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Communicating COVID-19 risk changes: Signalling with words, phrases, and messages

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ABSTRACT

During COVID-19, governments issued messages to trigger action, encourage sustained behaviours (e.g., social distancing, hand hygiene), and manage system wide risk. This study examines messages issued across two stages established by the World Health Organization (WHO): (a) pre-pandemic early intervention stage and (b) within-pandemic escalation stage. In April 2020, approximately one month after COVID-19 was declared a pandemic, an experiment using a sample of 769 Australian participants was conducted. Using a between-subject design, participants assessed the way messages (curated and then expertly attributed to the two stages) were perceived and influenced behaviours. Next, it examined the power of words and phrases, selected from the same messages, for (a) their potential to signal risk, warning, and behavioural response and (b) the extent to which they reflected pandemic stages.

Results showed that between the two stages, messages were differentiated by negative affect, assertiveness, and risk. Subsequently, increased negative affect, assertiveness, and risk indication increased adaptive behavioural intentions. However, increased assertiveness also increased non-adaptive behavioural intentions, though increased risk indication reduced non-adaptive behavioural intentions. Signal words and phrases, which hold potential as iconic features for biological hazard messages, showed varying performance across message stages, indicating an opportunity to improve them. Taken together, the findings contribute to academic and policy approaches for adapting communication to changing risk.

1. Introduction

Virus outbreaks and their potential for pandemic status create a sustained need for accurate and timely information that can be used to guide risk perception and adaptive behaviour. This study examines how to communicate risk within and between two stages, pre-pandemic early intervention stage and within-pandemic escalation stage of COVID-19. These stages are delineated by the World Health Organization (WHO) and used by governments when activating response plans, implementing control measures, and issuing communication guidelines. The pre-pandemic early intervention stage refers to the time prior to the declaration of pandemic where human to human transmission is occurring and initial messaging around preventing and reducing risk is recommended. The within-pandemic escalation stage refers to the period of time after a pandemic has been declared where there is sustained transmission across two or more countries, and where messaging typically seeks to escalate perception of risk. In its advisories about COVID-19, the WHO signalled the importance of risk communication and community engagement readiness and response, by stating that “failure to communicate well lead [sic] to a loss of trust and reputation, economic impacts, and – in worst case – a loss of lives” ([1]; p. 1).

In previous epidemics like HIV/AIDS, alignment between the WHO guidelines and member state emergency management systems was considered a success factor [2]. However, studies also highlighted deficits with the WHO model including failure to (a) create common understanding of phases among nation states [3], (b) accurately reflect pandemic threat, and (c) avoid public confusion [4].

In the early stages of COVID-19, local and global warning systems were considered “woefully underdeveloped” leading to calls to mitigate future waves of COVID-19 by drawing on early warning systems as applied in environmental hazards ([5]; p. 1). According to

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Fearnley and Dixon [5]; future pandemic early warning systems could comprise system processes across multiple organisations, the identification of “what combinations of text and iconographies work across traditional and social media (Facebook, Twitter, WhatsApp etc.) to indicate risk levels, and required or advised actions”, and areas of system standardisation and localisation (p. 2).

The noted deficiencies in COVID-19 early warning systems [5] creates an opportunity to consider how the Sendai Framework for Disaster Risk Reduction can complement the WHO pandemic model. Specifically, the Sendai Framework’s multiple priorities for the appropriate management of disaster risk, from understanding risk to investing in disaster risk reduction, can complement the WHO pandemic model, which is a multi-stage model that builds from no to sustained community outbreaks. Effective early warning systems comprise knowledge of risks and hazards, monitoring and warning services, issuing of warnings to people at risk, and public awareness and preparedness [6]. These factors present a focus point for integrating Sendai Framework priorities and WHO protocols around community-oriented risk communication practices, with particular emphasis on communication about preparedness and monitoring as severity and risk reduction measures change.

To support this integration, we examined with Australian adults in April 2020, approximately one month after COVID-19 was declared a pandemic, how messages and the signal words and phrases that emerge from them perform in pre-pandemic early intervention and within-pandemic escalation stages. These actions provide an evidence base to guide ongoing risk reduction research and future-focused practice within biological hazards. This study makes three contributions. First, it contributes empirical evidence to support calls for the risk communication and guidance aspect of improved emergency warning systems for biological hazards [5], by investigating the iconic features of warning levels for an intangible threat. Second, while many studies advise the use of effective risk communication with biological and natural hazards (e.g., COVID-19 and floods), most rarely examine how individuals evaluate and respond to specific messages and word choices that are designed to convey risk and encourage adaptive behaviour. Without direct evidence, we lack a rigorous basis to guide the development of standardised communication models that might also support differences in gender and other demographic data [7]. In this study we investigate how people perceive and respond to words and messages, and hence, provide this evidence base. Third, it is equally rare to find work that considers how messages change or adapt across time and as risk changes. Although the Sendai Framework and WHO protocols provide broad guidelines for public communication during multi-phase hazards, the current study adds empirical evidence to differentiate between stage. Accordingly, by providing evidence about COVID-19 risk communication, the current study offers empirical rigour to enhance the iconic features of risk communication across pre-pandemic early intervention and within-pandemic escalation stages and support future risk reduction initiatives.

2. Risk communication to guide safety during biological hazards

2.1. Origins and opportunities for the WHO pandemic framework and risk communication

To provide a global model for pandemic preparedness and response, the WHO developed its pandemic framework in 1999 with subsequent updates in 2005 and 2009 [8]. It comprises six phases from initial identification of a virus within one country to confirmed pandemic status (see Table 1). Corresponding to these phases are communication guidelines, which for Phases 1–3 reference external communication about real and potential risks, reflecting the risk-oriented informational component of risk communication. In Phase 4, which represents a pre-pandemic phase, the WHO recommends communication comprises early interventions that can attenuate population and individual risk. Phases 5 and 6 are pandemic phases that reflect the need for continuous information about risk and mitigation measures.

