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Cross-cultural comparison of behavioural itinerary actions and times in wildfire evacuations

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ABSTRACT

Evacuation of residents during wildfire is a highly time-sensitive process. Available time may be limited. Previous research on other types of incident demonstrate that individuals delay their evacuation by first undertaking actions in response to the threat. However, currently there is little evidence of what actions individuals undertake ('behavioural itineraries'), how many, which are prioritised, and how much time is committed to them in a wildfire. Additionally, where some understanding exists concerning human behaviour in wildfire evacuations, data has mostly been acquired from Australia; European regions, which are increasingly threatened by wildfires, lack attention. This study presents the first cross-cultural investigation of its kind: survey data (N = 293) from the South of France and Australia were compared. Participants with actual experience of wildfires and those inexperienced yet residing in at-risk areas answered questions about what they did or would hypothetically do, respectively, and for how long, prior to commencing evacuation. Results revealed that, across the two regions, the discrete actions comprising behavioural itineraries were similar overall, albeit their priority sometimes differed. However, when analysed by category, the prioritisation of actions was uniform across samples. Of significance is the finding that regional differences were also observed in relation to: mean number of actions, time committed to actions and the influence of socio-demographic factors, indicating geographical and cultural determinants. Implications for future research, evacuation modelling and wildfire management, education and training are discussed.

1. Introduction

1.1. An ongoing wildfire evacuation challenge

Recent wildfires (also known as bushfires or forest fires) in Europe, Australia, and other parts of the world illustrate how rapidly growing cities and nature challenge one another, and most of all, human safety. Disasters like these claim people's lives as well as affect individuals' physical and psychological health (Jogia et al., 2014; Russel, 2017). Unfortunately, neither published fire statistics provided by European countries (Brushlinsky et al., 2019), nor Australia's official bushfire data source (Geoscience Australia, 2020), report the number of people involved in wildfire evacuations. However, some political organisations, local researchers, and the international media have followed and documented cases. For example, in 2017, around 12,000 people evacuated in an incident in France (Valabre, 2017), a country where policy typically dictates staying put inside one's home (GOUVERNEMENT.fr, 2020). In 2018, a year where large wildfires were experienced by a greater number of European countries than recorded previously (European Commission, 2018), hundreds evacuated during an incident in Greece, many heading for the sea; unfortunately, this ended in the greatest number of fatalities seen in a European wildfire (CBS News, 2018; Škrlec, 2018). In 2019, nearly 9000 people evacuated during an incident on the Spanish island Gran Canaria, while even Norway experienced a mass evacuation of 250 people (Log et al., 2020; The European Space Agency, 2019). The 2019/2020 Australian bushfire season has seen the largest bushfires ever reported in Australia. During this period, the state of Victoria for the first time ordered mandatory evacuations – previously allowing people to choose to stay or go at their own risk (Loh, 2007). In just the Mallacoota region alone, over 1000 people were evacuated in the largest sea-based evacuation in Australian history (Filkov et al., 2020). Given current projections of climate change, wildfire occurrence across the globe is likely to become more frequent (Filkov et al., 2020; IPCC, 2018) and so too may associated mass evacuations.

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1.2. Evacuation decision-making

To date, research on human behaviour in wildfires has mainly investigated evacuation decision-making. This means choosing to either stay – to passively shelter-in-place or actively defend one's property – or to evacuate as a form of protective action (Cova et al., 2009; McCaffrey & Rhodes, 2009; McCaffrey et al., 2015). Decision-making involves preceding (and sometimes succeeding) stages, including processes such as risk perception and information seeking, during which individuals may be influenced by changes in the environment, and/or by advice/instruction received from official and unofficial sources (Folk et al., 2019). In an ideal situation, these processes will conclude in a swift decision to evacuate (assuming that evacuation is the most appropriate protective action in the given circumstances). However, those involved in wildfire management should understand and prepare for the fact that, even in an ideal situation, evacuation movement may not occur immediately.

1.3. Wildfire evacuation modelling

Planning for disaster responses to wildfires in urban environments is increasingly important. To help such preparations, researchers have identified the need for integrated urban-scale (or large-scale) fire evacuation models, and proposed merging three computer simulation tools (pedestrian, traffic and fire) (Ronchi et al., 2019; Veeraswamy et al., 2018), which can be used to predict population movement and behaviour during wildfires. Furthermore, Lawrence et al. (2020) have demonstrated an integration of the state-of-the-art pedestrian and vehicle evacuation models and fire models, which can be utilised by practitioners for real-time management as well as planning (for more detail, see Chooramun et al., 2019; Lopez et al., 2018; Monedero et al., 2019; Tolhurst et al., 2008). One recent adaptation of an evacuation model, which coupled large-scale pedestrian evacuation with a fire spread model, was applied to simulate the UK Swinley forest fire (Veeraswamy et al., 2018). It demonstrated that wildfire evacuation is a time-sensitive process and there is a need to consider various factors including available routes, the time required for the population to reach shelters and, importantly, the role of 'response time' when determining human survivability and the appropriateness of evacuation over staying put. Response time is the period between being alerted to the fire and the commencement of the subsequent evacuation movement to a place of relative safety, and is defined as comprising both cognitive processes (e.g. perceiving and interpreting cues to the fire, making decisions) and actions (taken in response to the cues and decisions) (Galea et al., 2017; Gwynne et al., 2016; Proulx & Fahy, 1997). The focus of this paper is on the actions performed prior to commencing evacuation movement, which for an individual can be said to represent their 'behavioural itinerary', and the overall time committed to such actions, referred to here as 'behavioural itinerary (BI) time'.

