A literature review of best practice
communication of climate science and impacts:
GUIDE FOR POLICY MAKERS

MONASH
CLIMATE CHANGE
COMMUNICATION
RESEARCH HUB

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Table of Contents

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1. Glossary

Attention economy is an approach to communication strategies which begins with research on where the most attention is given to media sources. These may include, electronic and print forms of media but also graffiti, freeway billboards or screens at sport stadia. The attention economy does not discriminate between types of audiences or media, but follows the principle that wherever there is attention, that is where you want to be with your message.

CAN International or Climate Action Network International is an umbrella body of over 1200 Non-Governmental Organizations (NGOs) in more than 120 countries, working to promote government and individual action to limit human-induced climate change to ecologically sustainable levels.

CCC is shorthand for climate change communication

The **Center for Climate Change Communication ('4C')** was established in 2007 at George Mason University in the US, and best known for its 'Climate Change in the American Mind' or 'Six Americas' research with Yale University. 4C applies social science insights to help society make informed decisions that will stabilize the earth's climate, and prevent further harm from climate change.

Filter bubble is a term developed by Eli Pariser to denote the way in which social media content increasingly becomes enclosed in a myriad of insular bubbles. In the case of news feeds, personalisation of search and search history algorithms guarantee the dominance of echo chambers online (Pariser, 2011). The segmentation of mainstream audiences by climate change perceptions suggests that filter bubbles work to reinforce and maintain such divisions (see also Tandoc and Eng 2018).

Five Australias refers to several segmentation profile studies (also known as Latent Profile Analysis studies) between 2010 and 2018 that found five different stances on climate change in Australia: Alarmed, Concerned, Uncertain, Doubtful and Dismissive.

Gateway beliefs legitimate or undermine a range of other related beliefs. In CCC, various studies have shown that belief or disbelief in the scientific consensus on human-caused climate change plays an important role in the formation of public opinion on the issue. See Van der Linden et al. (2015).

Inoculation theory examines how the influence of misinformation on public perceptions and literacy can be reversed by drawing attention to the fact that 'fake expertise' has been used for misinformation campaigns in the past and are currently being used. Such exposure of fake experts has been shown to completely annul the influence of the misinformation (Van der Linden et al. 2017).

Knowledge Deficit Theory contends that providing the public with more facts about an issue like climate change will translate into effective decision-making. Typically, the theory focusses on the kind of information rather than its source and audience. The theory also assumes that simply by providing information the public will be able to make effective decisions. However, in an attention economy, CCC also needs to engage the public to be receptive to the science.

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Message framing is an important area of research in relation to audience research. As there is not one kind of message that will engage all audiences as a precursor to communicating climate science and impacts, research is needed on matching messages with audiences. However, messages are always set within frames of interpretation. For example, the danger that climate change poses is an important message to communicate, but is typically framed in a variety of ways, including health, risk, economic cost, national security and food security.

The **Monash Climate Change Communication Research Hub** **(MCCCRH)** is a research centre established at Monash University in early 2017 to research ways of building climate literacy in Australia. The Hub researches the attention economy in Australia to determine ways of increasing attention on climate science from trusted sources. Sources include TV weather presenters, local newspapers and popular music. The Hub brokers climate science information from climatologists and packages this information in factual, easy to process and repeated forms and delivers it to large audiences.

Non-persuasive communication is a term developed by Barusch Fischhoff (Carnegie Mellon University, US) to denote the fact that scientists are uncomfortable with advocating the implications of climate science and are inclined to provide factual information that is directed toward other scientists. However, he argues that scientists have also failed the public, by not providing it with the information needed to make climate-related decisions in a credible, comprehensible way. Whilst it is not the place of scientists to advocate how people should react to the science, they have a responsibility to ensure the science is clearly and non-persuasively communicated to the public and not just each other. (Fischhoff 2007)

Pluralistic ignorance is a concept used by Prof. Janet Swim, (Penn State University, US) to explain how inaccurate perceptions of others' opinions contribute to self-silencing among those concerned about climate change (Geiger & Swim, 2016).

The **United Nations Framework Convention on Climate Change** **(UNFCCC)** is a division of the United Nations that organises the annual Conference of Parties.

The **Yale Program in Climate Change Communication** **(YPCCC)** was established in 2005 to conduct scientific research on public climate change knowledge, attitudes, policy preferences, and behaviour at the global, national, and local scales.

2. Key Recommendations

- The best practice for communicating climate science and impacts is to formulate clear messages, that are repeated often by trusted sources to targeted or general audiences.

- In any targeted climate change communication strategy, research is needed to understand which messages and trusted sources those audiences care about. The audiences can range from sectoral (government, business, NGO's) to geographic (metropolitan, peri-urban, farmers) or demographic (by age, gender, income, education etc.).

- Audience research is also needed to understand how general audiences are divided by kinds of climate change concern and belief (e.g. Alarmed, Concerned, Uncertain, Doubtful and Dismissive) and how these match with the social groups described above.

- The above audience research is essential for targeted messaging, but is ineffective for general messaging to broad populations. The only communication strategy which works with undifferentiated audiences is known as 'non-persuasive' communication.

- Overwhelmingly, all audiences care about *local* climate change information when compared to national and global information.

- The Victorian State Government should enlist the assistance of not only climate scientists in communicating the science and impacts of climate change, but also farmers, firefighters, paramedics, doctors, nurses and weather presenters who have been identified as highly trusted sources.

- Messages which emphasize the 97% consensus amongst scientists are very effective at engaging audiences and removing uncertainty about climate change.

- The profile and visibility of climate scientists in the community needs to be raised further.

- A communication strategy should encourage discussion of climate change throughout the community, as friends and family are the most trusted sources, and such a strategy would assist in overcoming the 'perception gap'.

- Social media should be avoided as a primary communication tool of climate science.

- The risks of climate change should be framed at a level that accords with how individuals deal with everyday risks.

- Risk communication, such as that used by the IPCC (for consumption by policy makers) needs to be translated into stories that are suited to a general audience.

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- Effective communication of adaptation should emphasize that climate change is visible at local scales right now and ongoing discussion is needed for particular communities.

- The Victorian Government should develop a web-based user-interface similar to Ku-ring-gai Council in NSW which allows for a personalised assessment of Victorian residential properties for climate change adaptation

3. Methodology

This *Guide for Policy Makers* is the result of a *Literature Review of best practice communication of climate science and impacts* conducted by the Monash Climate Change Communication Research Hub in 2018-19.

A starting premise in the methodology is that the review took the communication of 'climate science and impacts' to be equated with the communication of climate change. The consequences of understanding the impacts of climate, as explained by the science, is to understand how the earth's climate is changing.