In the current study, these guidelines collectively result in two stages of risk communication messages. The pre-pandemic early intervention stage integrates Phase 4 of the WHO’s pandemic framework, which advises the promotion of recommended interventions to reduce individual and population risk [8]. It also comprises the WHO’s technical guidelines for when one or more cases have been identified, which recommend public communication should establish, build, or maintain trust, and manage uncertainty offering consistent and regular information and guidance to encourage protective behaviour and address misinformation and misperception [1]. The within-pandemic escalation stage combines Phases 5 and Phase 6 of the WHO’s pandemic framework, which advises continuous

| Phase                                | Description                                                                                           | Communication guidelines                                                                 |
|--------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Phase 1–3 Predominantly animal with few human infections | Phase 1 indicates no animal viruses reported to cause human infections, while Phase 3 is where an animal or human-animal reassortant virus has caused sporadic cases or small clusters of disease but not yet resulted in sufficient transmission to sustain community-level outbreaks. | Complete communications planning and initiate communications activities to communicate real and potential risks |
| Phase 4 Sustained human-to-human transmission | Human to human transition of an animal or human-animal influenza reassortant virus able to sustain community level outbreaks has been verified. | Promote and communicate recommended interventions to prevent and reduce population and individual risk. |
| Phase 5 Pandemic                      | The same identified virus has caused sustained community level outbreaks in two or more countries in one WHO region. In addition to Phase 5, the same virus has caused sustained community level outbreaks in at least one other country in another WHO region. | [Linked to both Phase 5 and Phase 6] Continue providing updates to general public and all stakeholders on the status of pandemic and measures to mitigate risk. |

Source: [8]
updates on the pandemic status and risk mitigation measures [8]. In addition, this second stage includes technical guidelines for ongoing transmission, which recommend that trust is maintained, and communication is tailored to public perceptions and needs, and remains regular and consistent, reflecting the severity of the situation and elaborating on the reasoning behind any challenging decision [1].

Given this framework for communicating pandemic risk, it is important to examine risk communication. Risk communication serves a dual purpose of both informing of risk and encouraging adaptive behaviours that reduce personal and community risk [9–12]. This study adopts Rickard’s (2021) definition for risk communication as a pragmatic function:

Risk communication is a strategic, one- or two-way, and (sometimes) iterative process of sharing information, often, but not exclusively, with an intended: (1) outcome, such as limiting exposure to a given hazard; (2) message, such as avoiding a geographic location; (3) messenger, such as a government agency; and (4) audience, such as a local community (p. 468).

Rickard’s (2021) definition reflects a similar application in public health where Weaver et al. [13] refer to risk communication as “the effective and accurate exchange of information about health risks and hazards — often during a crisis or emergency — that advances risk awareness and understanding and promotes health-protective behaviours among individuals, communities, and institutions” (p. 601). In the context of COVID-19, studies have highlighted how risk communication activities can be crafted to support uptake of public health interventions [14].

2.2. Risk communication across pandemic stages

The dual role of risk communication, that is to inform about risk as well as guide appropriate behaviours to mitigate risk, frames this research. Specifically, risk communication content should be accurate, timely, relevant, and credible to support information processing and decision-making [15–17], and decision-taking (Lindell & Perry, 2012). To achieve these tasks, risk communication should comprise content that is assertive [18], emotive [19–21], trusted [22,23], and perceived as effective [24].

Although there is common regard for and acceptance of these message factors, much of the extant literature examines risk communication by a single disaster stage as opposed to multiple stages [25]. Like some natural disasters (e.g., bushfires), pandemics are considered prolonged events that escalate and de-escalate and vary by transmission speed and also public information need [5,26,27]. Indeed, Reynolds and Quinn [27] note that “communication needs and strategies will change according to the phase of the pandemic” (p. 15).

Given this recognition for change in communication postures during pandemics [27], of particular interest are how the message factors linked to risk communication, that is, assertiveness, negative affect, trust, and perceived effectiveness, change across stages. These factors are defined and examined in the context of changing risk.

**Assertive content.** Assertiveness is a communication approach that relies on imperative language (e.g., do, must) to create a sense of urgency and desired result [28]. Assertive language can also cause message avoidance by reducing perceptions of individual freedom [29–31]. Yet, assertive language can also gain compliance when people perceive a sense of personal importance [32], and clarify between their level of personal investment and a favourable outcome [33]. Within this study, it is expected that the messaging will be seen as more assertive in the within-pandemic escalation stage compared to the pre-pandemic early intervention stage.

**Negative emotion.** When presented with a biological or natural hazard, an affective response is a likely response from affected stakeholders [21,34]. Models of risk information seeking and processing indicate that heightened risk is associated with negative affect such as worry or fear [21]. Affect can subsequently influence information seeking, processing, and decision-taking [20,21,34]. In this study, given the nature of the communication associated with the pre-pandemic early intervention stage compared to the within-pandemic escalation stage, it is anticipated that negative affect will increase across the message stages.

**Trust in information.** A factor of successful risk communication is consistently trusted message design [22]. Trusted content represents the best available, sufficient, and truthful information (Sponarski et al., 2014); [23], and should, ideally, be sustained throughout the risk or crisis event. Risk communication that is consistent across levels of government can avoid undermining trust, which might subsequently limit adaptive behaviour uptake [5,27]. In this study, regardless of the levels of change to risk, to be effective, risk communication must be trusted [22]. As a result, trust in information should remain constant across stages.