Some efforts have been made in recent years to highlight the need for incorporating knowledge on human behaviour in emergencies into evacuation modelling, and moreover methodological suggestions have been provided on how this could be done (Kuligowski, 2013; Kuligowski et al., 2017). Nonetheless, wildfire evacuation modelling is lacking empirical evidence about what people do during the response phase and the resulting delays to the commencement of the evacuation movement phase (McLennan et al., 2018).

1.4. Evacuation delay in the built vs. urban environment

Research on building evacuations shows that individuals tend to undertake various activities before they leave the at-risk area, thereby delaying evacuation; this research has contributed to an enhanced understanding of response times and response phase behaviours, and some cross-national studies have additionally highlighted the impact of culture on building evacuation delay (Day et al., 2013; Galea et al., 2012; Galea et al., 2015; Galea et al., 2017; Kuligowski, 2013; McConnell et al., 2010; Tavares et al., 2006). Nonetheless, in wildfire evacuations, individuals may receive more early cues (environmental or social cues, such as the sight of smoke in the distance or news reports warning of a fire elsewhere in the area) before realising that evacuation is necessary (e.g. when receiving an evacuation order). Furthermore, such incidents are likely to require evacuation from an area well beyond just the buildings that are currently at immediate risk. So, individuals will need to travel a greater distance to reach safety, possibly take others such as dependents and animals with them, as well as take provisions to cover an extended time away from home (Folk et al., 2019). Due to these differences in scale, the number and range of response actions undertaken, and the time taken to complete them, prior to leaving, may be greater than that estimated from building evacuation research.

Moreover, currently available large-scale evacuation models either have individuals in the at-risk population randomly start evacuating according to an assumed distribution (Cova & Johnson, 2002; Li, Cova, & Dennison, 2015) or, in other cases, household evacuation is triggered after a time when the authorities (e.g. police) are estimated to have reached each home and knocked on the door, thereby simulating the delivery of a face-to-face evacuation order (Veeraswamy et al., 2018). To achieve simulations that represent a more realistic nuanced scenario, evacuation delays should be based on knowledge of or informed estimations about the circumstances and activities of the individuals comprising the at-risk population.

1.5. Need for geographically- and culturally-diverse data

Current research into behavioural responses to wildfires has scarcely addressed European wildland-urban interface (WUI) settings, the context of which may differ from the more extensively explored settings in Australia. There, the largest information resource regarding responses became available following the 2009 Black Saturday bushfires in Victoria, when the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC, 2020) was established. Studies contributing to BNHCRC covered fundamental themes such as community involvement in bushfire responses (McLennan & Omodei, 2011), differences between communities in their individuals' responses to bushfires (Morrison, Lawrence, & Oehmen, 2014), and how individuals make decisions to stay and defend their property, evacuate or shelter-in-place (McLennan et al., 2012; McLennan, Paton, & Beatson, 2015a; McLennan, Paton, & Wright, 2015b). However, authors of these studies have emphasised the possible shortcomings of generalising their findings beyond Australian settings due to their particular policies towards evacuation and property defence (McLennan, Paton, & Beatson, 2015a). A comparison of responses in Australia with that in North America found that differences lay in wildfire policies (Mclennan, Cowlishaw, Paton, Beatson, & Elliott, 2014). The same conclusion was reached in North American literature referencing Australian cases (Stephens et al., 2009). Thus, it would be unwise at present to generalise findings on human responses to wildfire evacuations in these regions to others such as France, Greece, Spain, or Norway.