The literature review surveyed international literature on climate change communication (CCC) that documented 'best practice' methods or strategies that have had a measurable positive impact on government, industry or community capacity for effective decision-making on climate change.

The review covered, local, national and international approaches to communicating climate science and its impacts were classified and ranked according to which approaches had achieved measurable positive impacts on effective decision making. The impact of these communication strategies were then sorted into government, industry and community audiences.

The review found that Australian and Victorian audiences are highly segmented on climate change, and that there are at least five segments relevant to effective climate change communication in Victoria: Alarmed, Concerned, Uncertain, Doubtful and Dismissive. To the extent that audiences are divided into such segments, any CCC strategy will require at least five different kinds of messages.

The summary also outlines what kinds of messages have been effective with specific audiences outside of Victoria, but which are nevertheless relevant to Victoria. These refer to:
    i. The general community: how do messages on the economic, environmental, health and social impacts of climate change rank in terms of effectiveness?
    ii. Government decision-makers: how do messages on the economic, environmental, health and social impacts of climate change rank in terms of effectiveness?
    iii. What is the level of climate change literacy with these audiences and how does this literacy relate to behaviour response?
    iv. What kinds of narratives about climate change and its impacts elicit the most effective behavioural response… fear, efficacy, hope etc?
    v. Who are the most trusted sources to deliver information on climate science and its impacts?

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4. Key Findings

The key findings derived from evidenced-based literature are:

- Climate Matters in the US was the only group found to have a record of 'best practice' approaches to communicating climate change and its impacts that have had a measurable influence.

- Australians, and by extension Victorians, are divided on climate change into at least five groups: Alarmed, Concerned, Uncertain, Doubtful and Dismissive.

- Influencing audiences requires strategies of engaging those audiences rather than simply communicating the science.

- Where a population is divided on climate change, research is needed into each kind of audience, and which messages and aspects of the science suit each audience, which channels are needed to reach that audience and which sources those audiences trust.

- Information on the local impacts of climate change is more effective at engaging audiences than national or global information.

- Combining both emergency and hopeful messages in one is an effective way to communicate the science in the same message.

- Apart from climate scientists, the most trusted and visible sources to deliver climate information in Victoria are farmers, firefighters, paramedics, doctors and nurses. Increasing the visibility of climate scientists will also generate further trust.

- Social media as a communication channel will simply reinforce the existing division between Victorians on climate change.

- There is a large perception gap on climate change in Victoria. Whereas 78% of Victorians feel they are engaged and concerned with climate change they believe only 48% of other Victorians feel the same way (Sustainability Victoria, 2017). Resolving this gap requires direct conversations between community, family and friends about climate change and its impacts, a strategy which is promoted in the CCC strategies of the most effective CAN NGO's.

- The most effective form of communicating climate science is non-persuasive communication of factual information that is repeated often, to large audiences by trusted sources. Such communication can overcome the perception gap as well as the division of types of audiences.

- Communicating the health impacts of climate change is best done with affective imagery.

5. Best practice in communicating climate science and impacts – Literature review summary

5.1 Overview

Following extensive review of over 570 academic texts, 1217 climate related NGO's, 17 'best practice' guides for climate communications used by the IPCC and 580 Australian government websites, it was found that only a small percentage qualified as documenting 'best practice' in communicating climate science and impacts. Moreover, very little of the literature subscribes to a knowledge deficit model (that all that is required for 'effective communication' is to transmit the appropriate knowledge). Rather, most of the literature addresses the need to engage audiences as a pre-condition to effective CCC. Nearly all of this literature is related to communication practices being conducted outside of Australia.

1. From reviewing the literature, it was revealed that only the *Climate Matters* program run by Climate Central in the US, and supported by the Yale Program in Climate Change Communication (YPCCC) and the Center for Climate Change Communication (4C) at George Mason University, qualified meeting all three criteria of:
    i) communicating reputable climate data and projections.
    ii) communicating the economic, environmental, health and social impacts (as a minimum) of climate change
    iii) clearly demonstrating how communications strategies have been assessed as best-practice, noting how the impact of those strategies have been measured, allowing for reader comparison of results.

2. A larger amount of literature (reviewed below) documented attempts at communicating the economic, environmental, health and social impacts of climate change, **with some evidence** of how this impacted decision making of either the public or government. Typically, the evidence was based on sociological surveys, some of which tested messages about the science and impacts, but were not the result of a mass program of delivering climate information to a broad audience. The standout literature here was that used by the IPCC in their communication practices (see Spence & Pidgeon, 2010; Kirchhoff et al., 2013; Climate Outreach, 2015a; Climate Outreach; 2015b).

5.2 Best practice in CCC – the case of *Climate Matters*

Climate Matters is a program of Climate Central in the US that is supported by the Yale Program in Climate Change Communication and the Center for Climate Change Communication. In 2009, *Climate Matters* identified broadcast meteorologists as skilled science communicators who could reach large and diverse audiences and who had the potential to help viewers understand the science of climate change and its impacts. In 2010, Climate Matters partnered with weather presenter Jim Gandy (Chief Meteorologist at WLTX Columbia, South Carolina) and his news director Mary-Beth Jacoby to create and pilot test the

program by showing graphs of climate data, recent examples of which can be found at this archive link. Together with the Center for Climate Change Communication, *Climate Matters* conducted pre and post-test surveys of local TV news viewers in Columbia using both panel and cross sectional surveys, as documented by Zhao et al. (2014). At the end of the one-year pilot test they found that WLTX viewers had developed a more science-based understanding of climate change than viewers of other local news stations. The key findings included:

- New WLTX viewers were more likely to believe at follow-up that global warming was primarily human caused than non-WLTX viewers;
- Those who recognized more graphs and stories from *Climate Matters* were more certain that global warming was happening compared to those who recognized fewer;
- On a scale of -4 to +4, with -4 being completely certain climate change *isn't* happening to +4 being completely certain climate change *is* happening, those who recognised four graphs and stories were +2.01 on the certainty scale compared to +1.39 who saw no stories. This finding included a 95% probability that it was not chance);
- On a scale of -4 to +4 with -4 being no concern that climate change is happening to +4 being high concern that climate change is happening, those who recollected four graphs and stories were +3.04 on the concern scale compared to +2.74 who saw no stories. This finding included a 99% probability that it was not chance;
- Those who were aware of *Climate Matter*s were more concerned about global warming at follow-up than those who were not (+0.09 vs –0.04, *with* 95% probability that it was not chance);
- Those recognizing more *Climate Matters* stories were more concerned (+0.16 for four stories vs –0.08 for zero stories, 95% probability) and more likely to believe that scientists are in agreement regarding the reality of global warming (55% vs 22%) than those recognizing none. No other relationships in the regressions were significant.