**Perceived effectiveness.** The construct of perceived effectiveness is often used as a pre-implementation, cognitive indication of the potential success of health communication (Yzer et al., 2015). Perceived effectiveness considers whether messages gain attention, and are convincing and timely [24]. Given its role as a proxy indicator for the effectiveness of health campaigns, regardless of the level of risk, the perceived effectiveness of risk communication should remain constant across the stages.

However, given scant consideration for the dynamics of change in risk communication messages, this study seeks to inform the research record by examining changing risk during COVID-19. These insights culminate in the following hypothesis:

**H1.** Between the pre-pandemic early intervention and within-pandemic escalation stages, risk indication, assertiveness, and negative affect increase to a greater extent than trust and perceived effectiveness.

Given pragmatic risk communication is often designed with an intended behavioural outcome (e.g., protective action; Rickard, 2021), this study also examines how message factors influence behavioural intention. Adaptive behaviours include actions such as following instructions [35], or seeking and sharing information with others [17,36], and non-adaptive behaviours include ignoring the message or taking no action.

Based on the evolution between each stage, it is expected that message factors (e.g., negative affect and trust) will consequently influence behavioural intentions. Negative affect, most commonly operationalised as worry [21], affects how people might seek or avoid information [34]. Past research into H1N1 found that taking preventative action was associated with heightened anxiety [37]. However, in a natural hazard context, if pushed too far, negative affect can lead to non-adaptive responses such as warning avoidance.
In addition, trust can guide attitudes and behaviours in natural hazard risk [38], and for small businesses, perceived effectiveness of bushfire warnings predicted protective action intentions [39]. Specifically, we propose that between the stages, an increase in adaptive behavioural intentions such as following instructions, seeking further information, and sharing the message and a reduction in non-adaptive behavioural intentions (e.g., ignoring the message, doing nothing) are expected. This leads to the following hypothesis:

H2. Between the pre-pandemic early intervention and within-pandemic escalation stages, assertiveness, risk indication, and negative affect will mediate adaptive and non-adaptive behavioural intentions.

2.3. How words signal risk, affect, and behaviour during pandemics

The effectiveness of risk communication messages is influenced by the words they employ. Signal words are used to convey to audiences, in simple terms, the quantification of risk and behavioural connotations [40]. They reflect hazard (e.g., explosive), calls-to-action (e.g., stop), and impacts of risk (e.g., deadly). For example, signal words such as danger, caution, urgent, and beware are iconic to product warning labels because they gain attention and indicate varying levels of warning, risk, and behavior [40–42].

Good practice suggests value in identifying and utilising signal words across different threat levels. For example, under their traditional area of study in product-based settings, low threat is implied by words like caution and note whereas high threat is transmitted by words like danger and deadly [43,44]. The appropriate stratification of signal words matched to relevant hazard level helps to ensure accurate understanding of severity, which in turn supports effective decision-making and action [40,41]. Moreover, a range of signal words within each threat level can help reduce message fatigue and habituation that is naturally associated with standardised warnings or where hazard levels are not dynamic [45]. Insights related to sufficiency or terms and indications of escalating threat can be usefully translated into disaster risk reduction research.

In the biological hazard context of a pandemic, signal words hold potential as components of standardised communication that reflects the different stages of risk and action as part of early and emergency warning systems [5]. During COVID-19, commonly used signal words included spread, accurate, and avoid. These words consider hazard and impact categories but are skewed towards the calls-to-action category noted in the signal word literature [40]. In part, this bias is due to their curation from messages developed in haste by governments to support a rapid response to COVID-19. Importantly, this rapid response may not adequately reflect the full range of signal words or any cross-cultural differences.

However, given the use of signal words can support a standardised risk communication model for biological hazards [5], it is important to consider the different meanings of signal words and their appropriateness of alignment across stages. That is, it is important to ascertain if signal words of lesser intensity in indicating risk, warning, and behaviour are correctly utilised during the pre-pandemic early intervention stage, and with those words signalling greater intensity used during the post-pandemic escalation stage. We expect, given the rapid response to COVID-19, that the intensity of signal words will vary considerably within stages, rather than being cleanly aligned with each stage, respectively. To add empirical evidence about the use of signal words within the biological hazard context and across different stages, we pose the following hypotheses:

H3a. Ratings of risk indication, warning indication, and behaviour indication will be correlated for individual signal words drawn from COVID-19 messages.

H3b. The strength of risk and warning indications for individual signal words will vary considerably within pandemic stages rather than lesser indications being aligned the pre-pandemic stage, and greater indications being aligned with the within-pandemic stage.

Importantly, in the context of a novel hazard like COVID-19, signal words used in isolation can provide insufficient information to judge risk [40]. In addition to words, during COVID-19, common phrases include stop the spread, act now, and avoid close contact. Similarly to individual signal words, it is important to ensure signal phrases correctly align across pre stages, with phrases of lesser intensity aligned to the pre-pandemic stage and phrases of greater intensity aligned with the within-pandemic stage. As previously...
noted, the rapid development of messaging for COVID-19 likely meant some misalignment was apparent, which may have implications such as over-sensitising people too early, particularly if phrases of greater intensity were used prior to the pandemic declaration. We expect this would likely have been the case given the novelty of COVID-19. To support an empirical evidence base, we propose the following hypotheses for signal phrases:

**H4a.** Ratings of risk indication, warning indication, and behaviour indication will be correlated for signal phrases drawn from COVID-19 messages.

**H4b.** The strength of risk and warning indications for signal phrases will vary considerably within pandemic stages rather than lesser indications being aligned the pre-pandemic stage, and greater indications being aligned with the within-pandemic stage.