Potential differences between European and more researched regions may lie not only in the regions' wildfire policies but also in their wildfire experience, urban planning and construction methods, and other aspects that shape their safety culture[1] and geography. Due to such

[1] In this paper, 'culture' refers to aspects that are largely shared among individuals within a group, such as values and norms, and which influence behaviour (Ilesanmi, 2009). While other research has focused on 'national culture' – where France and Australia have already been shown to be culturally distinct (Beugelsdijk & Welzel, 2018; Hofstede Insights, 2020; see also Minkov & Hofstede, 2012) – this paper focuses on 'safety culture' within nations. Kinateder et al. (2015) reflect that safety culture involves a process where the values and safety-related norms in an organisation influence its members' protective action behaviour. We echo this concept but replace 'an organisation' with 'a wildfire-prone region' and 'members' with 'residents'.

aspects, in some regions of Europe, both the authorities and civilians may default to a 'stay put' strategy in the event of a wildfire. Should no fatalities follow, then this will likely reinforce 'stay put' as the decision to take in subsequent wildfires. Indeed, it may be the safest choice in many cases. However, given the dynamic nature of wildfires, the speed at which fires can rapidly change in their number, severity and direction (Ager, Preisler, Arca, Spano, & Salis, 2014), plus the fact that it is always prudent to have a 'plan B' (Eriksen, Penman, Horsey, & Bradstock, 2016), evacuation should not be automatically discounted. The lack of human behaviour and evacuation data relevant to European settings is partly due to 'stay put' being the predominant strategy.

Finally, not everyone residing in an at-risk area will have directly experienced a wildfire, either in recent years or at all. Yet, it would be useful to understand their intentions, so as to prepare for such an event. Intentions can be probed using hypothetical-scenario surveys. To a certain extent, studies on wildfire evacuation have already embraced the potential of these tools (McLennan et al., 2013), and some studies on other types of disaster have found coherence between individuals' intentions and actions (Huang et al., 2015; Kang et al., 2007). However, there is currently a lack of direct comparisons between responses to hypothetical wildfires and responses to wildfires actually experienced. In addition, where comparative studies have been conducted in the field of disaster research, they have been carried out within the boundaries of a single country.

Thus, this study sought to: (1) reach out to individuals who had recent experience of a wildfire and ask what response actions they undertook prior to commencing evacuation and how long it took them; (2) reach out to individuals in at-risk areas who lacked such experience, present them with a hypothetical evacuation scenario, and have them think about what response actions they would undertake and how long it would take them; and (3) conduct these surveys in both a European setting (South of France) and an Australian setting to facilitate a comparison. Such data could then be used to improve both planning and real-time management of evacuation in wildfires, by providing a more informed foundation for model users to construct or apply behavioural itineraries and times.

2. Methods

2.1. Study design and materials

Cross-cultural research has particular requirements regarding its methodology (see Berry, 1969, for criteria on 'functional equivalence', 'emic' and 'etic' approaches, and 'conceptual equivalence'). Thus, in order to design an online survey that would be suitable for wildfires and residents in two different regions, existing wildfire evacuation survey materials and data, from Australia (Royal Commission, 2009), were first identified and analysed. Then, time was spent in the French region to learn about wildfire-related and more general behaviour there, including local language use. Subsequent similar time was spent in the Australian region. Additionally, sources of information on France and Australia's respective safety cultures as expressed through policies and practices, risk plans, and so forth were identified and examined (for further details, see Vaiciulyte, 2020). At the time of the study, the current wildfire policy in the main areas from where participants were recruited stated a preference for (in the South of France, including the island of Corsica) 'staying put' for the purposes of sheltering or (in the state of Victoria, Australia) early evacuation. In the former area, the policy was consistently reinforced through various channels and practices. In the latter area, there were some competing messages such as a legal exception dictating that individuals cannot be compelled to leave property in which they have a 'pecuniary interest'; that is, individuals cannot be stopped from staying to defend their homes, a position extensively explained in a paper published by BCRC (Loh, 2007). Thus, it was hypothesised that the French samples would have shorter BI times and be less uniform in the actions undertaken due to not being versed in evacuation or evacuation preparation. In contrast, it was hypothesised that the Australian samples would display longer BI times, because despite some participants following policy, more would be reluctant to conform and therefore hold off evacuating for longer. Additionally, it was hypothesised that the Australian samples would display more commonality in the actions undertaken due to already being mindful that evacuation was an option.

While both study regions would receive the same survey questions, there was a need for two different questionnaires: one for individuals with relatively recent actual experience (AE) of wildfires, and a second, hypothetical (H) scenario questionnaire for individuals with less recent or no wildfire experience, living in at-risk areas. The survey landing page instructed participants to complete the questionnaire most suited to their circumstances (and their preferred language, French or English). AE questions first related to a description of participants' most recent wildfire experience (e.g. the initial cue to the wildfire, when it was received, the content of any official warning), then asked what participants did during this incident and how much time they committed to their actions, while H questions related to what participants would intend doing in a wildfire and how much time they would commit to this. Since AE participants would have experienced varying degrees of time pressure regarding when to start leaving (i.e. relatively less pressure where their first cue to the fire was an official warning received long before the fire reached their location vs. greater pressure where they first received environmental cues such as the sight of smoke and embers in their vicinity), H participants received an additional instruction to simulate such conditions. That is, H participants were randomly assigned to a scenario where they were told that they had either 60, 30, or 15 min to commence evacuation movement. It was felt that any period longer than 60 min would prove challenging for participants to imagine and provide realistic behavioural itineraries and BI times.