For full details on this study, see Zhao et al. (2014).

Central to *Climate Matters* is the concept of 'non-persuasive' communication, which is that climate science information should be '*simple clear messages, repeated often, by a variety of trusted sources*' (Myers et al., 2015). Clear messages, delivered via charts and simple facts were shown to be the most effective by Van der Linden et al. (2014). This insight is corroborated in other independent studies (Avineri & Waygood, 2013). The *Climate Matters* principle of 'non-persuasive' communication is strongly derived from the work of Barusch Fischhoff (2007) and Maibach et al. (2016). To devise a successful communication program, you need to research your audience, the kinds of messages that work with those audiences, and a technique of transmitting them. Climate scientists, decision (policy) scientists and social scientists must work together to develop effective 'decision-aiding interventions' (see also Mukherjee & Howlett, 2018; who argue that 'policy advisory groups' of sociologists are needed to liaise between scientists and policy makers). In order to deliver effective interventions, Fischhoff (2007) emphasises that the following three specialists must work together:

- A climate scientist must present facts and evaluate the accuracy of information. Accuracy evaluation can refer to the initial dissemination or correcting public misinformation. Their role thus revolves around accuracy.
- A decision scientist identifies the facts that are important to people when making policy decisions. Thus, their role revolves around relevance.

- A social scientist's role is to look at how people respond to the facts and identify the audience's aims, motivators, inhibitors and obstacles during communication. Their role thus revolves around clarity.

The US programs in CCC also draw on much of the psychological literature to understand audience experience of messages, social norming, psychological distance, message framing and appealing to human motivation (Eg. See Van der Linden, Maibach and Leiserowitz, 2015). It is also important to note that the US literature is suited to Australian policy-making because of the extensive similarities between the two countries. Responses to climate change are politically divided, both countries have a concentrated media and per-capita emissions in both countries are among the highest in the world. Further, 4C and YPCCC are also the leading international 'best practice' researchers in how to understand audiences, through their Climate Change in the American Mind study.

5.3. Matching climate messages (economic, environmental, health and social) to specific audiences

The following table (on the following page) describes which kinds of CCC messages work, the channels in which they do so, to which audiences they are effective and from which sources they need to be delivered by. The table is a summary of the literature presented in the discussion that follows (see following page).

AUDIENCE	MESSAGE	TRUSTED SOURCE	MEDIA
GENERAL			
Undifferentiated	Climate science via non-persuasive communication	Weather presenters, local newspapers, climate scientists, friends & family	TV & daily newspapers
Undifferentiated	Local climate impacts	Weather presenters, local newspapers, farmers, firefighters, doctors, nurses & paramedics, friends & family	TV & local newspapers
Undifferentiated	97% consensus amongst scientists	Climate scientists & local newspapers	TV & daily newspapers
Undifferentiated	Health impacts	Doctors, nurses & paramedics	TV & daily newspapers
Undifferentiated	Fear and hope	Weather presenters, local newspapers, Farmers, firefighters, doctors, nurses, paramedics, friends & family	TV & daily newspaper
TARGETTED			
City Residents	Extreme weather agricultural impacts	Farmers	TV & daily newspapers
Conservatives	Economic co-benefits of Action	Farmers & firefighters	TV & online newspapers
Farmers	Risk as an economic issue, soil management	Pro-mitigation farmers	Local newspapers
Local Government Residents	The need to audit homes for climate risk	Council	Council newsletters
Business and Workplaces	Social comparison that others are accepting science and acting	Other business leaders, scientists & celebrities	Social media, TV & daily newspapers
Policy Makers	Risk communication	Climate scientists & economists	Direct advice
Networked Social media users	Climate impacts	Celebrities	Social media
LATENT PROFILE ANALYSIS			
Alarmed	Resilience	Climate scientists	TV, Online quality newspaper
Concerned	Climate science efficacy	Climate scientists, celebrities, weather presenters & community journalists	TV, Online quality newspapers
Uncertain	Climate science 'Deteriorating Atmosphere' (not GHG)	Climate scientists, celebrities, weather presenters & community journalists	Online, tabloids, commercial TV
Doubtful	Climate science	Climate scientists, celebrities, weather presenters & community journalists	Online, tabloids & commercial TV
Dismissive	Social welfare, economic and scientific development, impacts on animals	Farmers, firefighters & doctors	Online, tabloids & commercial TV

Table 1: Matching messages and sources with audiences. Source: MCCCRH

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5.3.1 International

A growing body of literature has established that the most effective way to convince audiences of the **environmental** impacts of climate change is to draw attention to the scientific consensus. Numerous studies suggest that highlighting the 97% consensus on climate change results in audiences being more able to accept the science. Several articles also noted that that belief or lack thereof in the scientific consensus on human-caused climate change was one of the most important issues in the formation of public opinion (see Van der Linden et al., 2015; Lewandowsky, Gignac & Vaughan, 2013; Myers et al., 2015). Scientific consensus is referred to in the literature as a 'gateway belief' which legitimates a range of other related beliefs (Van der Linden et al., 2015). Van der Linden et al. (2017) found that the communication of scientific consensus is effective for the acceptance of anthropogenic climate change. However, it was noted that this communication can be nullified if it is accompanied by misinformation about climate change. Therefore, this article recommends the use of 'inoculating messages.' These messages highlight the presence of misinformation and refute common arguments against the information that the communicator is presenting. Further, activities that improve the visibility and communication skills of climate scientists themselves as trusted sources can aid CCC (Hassol, 2008). However, there is a threshold for climate scientists' ability to communicate the science as they are averse to any kind of advocacy program. Pertinently, a recent study of 1235 individuals in the US found that advocacy from scientists reduced their credibility (Kotcher et al. 2017).

With regards to visual communication, studies of images used in the communication of **environmental** impacts of climate change showed that when images became too common, audiences fatigued (Chapman et al., 2016). However, the same study also found that images of trusted persons tended to resist such an effect. Interestingly, a communication strategy used in the US that sought to sensitize audiences to the impact of climate change on just one national park was evaluated as highly effective (Monani et al., 2018). The authors constructed a website with images designed to inspire emotional connection to the park. This also included information about the impact of climate change on the park. A survey was administered to participants before and after visiting the website which found that there was a stronger attachment to the park in its threatened state, highlighting an attachment to place. However, the authors did not explain how people could be attracted to the website in any ongoing way.