Taken together, these hypotheses can provide an important empirical base to support the development of standardised communication as part of early and emergency warning systems for biological hazards like pandemics [5]. This potential is summarised in Fig. 1 that notes how an escalation between stages of a biological hazard are reflected in messages, words, and phrases that can encourage adaptive behavioural intentions and reduce non-adaptive ones.

### 3. Material and methods

A cross-sectional survey requested participants rate a COVID-19 message to answer H1 and H2, and signal words and phrases that emerged from these messages to answer H3 and H4, respectively. The study was reviewed and approved by QUT’s Human Research Ethics Committee (approval number 1900001118).

#### 3.1. Participants

A total of 769 people participated in the survey (49.5% female), which took approximately 10–15 min to complete. Market research company Dynata was engaged to ensure the sample was nationally representative in terms of reflecting the Australian population with ages ranging from 18 through to 75 years and older. The most frequent group reported was aged between 45 and 54 years (22.1%) with the majority of participants reporting their age as being between 18 and 54 years (69.6%). Characteristics of the sample are presented in Table 2.

#### 3.2. Context and method

At the time of data collection, Australian States and Territories were enforcing self-isolation for people who tested positive to COVID-19 and hotel quarantine for Australians returning from overseas. Many non-essential businesses were closed, restaurants were open only for takeaway or delivery services, and schools were open only to children whose parents or carers worked in essential services. At this point in time globally, there were approximately 1.7 million confirmed cases and almost 106,000 deaths (www.who.int, April 12, 2020) with Australia reporting a total of 6359 confirmed cases, and 61 deaths (www.health.gov.au, April 13, 2020).

Preceding data collection, the authors curated messages as used by governments in the United Kingdom, United States, Australia, and the WHO. These messages reflected publicly available, and arguably organically developed, short-form message content from the WHO [1,8]; and member states. These messages were curated by the researchers in March 2020 following the declaration of COVID-19 as a pandemic based on representativeness of available messaging from multiple sources at the time. Messages from these countries was chosen given Australians were exposed to both local and global messages, and because of the considerable media coverage in Australia of events unfolding in the United Kingdom and United States.

A group of academic and industry experts categorised these messages against the WHO pandemic framework using two criteria: (a) pre-pandemic early intervention stage content to comprise adaptive behaviours such as social distancing and hand hygiene and misinformation and (b) within-pandemic escalation stage content to comprise an escalation in behavioural actions, the status and

### Table 2
Sample characteristics.

|                        | Frequency | Percent |
|------------------------|-----------|---------|
| Total participants     | 769       |         |
| Sex                    |           |         |
| Male                   | 383       | 49.8    |
| Female                 | 381       | 49.5    |
| Other                  | 1         | 0.1     |
| Prefer not to disclose | 4         | 0.5     |
| Education              |           |         |
| Left school before Year 10 | 21   | 2.7     |
| High school to Year 10 | 53        | 6.9     |
| High School to Year 12 | 125       | 16.3    |
| TAFE qualification     | 241       | 31.3    |
| Bachelor degree        | 206       | 26.8    |
| Postgraduate award     | 123       | 16.0    |
| Dependents             |           |         |
| Yes                    | 311       | 40.4    |
| No                     | 458       | 59.6    |
severity relating to ongoing transmission, and a rationale (see Table 3). In the cross-sectional survey, participants were randomly allocated one message with data supporting H1 and H2.

These messages were used to derive key signal words and phrases. Although outside of the scope of the current research, we must acknowledge that the selection of messages pre-determined the nature of signal words, and hence did not consider cross-cultural or language differences, an area noted for investigation in future research. Table 4 depicts the selected signal words and phrases tested in the cross-sectional survey to answer H3 and H4.

### 3.3. Measures

To rate signal words and phrases, we followed the work of Hellier et al. [41]. Signal words or signal phrases were assessed individually by participants, with each participant assigned to see and evaluate only half of the total number being tested, so as to avoid fatigue. That is, for each signal word or phrase they were assigned, participants rated them individually using a series of single item scales. The scales requesting perceptions of warning (“indicate the extent you perceive the phrase to indicate a warning”), risk (“indicate the extent you perceive the phrase to indicate risk”), and behavioural response (“indicate the extent you perceive the phrase to indicate an action or behavioural response”). In line with the signal word literature, these items were measured on a 9-point scale with 1 representing “no indication” and 9 representing “always having an indication” [41].

With respect to the messages, participants rated one randomly selected message using a range of established measures. Risk indication was rated using a single-item question (“To what extent would you rate this message overall as indicating risk”) via a five-point scale with one indicating minor and five indicating major risk [41]. For trust in information (α = 0.90) participants indicated their agreement on three items: (i) The message was truthful, (ii) The message provides me the best available information on this event, and (iii) The message provided me with enough information to take action [23]. Perceived effectiveness (α = 0.89) was measured using three items: (i) The message gained my attention, (ii) The message was convincing, and (iii) The message was timely [24]. Negative affect was measured using its two most common emotions of worry and fear, selected also based on the newness of COVID-19 at the time of study [21]. Message assertiveness (α = 0.78) was measured using six items that rated the extent to which the message was imposing, assertive, sought compliance [18] forced a quick decision, tried to manipulate me, and tried to pressure me [30]. For protective action intentions, participants indicated their likelihood to undertake (a) adaptive actions (α = 0.76) to follow instructions immediately [35], seek further information [17], and share the message [36], and (b) non-adaptive actions or those that do not reflect the intentions of the source of the message (α = 0.80) to ignore the message and do nothing.

