current track the cyclone is expected to hit Capricornia in 48 hours (8am, Monday morning). It is currently tracking as a Category 1 and it is not expected to weaken until it passes Capricornia. The strongest wind gusts from this cyclone are expected to be up to 125 km/h.



Remember to answer the rest of the questions as if you own and live in the house presented below. Also, remember that this house is located in Capricornia.

Given the cyclone scenario presented, would you evacuate your house?

- O Yes
- O No

Given the situation presented, would you prepare your house? (e.g., clean up yard, put up plywood on windows)

- O Yes
- O No

If you did not evacuate, what category level would you consider evacuating?

- O Category 1
- O Category 2
- O Category 3
- O Category 4
- O Category 5
- O Never

If you did not prepare, at what category level would you consider preparing?

- O Category 1
- O Category 2
- O Category 3
- O Category 4
- O Category 5
- O Never

How likely is it that you would perform the following activities?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Tidy yard and secure outdoor furniture	O	O	O	O	O	O	O
Trim tree branches	O	O	O	O	O	O	O
Clean gutters	O	O	O	O	O	O	O
Put ply-wood up on windows	O	O	O	O	O	O	O
Tape windows with a cross pattern	O	O	O	O	O	O	O
Cover the inside of windows with plastic and tape the seams	O	O	O	O	O	O	O

How likely is it that this cyclone would cause the following in your town?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Downed trees and/or power lines	O	O	O	O	O	O	O
Downed fences	O	O	O	O	O	O	O
Loss of power	O	O	O	O	O	O	O

Given your level of preparedness, what level of damage would you expect your house to receive from this cyclone?

No damage					Moderate damage				Complete destruction of house	
0	1	2	3	4	5	6	7	8	9	10

Considering your level of preparedness, how likely is it that you would see the following types of damage to your house?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Partial roof failure	O	O	O	O	O	O	O
Complete roof failure	O	O	O	O	O	O	O
Damage to house exterior from flying debris	O	O	O	O	O	O	O
Smashed/cracked windows	O	O	O	O	O	O	O
Damage to house interior due to water ingress	O	O	O	O	O	O	O

Considering the types of damage you think are likely, to what extent do you agree that you would experience the following emotions before, during or after the cyclone?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Fearful	O	O	O	O	O	O	O
Excited	O	O	O	O	O	O	O
Worried	O	O	O	O	O	O	O
Full of dread	O	O	O	O	O	O	O
Depressed	O	O	O	O	O	O	O
Entertained	O	O	O	O	O	O	O

Do you think the level of damage would be different if you did not prepare?

O Yes

O No

Do you think you would feel differently about this cyclone if you did not prepare?

O Yes

O No

If you **did not prepare** at all, what level of damage would you expect your house to receive from this cyclone?

No damage					Moderate damage					Complete destruction of house
0	1	2	3	4	5	6	7	8	9	10

If you **did not prepare**, how likely is it that you would see the following types of damage?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Partial roof failure	O	O	O	O	O	O	O
Complete roof failure	O	O	O	O	O	O	O
Damage to house exterior from flying debris	O	O	O	O	O	O	O
Smashed/cracked windows	O	O	O	O	O	O	O
Damage to house interior due to water ingress	O	O	O	O	O	O	O

Considering the types of damage you think are likely if **did not prepare**, to what extent do you agree that you would experience the following emotions before, during or after the cyclone?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Fearful	O	O	O	O	O	O	O
Excited	O	O	O	O	O	O	O
Worried	O	O	O	O	O	O	O
Full of dread	O	O	O	O	O	O	O
Depressed	O	O	O	O	O	O	O
Entertained	O	O	O	O	O	O	O

Let’s change the scenario. Let’s assume that you know the same cyclone will occur with 100% certainty next cyclone year. You will be living in the same house when this cyclone hits next year.

Knowing this cyclone is coming in a year, how likely is it that would you install any structural upgrades on your house? (e.g., upgraded roof or installed cyclone shutters)

O Extremely likely

O Moderately likely

O Slightly likely

O Neither likely nor unlikely

O Slightly unlikely

O Moderately unlikely

O Extremely unlikely

How much money would you be willing to spend to upgrade your house? Please write a value between $0 and $30,000.

____

How likely is it that you would install the follow upgrades? Keep in mind the cost of the upgrade.

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Complete roof upgrade ($25,000)	O	O	O	O	O	O	O
Install fixed cyclone shutters ($3,000)	O	O	O	O	O	O	O

Considering the likelihood that you will invest in the structural upgrades presented above, what level of damage would you expect your house to receive from this cyclone?

No damage					Moderate damage					Complete destruction of house
0	1	2	3	4	5	6	7	8	9	10

With structural upgrades installed, how likely is it that you would see the following types of damage to your house?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Partial roof failure	O	O	O	O	O	O	O
Complete roof failure	O	O	O	O	O	O	O
Damage to house exterior from flying debris	O	O	O	O	O	O	O
Smashed/cracked windows	O	O	O	O	O	O	O
Damage to house interior due to water ingress	O	O	O	O	O	O	O

Considering the types of damage you think are likely **with structural upgrades installed**, to what extent do you agree that you would experience the following emotions before, during or after the cyclone?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Fearful	O	O	O	O	O	O	O
Excited	O	O	O	O	O	O	O
Worried	O	O	O	O	O	O	O
Full of dread	O	O	O	O	O	O	O
Depressed	O	O	O	O	O	O	O
Entertained	O	O	O	O	O	O	O

End of Survey. Thank you for your time!