For conservative audiences, communicating the co-benefits of making decisions that respond to climate change should be a pre-cursor to, or alternative to, communicating the science and impacts. If the co-benefits were greater technological or economic benefits that nevertheless addressed climate impacts, Bain et al. (2012) and Bernauer and McGrath (2016) found this to be a better strategy than communicating the science. Bain et al. (2012) also found that dismissive audiences were more likely to accept pro-environmental messages framed in terms of social welfare and **economic** development, as opposed to framing messages in terms of climate change risks. The authors argue that:

> *'it is commonly assumed that convincing deniers that climate change is real is necessary for them to act pro-environmentally. However, the likelihood of such groups accepting the science simply by using scientific evidence is limited because these attitudes increasingly reflect*

ideological positions. An alternative approach is to identify outcomes of mitigation efforts that deniers find important.'

These may include **economic** or scientific development associated with renewables or cleaner air quality. One study in the US found that messages to conservatives that communicate the impacts of climate change on animals and other species can evoke more powerful emotional responses than perceived threats to humans (Dickinson et al., 2013).

Several studies reviewed also found **health** to be a key frame for engaging audiences on climate change. Leiserowitz and Smith (2018) contend that health is a useful paradigm frame for communicating the risks of climate change impacts, and in a study with 673 participants found that affective imagery is a powerful way to make this frame salient. Further, Roser-Renouf et al. (2014) found in a study of 1275 American adults, that the 'Alarmed' attitudinal segment of the 'Six Americas' (see *Understanding the climate change audience*) was the only segment able to name the health consequences of climate change, highlighting the need for a lot more communication of this impact. This report makes the recommendation that the most effective communication of the health risks associated with climate change is through health organisations to doctors who then communicate that information to their patients. In another study of 1127 individuals (Myers et al., 2012), respondents were shown articles on the environmental, security and health impacts of climate change. Across the different segments of the 'Six Americas', it was found that the health frame was the most effective at engaging people with climate change, whereas 'security' had little impact on those who did not accept the science of climate change. Maibach and Nisbet (2018) also found that the health frame was more effective at depoliticizing climate change.

A more **global** frame of climate change communications can be found in climate science communication guides used by the IPCC. A summary of the advice use by the IPCC's Expert Group in Communications includes:
- Scientific consensus is an important gateway belief
- Climate messages that induce fear (without hope) don't engage audiences
- Communicate solutions alongside the science
- Emotional appeals to the dangers of climate change impact can numb audiences.
- The risks of climate change should be framed at a level that accords with how individuals deal with everyday risks.
- Tell human stories
- Understand your audience before deciding on how localized messages should be.
- Make messages matter now
- Broaden messages to a national security or health frame
- Risk communication such as that used by the IPCC (for consumption by policy makers) needs to be translated into stories that are suited to a general audience.

5.3.2 Australian

In Australia, Morrison, Duncan and Parton (2013) found that perceived trustworthiness of celebrities, scientists and left-wing politicians decreased across the segments in a gradual trend line from Alarmed to Dismissive. They also found that the Cautious group was most prone to changing their voting intention and most open to changing their views on climate. For a subset of the Cautious group (stay at home parents, retirees and professionals) Morrison, Parton and Duncan (2013) also found that the word 'farmer' and images of farmers evoked the most positive emotions to act on climate change. Interestingly the term, 'deteriorating atmosphere' (rather than greenhouse gases) evoked the most positive response to all Cautious respondents. Using the same data set of 1927 respondents, Sherley et al. (2014) also found that words and images such as "farmer, nature, environment, weather and images of farmers and Australian rainforest" (p.276) were effective at engaging with the Cautious group. In contrast, narratives designed to invoke guilt were ineffective. In another study, Robertson and Murry-Prior (2016) interviewed 30 farmers and found that there were several barriers to farmers being receptive to climate science communication. They were that:

1) Adaptation to climate change was seen to be more distant than the time horizon of farm decision making
2) Farmers were optimistic that farming technology could keep ahead of climate change
3) Changing their business practices or moving to new locations was seen to be easier than adaptation.
4) The study also found some distrust of (urban-based) climate scientists' knowledge which was seen to undermine their own knowledge derived from living and working on the land.

In a further summary of studies into how to communicate climate to Australian farmers, Morrison, Huna and D'Alessandro (2018) argue that framing climate risk as an economic issue is the most effective form of engagement. This study can be contrasted with a UK study which found that focussing on soil management as an indirect way of bringing in climate science and impacts was more effective than a straight science communication campaign (Wilson and Roderick, 2018). In Australia, the Climate Council offers some of the clearest messaging to farmers and rural communities. Hine et al. (2016) further found that a communication campaign that focussed on adaptation messages was most successful across *all* segments of the sample where strong negative emotive content was used, or where adaptation advice was very localised. The importance of localised and up-to-date advice was also emphasised by McDonald (2018) and Moser (2018). When such messages were used, adaptation intentions were found to increase. Furthermore, it was found that including information on local impacts of climate change without using the term 'climate change,' was effective in increasing engagement by dismissive audiences.

Relevant to matching climate science with audiences is a study by Schäfer et al. (2014) that shows the drivers for media attention in Australia. Looking at two major Australian newspapers from 1996-2010, they found that political events, especially elections, increased media attention on climate change in Australia more than any other country in the analysis. Scientific activity, measured by the monthly output of articles

on climate change in high-profile journals, had negligent impact on issue attention in Australia newspapers. More significant were international factors such as the UN climate conferences (COPs). Similarly, UNFCCC Conference of Parties' were a political event that had their strongest influence in Australia.

There were also a number of studies that reviewed the current climate change adaptation and risk communication tools that are in use in Australia (Aldum et al., 2014; Boon, 2016). Boon's study looked at 1008 households across four Australian towns, including two in Victoria, and showed that prior disaster experience had no impact upon climate change risk perceptions. Instead, climate change risk perceptions were predicted by trust in climate change communications, climate change knowledge and the geographical location of the sample, suggesting the need for targeted, place-specific contextual communication interventions that consider the needs and socioeconomic characteristics of the community in question. In another Australian example, a CSIRO study by Rae Walker and Wendy Mason (2015) examined the health frame of CCC in terms of 'what current direct and indirect impacts of climate change are most relevant to organisations and the communities they serve?' They identified climate change impacts on six of the most vulnerable population groups - people with disabilities; older people; women and children; Aboriginal people; rural people; and people from culturally and linguistically diverse backgrounds - as well as discussing effective interventions. Other key issues covered include health and social impacts of climate change, adaptation, mitigation, climate change communication, organisational adaptation and a case study of innovation illustrating some of the book's themes. The Climate and Health Alliance in Australia work with health practitioners and patients as well as presenting a number of policy recommendations aimed at government bodies. They do not evaluate the impacts of their CCC but do present information on the impacts of climate change.