### Table 3

| Stage and purpose | Risk communication messages aligned to stages. |
|-------------------|-----------------------------------------------|
| **1. Early intervention stage:** Promotion of interventions to prevent and reduce risk and address misinformation [1,8] | Message 1: Help stop the spread of coronavirus. Know your risk, monitor your health and call ahead before seeking healthcare. [Adapted from message from Australian Federal Government] Message 2: We can all help to stop the spread of the coronavirus through good hygiene practices that everyone can adopt. [Adapted from message from Australian Federal Government] Message 3: Protect others from getting sick. Avoid close contact when you have a cough and fever. Seek medical care early and share your travel history with your doctor. [The World Health Organization] Message 4: Follow accurate public health advice. To avoid spreading rumours, always check the source. Learn more about #COVID19: www.who.int/COVID-19. [The World Health Organization] Message 5: As issues with the coronavirus change, it’s important to stay informed. Stay up to date on the latest information at health.gov.au. [Adapted from message from Australian Federal Government] |
| **2. Escalation stage:** Ongoing updates that reflects the status and severity of the pandemic and elaborates on reasoning behind decisions [1,8] | Message 6: As at 3pm today, there are 3966 confirmed COVID-19 cases in Australia. There have been 331 new cases in the last 24 h. Stay home, wash hands frequently, practise social distancing. [Australian Federal Government] Message 7: The rate of increase in new cases in Australia has declined. There have been 331 new cases in the last 24 h. Stay home, wash hands frequently, practise social distancing. [Australian Federal Government] Message 8: Everyone is required to stay home except to get food, care for others, seek healthcare, or go to an essential job. Keep 1.5 m distance from others. [California State Government, United States] Message 9: State Health orders everyone to stay home or in place of residence except as needed to maintain continuity of operation of critical infrastructure. [California State Government, United States] Message 10: New rules in force now: You must stay at home. More info and exemptions at health.gov.au. Stay at home. Protect others. Save lives. [United Kingdom] Message 11: Act now to reduce the spread of COVID-19. Follow this advice to save lives: Stay home, if you need to leave home, keep 1.5 m distance from others, stay connected online, wash your hands, cover your nose and mouth with a tissue when you cough or sneeze. [Victoria Emergency; State Government of Victoria, Australia] |
4. Results

4.1. Stages and message factors

H1 proposed that between the pre-pandemic early intervention and within-pandemic escalation stages, message factors of risk indication, assertiveness, and negative affect would increase to a greater extent than trust and perceived effectiveness. We conducted an Analysis of CoVariance (ANCOVA) for each message factor to analyse the effect of the progression across stages, controlling for effects of age, sex, and education. A summary of the analyses for risk indication, assertiveness, and negative affect can be found in Table 5, which shows that progression between stages was significant for negative affect and risk indication but not assertiveness. Analysis of the marginal means showed that the within-pandemic escalation stage was significantly higher than the pre-pandemic early intervention stage for negative affect ($M_{Stage1} = 3.42, SE_{Stage1} = 0.43; M_{Stage2} = 4.14, SE_{Stage2} = 0.12; F(1,631) = 14.12, p < .01, \eta^2 = 0.02$), and risk indication ($M_{Stage1} = 3.61, SE_{Stage1} = 0.09; M_{Stage2} = 3.93, SD_{Stage2} = 0.08; F(1,631) = 8.23, p < .01, \eta^2 = 0.01$). While the overall effect of assertiveness was close to significant ($p = .07$) when controlling for demographics variables, analysis of the marginal means showed the within-pandemic escalation stage ($M = 4.53, SE = 0.08$) to be significantly higher than pre-pandemic early intervention stage ($M = 4.17, SE = 0.09, F(1,631) = 8.30, p < .01, \eta^2 = 0.01$).

A summary of the analyses for trust in information and message effectiveness can be found in Table 6 where the ANCOVAs revealed no significant effect for message stages on these factors when controlling for age, sex, and education. Analysis of the marginal means showed no significant different for trust in information ($M_{Stage1} = 5.70, SE_{Stage1} = 0.10; M_{Stage2} = 5.63, SE_{Stage2} = 0.09; F(1,631) = 0.27, p = .601, \eta^2 < 0.01$) and perceived effectiveness ($M_{Stage1} = 5.75, SE_{Stage1} = 0.10; M_{Stage2} = 5.65, SE_{Stage2} = 0.09; F(1,631) = 0.52, p = .47, \eta^2 = < 0.01$).

In addition, as shown in Tables 5 and 6, the ANCOVAs revealed no significant interaction effects with the demographic variables that served as covariates. Thus, H1 was supported.

4.2. Stages and behaviour

H2 predicted that between the pre-pandemic early intervention and within-pandemic escalation stages, message factors would

Table 4
Signal words and phrases as noted by message stage.

| Stage Words | Phrases |
|-------------|---------|
| Stage 1     | Accurate |
| Stage 1     | Seek medical care early |
| Stage 1     | Rumours |
| Stage 1     | Follow accurate advice |
| Stage 1     | Early |
| Stage 1     | Avoid spreading rumours |
| Stage 1     | Contact |
| Stage 1     | Avoid close contact |
| Stage 1 and 2 | Avoid |
| Stage 1 and 2 | Stages 1 and 2 |
| Stage 1 and 2 | Avoid |
| Stage 2     | Coronavirus |
| Stage 2     | Protect others |
| Stage 2     | COVID-19 |
| Stage 2     | Protect |
| Stage 2     | COVID-19 |
| Stage 2     | Check the source |
| Stage 2     | Stage 2 |
| Stay        | Check |
| New         | Stay |
| Must        | New |
| Order       | Must |
| Act         | Order |
| Now         | Act |

Table 5
Summary of Analysis of Covariance – Message factors.