In a rural context, a study of the drought-affected Mallee in Victoria found that rural health workers were in need of mental health counsellors to cope with the impacts of drought on what they witnessed in their patients (Anderson, 2009). In urban Australia, Banwell et al. (2012) found that air conditioning technology was 'replacing everyday knowledge' about climate change. Furthermore, a series of city-based interviews found that the need for climate change knowledge was often annulled by adaptation solutions to increased heat which added to anthropogenic climate change. Lastly, a study of 217 Adelaide residents by Akompab et al. (2013) found that the top three concerns during a heatwave were comfort (60.7%), residents' garden (48.7%) and quality sleep (47.6%). At local government level communication, Sydney's Ku-ring-gai Council has developed 'Climate Wise Communities' as a way of strongly 'sensitizing' residents to climate information by conducting an extensive 'audit' of all citizens known as *Ready Check*. It provides a personalised assessment of each property for climate change adaptation, by locating your home address and outlining your property's risk to flooding, extreme heat, bushfire, ember attack, exit issues, storm and heatwaves. In engaging residents in this way, *Ready Check* is able to communicate a large amount of climate information and climate impacts at the same time as it is made obvious to residents why they need to know such information.

5.3.3 The limits of social media

In a review of CCC on social media, Tandoc Jr. and Eng (2018) found that whilst such a medium is good at amplifying climate change journalism, individuals tend to gravitate into groups to discuss their highly polarized views in echo chambers or 'filter bubbles' (Pariser, 2011).This effectively mirrors and reinforces the segmentation profile that is found in those national contexts and which diminishes political accountability of government that might otherwise be compelled to make effective decisions on climate change. Schäfer (2012) also found that climate scientists and scientific information are largely absent from social media debates internationally and that online CCC has limited impact on the broader public. Alternatively, enlisting celebrities as trusted sources can greatly assist CCC campaigns (Anderson, 2011; Boykoff & Goodman, 2009). It is also pertinent to note that that while social media can be fraught as a primary communication tool, the Victorian government's TAKE2 campaign has shown that social media can be important for the maintenance of relationships and tracking engagement once those relationships have been established.

6.0 Social impacts: selecting the audience

Several audience studies emphasized that climate change produces a range of different social impacts and the communication of these impacts should be selectively targeted to specific audiences. As a result of several field studies, Maibach et al. (2011) and Maibach, Roser-Renouf and Leiserowitz (2008) found that identifying like-minded audiences for CCC engagement is an essential precursor to communicating the science. Based at 4C and YPCCC, these researchers have used 'Latent Class Analysis' since 2008, showing that there are six different groups in America with distinct stances on CC (Maibach, Roser-Renouf & Leiserowitz, 2009). These groups, the Alarmed, Concerned, Cautious, Disengaged, Doubtful and Dismissive have been shown to be robust over time, and require six different types of messages. The Alarmed require messages of resilience; the Concerned need messages on efficacy; the Cautious need their climate literacy improved; the Disengaged need their literacy raised along with information on the economic benefits of energy independence; the Doubtful require messages of conservation and the co-benefits of reducing pollution; and finally, the Dismissive require messages that avoid climate science and focus on technological progress. The 4C and YPCCC research also looks at what medium these groups can most effectively be reached by, be that radio, TV, newspapers, social media etc. In another study, Horton and Doran (2011) conducted focus groups in the UK which recommended framing climate change as an issue of 'fairness' that appealed to everyone sharing the same environmental obligations. This approach accorded with Bolsen et al. (2014) who argued that social comparison, that showed that others accept the science and are responding to it, was a sound strategy for CCC. Social comparison can also work well when communicating to specific groups, such as workplace and organization settings (Dizon & Ma, 2018) as well as with corporate leaders (Hoffman, 2018).

The work of the YPCCC also suggests that in America, CCC needs to account for geographic differences in climate change beliefs, and that 'opinion maps' are needed to guide the messages delivered to different regions (Howe et al., 2015). This approach accords with the observations of Kahan and Carpenter (2017) that CCC needs to be applied to a diverse number of settings, and there is no general method of CCC that works (Lee et al., 2015). This research further reinforces the idea that CCC at a local scale is both necessary and effective at helping communities make effective decisions. Levine and Kline (2017) add to this analysis the importance of understanding CCC in relation to political affiliation at a local level insofar as political parties listen to their constituents.

A number of Australian researchers adopted segmentation analysis soon after Yale/4C began their studies. Ashworth et al. (2011), Hine et al. (2013) and Morrison et al. (2013) each conducted studies between 2010 and 2013. The work that social psychologist Don Hine and colleagues did for the National Climate Change Adaptation Research Facility (Hine et al 2013) is probably the best known. With the NCCARF study, Hine led a team that used all of the variables that 4C and YPCCC had been working with, but added some additional environmental factors including environmental concerns, green self-identity, emotional connection with nature, perceived spatial proximity and potential effects, trust in authorities and distress. With a large sample of just over 3000, Hine came up with five Australias: Alarmed, Concerned, Uncertain, Doubtful and Dismissive (see following page).
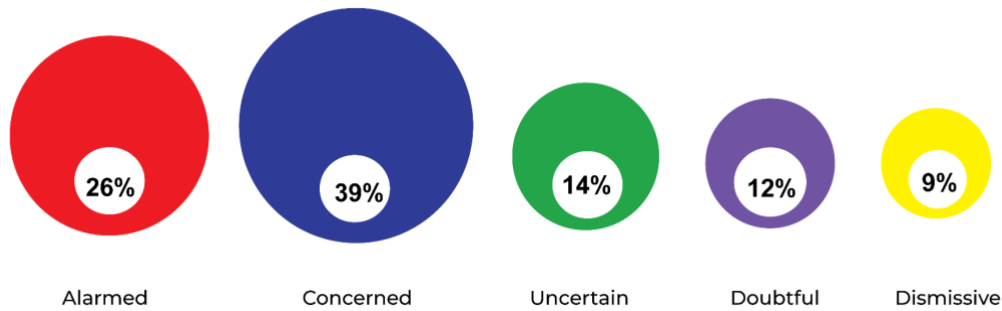
Figure 1: Global Warming's Five Australias. Source: Adapted from Hien et al. (2013).