| Source (df) | Model 1 DV: Negative Affect | Model 2 DV: Assertiveness | Model 3 DV: Risk indication |
|-------------|------------------------------|---------------------------|-----------------------------|
|             | F  | \eta^2 | p   | F  | \eta^2 | p   | F  | \eta^2 | p   |
| Corrected Model (137) | 1.484 | .24 | <.01 | 1.29 | .22 | .02 | 1.16 | .20 | .13 |
| Age (7)     | .80 | .01 | .59 | 1.18 | .01 | .31 | 1.64 | .02 | .12 |
| Sex (3)     | 2.39 | .01 | .07 | .56 | <.01 | .64 | 7.22 | .03 | <.01 |
| Education (5) | 1.03 | .01 | .40 | .60 | .01 | .50 | 1.00 | .01 | .42 |
| Stage (1)   | 11.52 | .02 | <.01 | 3.27 | .01 | .07 | 14.92 | .02 | <.01 |
| Stage x Age (6) | .39 | <.01 | .89 | .49 | .01 | .82 | .78 | .01 | .59 |
| Stage x Sex (1) | .03 | <.01 | .87 | 1.01 | <.01 | .31 | 1.89 | <.01 | .17 |
| Stage x Education (5) | 1.47 | .01 | .20 | 1.32 | .01 | .25 | .97 | .01 | .44 |
| SSerror (631)^* | 1852.97 | 747.54 | 678.30 |

* SSerror term represents Sum of Squares for the error.
4.2.1. Post-hoc analysis

Indication across message stages resulted in a decrease in non-adaptive behavioural intention. As a result, H2 was partially supported.

Key outcome variables. Negative affect (M\[0.02, 0.10\]), and message stage (M\[0.06\]) was not significant, the pathways of message stage progression on non-adaptive behaviour was not significant (β = 0.03, 95%CI [-0.21, 0.07]) were significant. As assertiveness increased across message stages, non-adaptive behaviours also increased. However, the increase in risk indication across message stages increase negative affect, assertiveness, and risk indication and their respective increase each leads to an increase in adaptive behavioural intentions.

The second pathway included message stage progression as the predictor variable and non-adaptive behaviours as the outcome variable. Mediators and control variables were the same as the first pathway model. Consistent with the first pathway model, the direct effect of message stage progression on non-adaptive behaviour was not significant (β = −0.14, SE = 0.08, 95%CI [-0.30, 0.01]). Although the indirect pathway of message stage → negative affect → adaptive behaviour (β = 0.01, SE = 0.06, 95%CI [-0.19, 0.06]) was not significant, the pathways of message stage → assertiveness → adaptive behaviour (β = 0.11, SE = 0.03, 95%CI [0.06, 0.18]) were all significant. The direction of the pathways suggests that progression through stages increase negative affect, assertiveness, and risk indication and their respective increase each leads to an increase in adaptive behavioural intentions.

The second pathway included message stage progression as the predictor variable and non-adaptive behaviours as the outcome variable. Mediators and control variables were the same as the first pathway model. Consistent with the first pathway model, the direct effect of message stage progression on non-adaptive behaviour was not significant (β = −0.14, SE = 0.08, 95%CI [-0.30, 0.01]). Although the indirect pathway of message stage → negative affect → adaptive behaviour (β = 0.01, SE = 0.06, 95%CI [-0.19, 0.06]) was not significant, the pathways of message stage → assertiveness → non-adaptive behaviour (β = 0.05, SE = 0.02, 95%CI [0.02, 0.10]), and message stage → risk indication → non-adaptive behaviours (β = −0.14, SE = 0.03, 95%CI [-0.21, −0.07]) were significant. As assertiveness increased across message stages, non-adaptive behaviours also increased. However, the increase in risk indication across message stages resulted in a decrease in non-adaptive behavioural intention. As a result, H2 was partially supported.

4.2.1. Post-hoc analysis

With sex providing significant results as a covariate, post hoc independent t-tests were conducted to highlight the effect sex had on key outcome variables. Negative affect (M\[male\]: 3.81, SD\[male\]: 1.77, M\[female\]: 4.12, SD\[female\]: 1.78, t(762): −2.37, p = .01, d = −0.17) and adaptive behaviours (M\[male\]: 3.51, SD\[male\]: 0.99, M\[female\]: 3.73, SD\[female\]: 1.01, t(762): −3.15, i < 0.01, d = −0.23) were both significantly higher in females compared to males. There were no significant differences across sex for assertiveness (p = .12), risk indication (p = .83), trust in information (p = .16), perceived effectiveness (p = .17), or non-adaptive behaviours (p = .09).

Table 7

| Word       | r (Warning/Risk) | r (Warning/Behaviour) | r (Risk/Behaviour) |
|------------|------------------|-----------------------|--------------------|
| Accurate   | .92              | .81                   | .85                |
| Rumours    | .88              | .76                   | .80                |
| Early      | .93              | .81                   | .81                |
| Contact    | .89              | .54                   | .57                |
| Avoid      | .74              | .52                   | .54                |
| Coronavirus| .78              | .70                   | .70                |
| COVID-19   | .79              | .69                   | .66                |
| Protect    | .87              | .67                   | .67                |
| Follow     | .88              | .49                   | .49                |
| Seek       | .91              | .63                   | .63                |
| Spread     | .88              | .79                   | .75                |
| Stay       | .91              | .70                   | .72                |
| Check      | .88              | .65                   | .66                |
| New        | .92              | .89                   | .87                |
| Must       | .89              | .79                   | .76                |
| Order      | .90              | .77                   | .75                |
| Act        | .85              | .61                   | .67                |
| Now        | .90              | .76                   | .76                |

Note: all correlations significant at the p < .01 level.
4.3. Signal words across stages

H3a proposed that ratings of risk, warning, and behavioural indications would be correlated for individual signal words drawn from COVID-19 messages. Using the dimensions identified by Hellier et al. [41]; we measured the extent to which each word indicated risk, warning, and behavioural response. Table 7 presents the results of a correlation analysis to show that words are all well correlated by their indicators of risk, warning, and behavioural response. Thus, H3a is supported.