Ashworth et al. (2011) limited their factor analysis to in-depth climate change literacy and concern, which produced only 'Four Australias' — Engaged 27%, Concerned and Confused 36%, Disengaged 15% and Doubtful 23%. However, while the description of the Doubtful group reported 'a moderate level of knowledge about climate change from some of that segment, it appears that the knowledge these people report includes many arguments that are proposed within the climate denialism movement. This group does include the confirmed climate sceptics, but also includes people with less extreme views. Across the group, support for government action on climate change is low. A total of 23% of the sample falls in this group' (Ashworth et al., 2011, p. 25). So, if Ashworth were to split the dismissive respondents from within the doubtful group, the study would yield five Australias. The Ashworth study nevertheless provided some valuable insights into the relationship between literacy and climate change concern. For example, a sub-segment of the doubtful group thought themselves to be climate literate from reading climate denialist blogs online, which made them dismissive of climate change. At the same time, the 'concerned and confused group' proved to only have moderate climate literacy but nevertheless described themselves as confused.
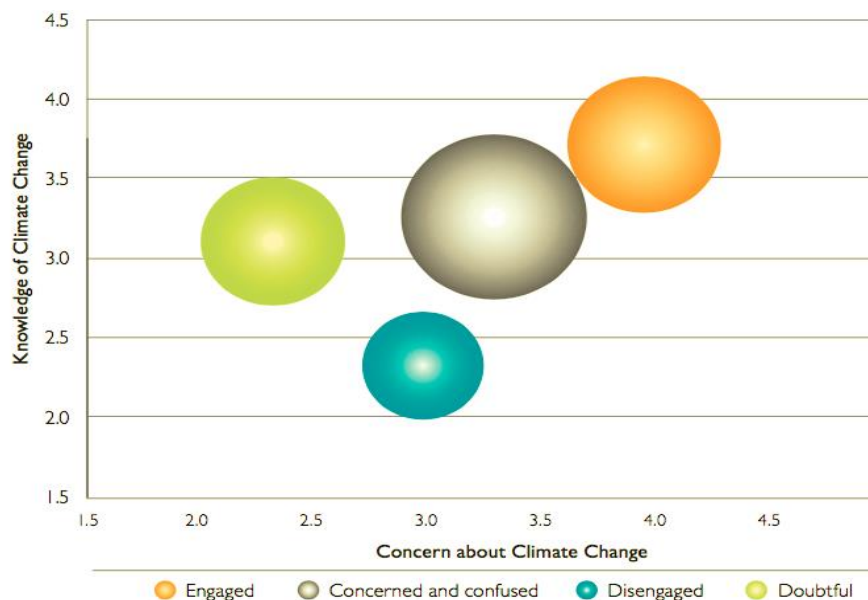

Figure 2: Knowledge of Climate Change. Source: Ashworth et al. (2011, p.25).

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Morrison et al. (2013) used broader variables in a survey of 1927 Australians, including: climate beliefs, issue engagement, policy support and behavioural response (energy use) and a small number of climate knowledge questions, in order to conduct a comparison with the research from the United States. As such, they found six Australias, based on the same questions posed in the first Yale/4C studies. As their comparison table shows:

> 'there was a smaller proportion of the Australian sample in the Alarmed and Concerned categories. Another noteworthy result is that more than 40 per cent were Disengaged, Doubtful or Dismissive in Australia, compared to 30 per cent in the US' (Morrison et al. (2013, p. 90)

	Alarmed	Concerned	Cautious	Disengaged	Doubtful	Dismissive
US (Maibach et al. 2011)	18%	33%	19%	12%	11%	7%
Australia	10.8%	22.5%	26.1%	20.0%	11.3%	9.3%

Table 2: Segment size in the US v. Australia. Source: Morrison et al. (2013, p. 89).

Following the initial flurry of research between 2010 and 2013, Hine and Morrison began to collaborate to produce a recent update which shows some longitudinal trends about climate change attitudes in Australia (2013). To do this, they took Morrison et al.'s template of Six Australias to compare the 2011 sample (n=1927) with a 2016 sample (n=2503) (see Morrison, Parton & Hine, 2018). Between the two periods, they found the proportion of households in the Alarmed and Concerned segments remained stable. Over the same period, a decrease was noted (28% to 20%) in the Doubtful and Dismissive segments and an increase noted (27% to 33%) in the Cautious and Disengaged segments. A stronger acceptance of anthropogenic climate change was found in the more recent sample overall. However, they found evidence of issue fatigue. Households reported that they had thought about climate change or talked about it less in 2016 compared to 2011. Paradoxically, whilst belief in climate had increased, there was an inverse decline in pro-mitigation behaviours. The study recommended climate communication strategies that would motivate households to redouble efforts to mitigate climate change, particularly the Cautious and Disengaged segments.

7. Current Australian audience research

The Monash Climate Change Communication Research Hub conducted research in 2017 on national TV audiences appetite for climate information. The 2017 survey (Holmes, Solano & Hill, 2017) looked at the willingness of television audiences to receive information. Of findings that could guide 'best practice' strategy of CCC the following were returned:

- 74.9% of respondents were interested in learning about the impacts of climate change in a weather bulletin.
- 84.65% of respondents indicated they would continue watching their main news program if it started presenting information on climate change.
- If other channels presented information on climate change when a viewer's main channel did not, 57.43% of the audiences said they would switch their news program.
- When asked what types of information audiences were interested in weather presenters including about climate change, the leading items were all about extreme weather:
  - powerful storms (63.62%)
  - heatwaves (63.05%)
  - bushfires (61.48%)
  - floods (61.77%
  - thunderstorm asthma (43.22%).
- Local climate impacts (46.65%) and historical data (45.22%) were favoured over global data (global impacts 36.09%, global historical data 34.66%)
- The three leading reasons why viewers wanted weather presenters to present impartial information about climate change were:
  - 'Because information about climate change is too politicised in Australia' (49.07%),
  - 'Because there isn't enough information about climate change' (44.76%)
  - 'Because this information will help me understand the weather better' (both with 41.75%).

7.1 Victorian Audience Research

To date, there is no Victorian focussed academic literature describing approaches to CCC that can been evaluated as 'best practice.' However, the MCCCRH has published three audience reports:

1. A 2017 report that filtered the national audience for Melbourne only, examining their views on climate change;
2. A much larger November 2018 report for Melbourne which surveyed 2039 residents;
3. A Regional Audience survey (n=750) that measured belief in climate change, literacy and behavioural response to messages. (see discussion below)

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The findings of the 2017 survey on Melbourne TV audiences' willingness to receive climate information did not vary much from the national sample discussed above except for types of information sought on:

- powerful storms (67.84%, up from 63.62%)
- heatwaves (65.33% up from 63.05%)
- bushfires (64.32% up from 61.48%)
- floods (63.82%up from 61.77%)
- thunderstorm asthma (56.28% up from 43.22%)