H3b proposed that the strength of risk and warning indications for individual signal words would vary considerably within pandemic stages rather than lesser indications being aligned to the pre-pandemic stage and greater indications being aligned with the within-pandemic stage. Fig. 2 illustrates the rating of signal words used in Stage 1 (including those that were used across both Stages 1 and 2, italicised, as listed in Table 4). In Fig. 2, the x-axis represents participants’ average indication of warning and the y-axis displays participants’ average indication of risk. Moderate indications for risk and warning were signalled by *rumours, accurate, early, contact, seek, check,* and *follow.* However, noted outliers were *avoid, protect, spread, COVID-19,* and *coronavirus,* which signalled a higher indication of risk and warning, despite messaging being pre-pandemic (Stage 1), in line with our predictions of signal word intensity in this context not always neatly aligning with the appropriate stage of the pandemic.

Fig. 3 illustrates the rating of signal words used in Stage 2 (including those that were used across both Stages 1 and 2, italicised, as listed in Table 4). In Fig. 3, the x-axis represents participants’ average indication of warning and the y-axis displays participants’ average indication of risk. As shown in Fig. 3, Stage 2 words signalled moderate risk and warning indication (e.g., *new, follow, seek, check*) as well as higher indications for some words (e.g., *spread and COVID-19*).

In relation to H3b, within and between each stage, signal words show considerable variation in their indication of risk and warning. This was particularly the case in Stage 1, where lower indication of risk and warning is warranted but where a number of signal words (e.g., *avoid*), showed a higher indication. In Stage 2, signal words (e.g., *new*) reflected moderate risk and warning indication compared to other words (e.g., *spread, COVID-19*) that signalled high risk and warning indication. Thus, H3b is supported.

4.4. Signal phrases across stages

H4a predicted that the ratings of risk, warning, and behavioural indicators would be correlated for signal phrases drawn from COVID-19 messages. Table 8 presents the results of a correlation analysis to show that phrases are all well correlated across all indicators. H4a is supported.

Fig. 4 illustrates risk and warning indication for signal phrases used in Stage 1 (including those that were used across both Stages 1 and 2, italicised, as listed in Table 4). In Fig. 4, the x-axis represents participants’ average indication of warning and the y-axis displays participants’ average indication of risk. As shown, despite being pre-pandemic (Stage 1), phrases showed varying indications of risk and warning, but mostly on the higher end of the spectrum. For example, phrases such as *seek medical care early, avoid close contact,* and *stop the spread* signalled a high indication of risk and warning and *check the source* and *avoid spreading rumours* signalled a moderate level of risk and warning. This latter finding is likely based on references in messages to finding accurate information as opposed to taking non-pharmaceutical actions.

Fig. 5 illustrates risk and warning indication of phrases used in Stage 2 (including those that were used across both Stages 1 and 2, italicised, as listed in Table 4). The x-axis represents participants’ indication of warning and the y-axis displays participants’ indication of risk. As shown, phrases that emerged from Stage 2 messages such as *act now* largely signalled high risk and warning with *stay informed* at a comparatively moderate level, as might be appropriate within-pandemic.

Overall, there was some variation in risk and warning indication for signal phrases. Notably, phrases from Stage 1 messages...
signalled mostly high indications despite being pre-pandemic, when lesser intensity of risk and warning indication might seem more reasonable. The risk of high levels of risk and warning indication in messaging prior to the actual within-pandemic stage is that community members may be over-sensitised too soon, and may begin to habituate, such that responses diminish by the time messaging at Stage 2 is encountered. Accordingly, H4b was supported.

5. Discussion

This study examined the performance of multiple government’s COVID-19 risk messages, including signal words and phrases, between pre-pandemic early intervention and within-pandemic escalation stages to guide evidence-based risk communication strategy for future pandemics.

At a message level, participants perceived an increase in heightened risk, negative affect, and assertiveness between pre-pandemic early intervention and within-pandemic escalation stages. Critically, despite the rise of these message factors from the pre-pandemic early intervention stage to the within-pandemic escalation stage, there was no harm to perceived trust in information or perceived effectiveness (i.e., perceptions of effectiveness of message content as opposed to intended actions, which was measured separately). Although these message factors can be usefully integrated into communication design principles, they showed interesting effects on behavioural intention that should be considered. Positively, increases in risk indication, negative affect, and assertiveness led to an increase in adaptive behavioural intentions. In addition, an increase in risk indication reduced non-adaptive behavioural intentions. However, an increase in assertiveness also resulted in increased non-adaptive behavioural intentions.

This dual effect of assertiveness is reflected in this study: The stronger effect appears with adaptive behaviours but its effect on non-adaptive behaviours suggests that assertiveness should not be the primary consideration for risk communication. The research record notes that despite its benefits, assertiveness can result in message failure when people perceive their freedoms are threatened [29–31]. Further pandemic studies could usefully consider the influence of personal freedom on assertiveness and behavioural intentions for both non-pharmaceutical and emergent pharmaceutical interventions.

These message-based findings provide important support for a standardised model for pandemic communication (see Fig. 1).

Table 8
Phrase specific correlations for warning/risk, warning/behaviour and risk/behaviour.

| Phrase                  | r (Warning/Risk) | r (Warning/Behaviour) | r (Risk/Behaviour) |
|-------------------------|------------------|-----------------------|--------------------|
| Seek Medical Care Early | .90              | .76                   | .76                |
| Follow Accurate Advice  | .83              | .68                   | .72                |
| Avoid Spreading Rumours | .83              | .70                   | .66                |
| Avoid Close Contact     | .86              | .73                   | .74                |
| Stop the Spread         | .90              | .74                   | .79                |
| Check the Source        | .88              | .69                   | .75                |
| Protect Others          | .92              | .77                   | .83                |
| Act Now                 | .81              | .63                   | .58                |
| New Rules in Force      | .85              | .76                   | .77                |
| Stay Informed           | .84              | .70                   | .73                |
| Stay Home               | .87              | .75                   | .75                |

Note: all correlations significant at the p < .01 level.

Fig. 3. Signal words used in Stage 2.
Specifically, communication guidelines should use negative affect, risk indication, and assertiveness (with caution) to reflect changes in severity of future pandemics and support the uptake of both non-pharmaceutical and pharmaceutical interventions during pandemics.

This research provides a new context for examining signal words and phrases, which reflected good practice based on their correlations across their indications for risk, warning, and behaviour [41,43,44]. This finding highlights opportunity for signal words and phrases to become iconic features of standardised pandemic warnings. However, given the variation of signal words and phrases by message stages, more work is needed to provide unique sets of substitutable words and phrases by message stage [40,41]. For example, an optimal set of pre-pandemic early intervention stage signal words should indicate lower risk, warning, and behaviour. Although the

Fig. 4. Signal phrases and their performance in Stage 1.

Fig. 5. Signal phrases and their performance in Stage 2.
present study highlights that accurate, new, and rumours (drawn from stage one messages) signal lower risk, they are associated with guiding information quality to avoid misinformation. As a result, future studies should test signal words that reflect a pandemic as well as a potential infodemic.

Further work, including at the level of application, is also needed around signal phrases to ensure that the appropriate intensity of risk and warning indication is communicated at the appropriate stage of the pandemic. In our data, we observed mostly high levels of risk and warning across both message stages, and particularly in Stage 1, when less intense risk and warning might be more appropriate. Ideally, these indications should build between stages to align to the level of risk and behavioural adaptation. When messaging is too intense too soon, it creates the possibility that community members will be over-sensitised too early, leading to fatigue and dismissal of later messaging, and that appropriate response to messaging may begin to habituate rather than increase at the later stages of the pandemic.

Much has occurred since the time of this study, one month after COVID-19 was declared a pandemic, subsequent risk communication that includes pharmaceutical interventions offer additional signal words and phrases worthy of testing to create a full suite of early to escalating signal words and phrases for future pandemic communication models. Overall, although noted differences between biological hazards like pandemics and natural hazards challenge an all-hazards approach [46], this study offers useful insights that can be applied across both natural and biological hazards. Specifically, it provides insight into the behavioural role of message factors (e.g., negative affect, assertiveness) as risk elevates. In the natural hazards context, communication research that examines escalating or de-escalating risk is scarce, offering an opportunity to also apply the conceptual model (see Fig. 1) into other hazard domains to support public policy, practitioners, and ultimately community outcomes.

5.1. Limitations and future research

The research was conducted during an extraordinary event which may have strongly influenced public acceptance of government actions. At the time of data collection, such actions were non-pharmaceutical in their nature, however, subsequent government actions (e.g., vaccination) and responses from groups of individuals (e.g., COVID-19 deniers, anti-vaxxers and anti-maskers) are an important limitation to consider in the early stages of future pandemics. Further, the research involved an Australian sample that would have had most experience with Australia’s pandemic response at the time of data collection. Countries may differ in their pandemic response processes (e.g., use of lockdowns, hotel quarantines for returning citizens) and this can impact on the way community members respond to risk communication messages, in either positive or negative ways (e.g., in terms of being trusting versus being cynical).

Supporting Rana et al.’s [7] finding of differences between sex, post-hoc analysis showed that negative affect and adaptive behaviours were significantly higher for female than male participants. Further research could involve retrospective or cross-country comparison studies, studies that examine for individual and sex differences, and also studies that consider alignment and response to Sendai Framework priorities and the WHO’s global response and framework. Indeed, future research should directly consider cross-cultural interpretations of signal words to see how they generalise to other countries using similar pandemic response strategies to Australia, since cultural and language differences likely mean a single set of words will function the same way universally.

Although the current research examines a classification of pandemic phases based on the WHO pandemic framework, future studies could also examine alternative stages of other long-term crises such as the climate crisis and related disaster management phases. Such research may provide useful insights into emotional and compliance ceilings, and habituation of response. In addition, longitudinal research could examine changes in the power or interchangeability of words (e.g., to see if similarity or closeness of words remains or changes as hazards become more sustained, or characterised differently by governments). Finally, as this study has identified initial evidence for iconic features of biological hazard warnings, further research could explore these features in more detail. For example, future work could involve controlled studies such as with behavioural experiments that offer people particular messages in a simulated hazard emergency and gauge actual responses.

6. Conclusions

To date, the research record has lacked an evidence base from which to examine and design risk communication messages and their iconic features in the context of multi-phase pandemics and other biological hazards. Given pandemics like COVID-19 profoundly impact society for enduring periods, evidentiary rigour is essential for supporting effective and timely communication of risk between government and communities in the early and ongoing stages of crises. Our results have identified potential iconic features for messages, with signal words and phrases that reflect warning, risk, and behaviours. While COVID-19 required intuitive construction of communication, the current study provides a model for standardised pre-pandemic communication designed to build understanding of risk and encourage early preventative behaviours and within-pandemic communication to support adaptive behaviour for future pandemics.

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Declaration of competing interest

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