Further, the results of the 2017 Melbourne report show that there was a latent segmentation profile showing 'Five Victorias' in the question: *How interested would you be in learning about the impacts of climate change in a weather bulletin?*
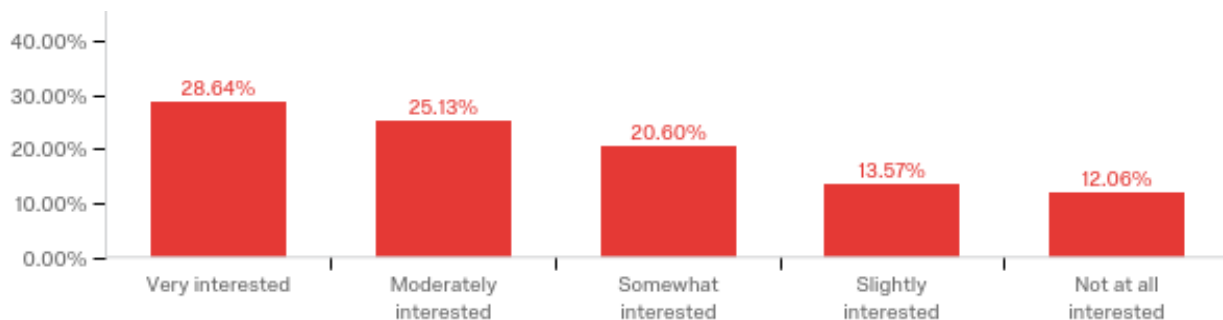

Figure 3: Interest in learning about the impacts of climate change from a weather bulletin. Source: Holmes, Solano and Hill, 2017.

The degree to which such interest could be mapped onto national categories of Alarmed, Concerned, Uncertain, Doubtful and Dismissive would require further Latent Profile analysis, by cross-tabulating literacy, concern and behaviour response. The following graph examines which sources were most trusted for climate change information in Melbourne.
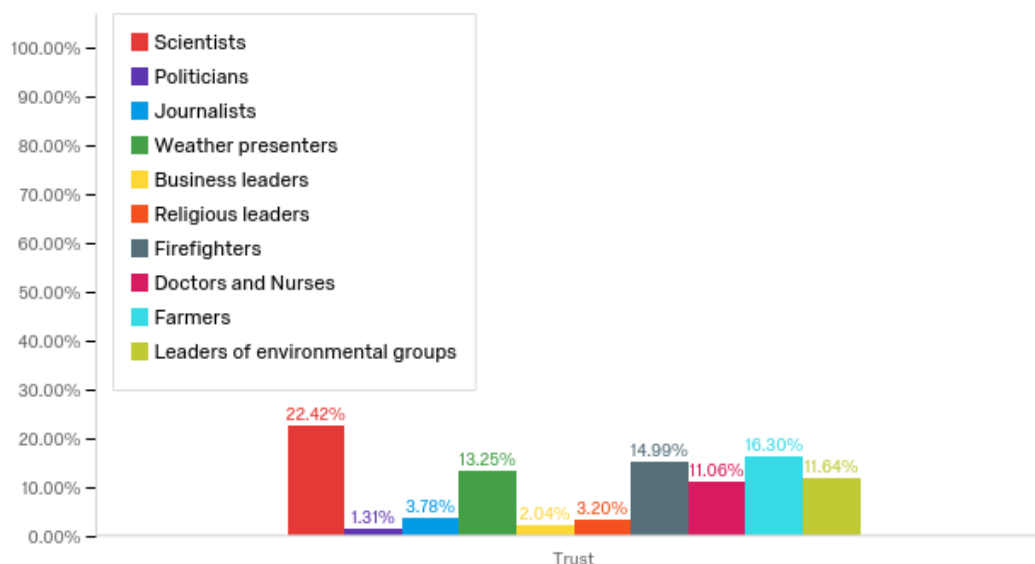

Figure 4: Levels of trust in different information sources of climate change. Source: Holmes, Solano and Hill, 2017.

Note that, of the top four sources who are trusted with climate science information, being scientists, farmers, firefighters and weather presenters, only weather presenters have ready access to large audiences and are skilled communicators. Since May 2018, the MCCCRH has been running a *Climate Matters* style program showing non-persuasive climate information on Victorian television. Preliminary results from a study currently underway have found that a small percentage of the surveyed group have already seen the packages on ABC Victoria. In the ongoing survey, which focuses on regional Victorian audiences, 27.8% of a sample of 759 respondents said they had seen the following graphs over a three-month period.
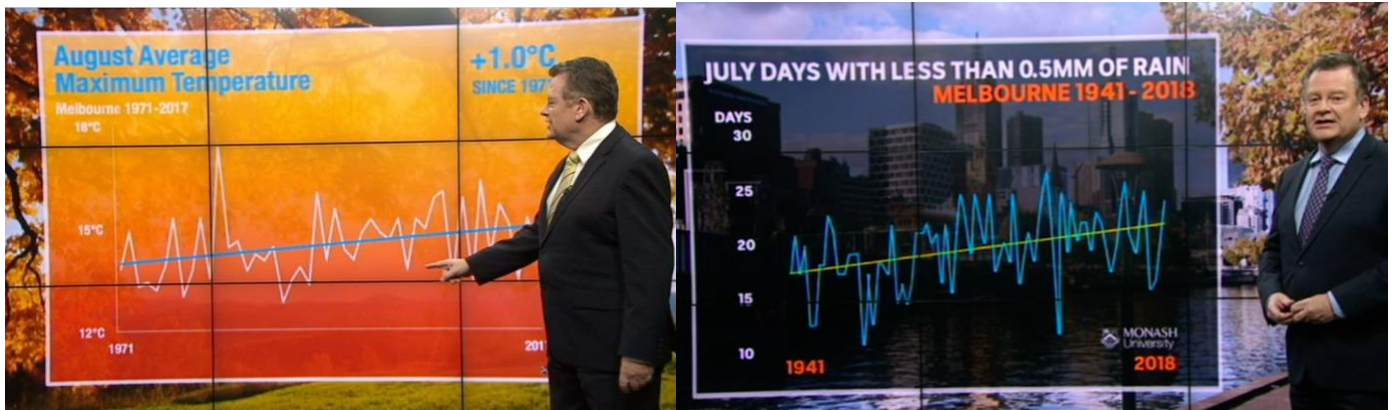

Figure 5: Examples of Monash Climate Change Communication time series graphs shown on the ABC in July and August. Source: MCCCRH (2018).

The 2018 surveys of Melbourne and Regional Victoria looked at two new areas of profiling climate literacy and behaviour response. To date, the Melbourne sample of 2039 Melbournians has been analysed. (Holmes, Hall & Thompson, 2018).

Literacy questions were grouped into:
   a) the current state of the climate/climate science ("status questions")
   b) basic definitional understandings of climate science ("definitions questions")
   c) the processes relating to climate change ("processes questions")

Overall, results showed that literacy about climate processes was quite low at 36%. Literacy on the current state of the science was also low at 39%, but definitional questions returned a higher result at 58%. In general, therefore, climate literacy of Melbourne residents is quite low.

Results by category (full sample)

Category	Topic	% of sample	No. correct
Status	Glacier melting trend	89%	1806
	Highest total CO2 country	54%	1108
	Scientific consensus	27%	541
	Highest per capita CO2 country	23%	467
	Atmospheric CO2 levels	5%	107
Definitions	Fossil fuels release which gas	76%	1544
	Greenhouse effect definition	62%	1255
	List of fossil fuels	23%	478
	List of greenhouse gases	5%	107
Processes	Climate system inertia	59%	1206
	Cause of coral bleaching on GBR	52%	1063
	Sea level rise system inertia	24%	498
	CO2 decay timeframe	10%	197

Table 3: Measure of Melbourne TV Audiences Climate Literacy. Source: MCCCRH (2018)

In the Melbourne sample, many people chose incorrect answers rather than "Don't know" responses, and this could imply confidence in incorrect information. This is pertinent as people are less likely to seek out new information if they don't perceive a knowledge gap.
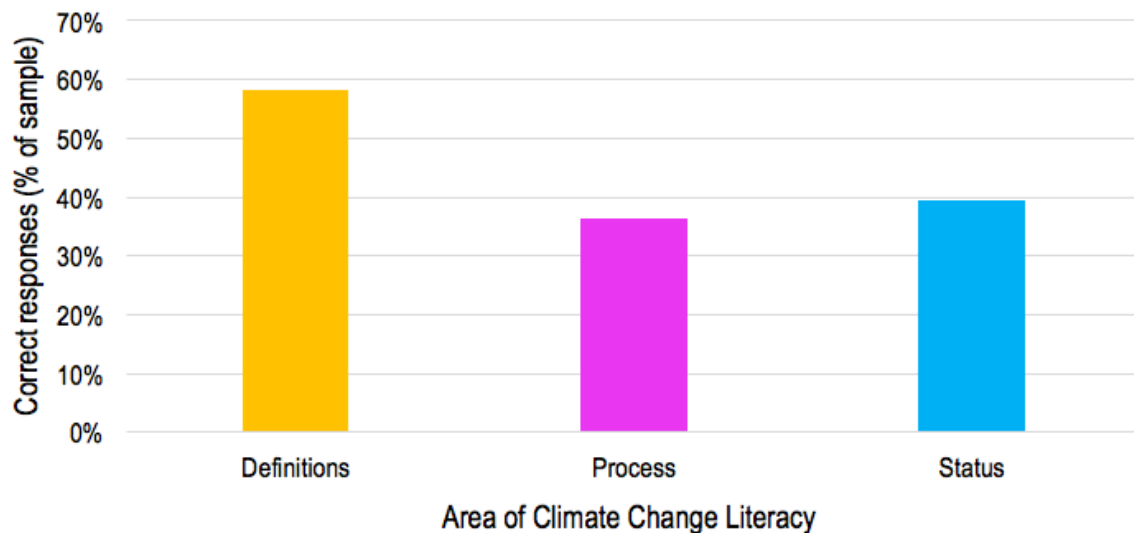

Figure 6: Results of 2018 Melbourne TV Audiences TV Survey. Source: MCCCRH (2018).

The only statistical differences (Chi-square tests) in results was across levels of education for overall literacy, and for definitions and process questions (but not status questions). There were no statistical differences across gender or age.
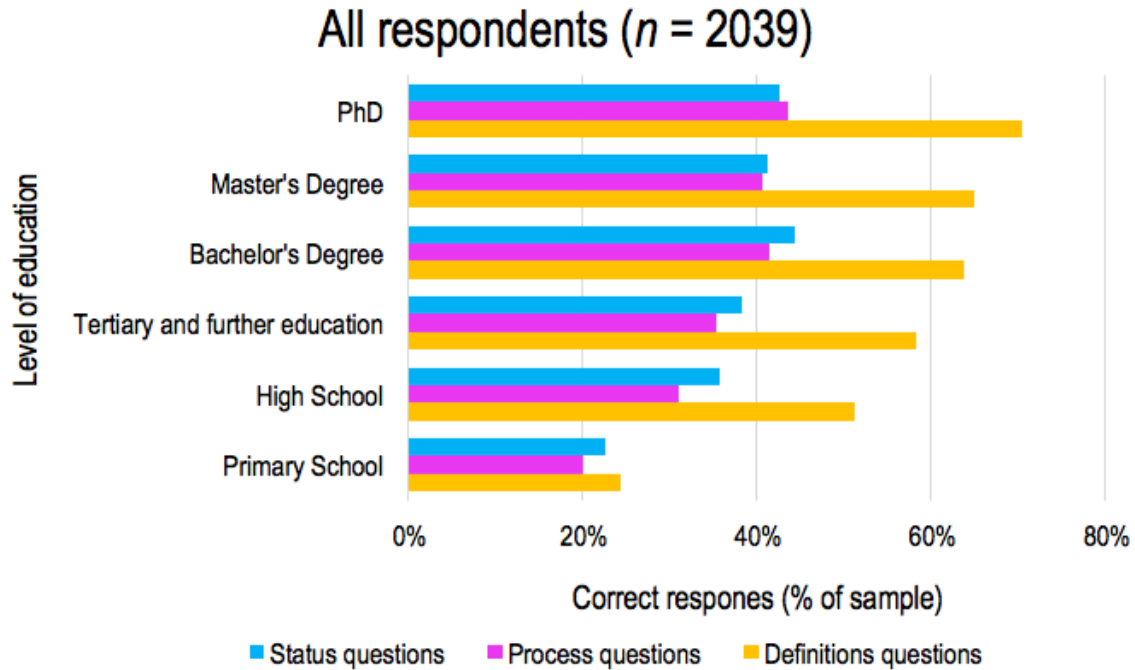
All respondents ($n = 2039$)

Figure 7: Results of 2018 Melbourne TV Audiences Survey. Source: MCCCRH (2018).

This analysis suggests that, insofar as media compete with education systems in literacy and socialization, public climate education by news services is an important component of climate communication strategies.

The MCCCRH is also able to produce filtered literacy and behaviour maps for all 26 Local government areas of Melbourne and for the five regional centres of 50kms around Ballarat, Bendigo, Shepparton, Traralgon and Wodonga.

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8. Recommendations for Future Research

- That the climate literacy of Melbourne audiences should be compared to that of regional audiences.

- Research is needed of what will be required to enable the Victorian government to undertake a personalised climate change audit of every Victorian property, which will can sensitize residents to climate change.

- Latent profile analysis of Victorians is needed according to the 5-6 segments on climate change found in Australian-wide studies.

- Studies are required of which messages are more likely to impact on effective decision making for each segment of climate attitudes.

- Opinion Maps of the Victorian community's understanding of climate science and impacts that shows regional variations climate-related segments in Victoria's.

- Sectoral analysis of what additional kinds of messages are needed by business and government should be undertaken.

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