2.1.1. Behavioural itinerary (BI)

To identify actions taken/intended to be taken in response to a wildfire, prior to evacuation movement, AE and H participants in both the South of France (SoFR) and Australia (AUS) were asked to choose from a list of >20 activities the ones that best described what they did/would do, from the moment of wondering about responding (following the receipt of real/hypothetical cues) until the moment of starting to leave. The options included discrete actions that were subsequently coded into five categories (Table 1) for parts of the analysis:

2.1.2. BI time

All participants were also asked to indicate the time (in minutes) they thought they spent/would spend on each of the activities they selected. The 12 answer options included '<1 min', '1 min', '2–3 min', 'up to 5/10/15/20/30/40/50/60 min', and '>60 min'. For the H participants,

Table 1
Discrete actions and their associated category.

Category	Discrete Actions
Seeking information	Check travel directions; Find out what neighbours are doing in response to the fire; Call family and friends; Charge mobile phone
Gathering belongings	Pack personal belongings; Pack money/wallet; Pack passport/driver's license; Pack documents (e.g. insurance policy, birth certificate); Pack children's items; Prepare food/drinks to take away with you; Load my vehicle for evacuation*
Protecting property	Fill sinks/bathtub/building gutters with water; Tidy up the garden/outdoors; Open the gate to the residence (to allow fire service entry to tackle fire); Turn the gas off
Protecting life/health	Get pets ready to leave; Shut the windows; Get dressed; Pack first-aid items/medication; Turn the air conditioning off
Other miscellaneous	Use the bathroom (e.g. take a shower, use toilet); Eat; Other activities not listed

* This option was only included in the AUS data collection after a review of the preliminary results from SoFR.

Table 2
Socio-demographic characteristics of the samples.

Sample		Age years	Gender % (n)		Household size % (n)				Medical cond.% (n)		Dwelling type % (n)		
	n	M (SD)	M	F	1	2–3	4–5	6+	Yes	No	House	Apart.	Mobile
SoFR-AE	26	42.31 (14.02)	27 (7)	73 (19)	12 (3)	38 (10)	23 (6)	27 (7)	27 (7)	73 (19)	81 (21)	8 (2)	12 (3)
SoFR-H	123	44.34 (13.40)	49 (60)	51 (62)	19 (23)	54 (67)	25 (31)	2 (2)	6 (7)	94 (116)	54 (66)	46 (56)	1 (1)
AUS-AE	45	45.56 (12.85)	29 (13)	71 (32)	11 (5)	49 (22)	33 (15)	7 (3)	13 (6)	87 (39)	96 (43)	2 (1)	2 (1)
AUS-H	99	44.47 (12.24)	27 (26)	73 (72)	5 (5)	72 (71)	21 (21)	2 (2)	16 (16)	84 (83)	82 (81)	17 (17)	1 (1)

some of these answer options exceeded the time within which they were told they had to commence evacuation – this was deliberate, as it was of interest to see how many participants would fail to comply with the instruction. For both H and AE participants, their answers were summed to provide their BI time. When summing, the mid-point was used if participants chose '<1 min' or '2–3 min' (i.e. 0.5 or 2.5 min), the minimum of 60 min was used if they chose '>60 min', and the stated maximum duration was used for all other answer options. Thus, if a participant selected e.g. two actions in total and estimated spending up to 2–3 min on the first and up to 15 min on the second, then they would have a BI time of 17.5 min.

2.1.3. Socio-demographic characteristics

Additionally, both AE and H participants were asked to provide information about their own characteristics such as age, gender (male, female), their household's size (1 person, 2–3, 4–5, 6 + persons), relevant medical conditions (any visual, hearing or mobility impairments, pregnancy), and their type of dwelling (house, apartment, mobile home/trailer).

2.2. Recruitment and participants

The University Research Ethics Committee approved the study methodology in spring 2017 (reference 16.3.5.15). There were two data collection periods, the first in summer 2017 for SoFR and the second in summer 2018 for AUS – peak wildfire seasons for those regions. At-risk areas were identified via information provided within the latest risk documents, i.e. DDRM (2015), DICRIM (2017), and the Victorian Bushfire Handbook (EMV, 2016). Recruitment occurred through a mixture of electronic and physical advertisements placed in regional newspapers, non-profit organisations (i.e. universities, libraries) and their web pages, and targeted social media. Participation was voluntary, open to adults aged 18+ years old, and no financial incentives were offered for completion. Participants were provided with links to mental health support organisations should the subject matter raise any thoughts or emotions they would like to talk through with someone confidentially.

Some 404 individuals from SoFR and 358 individuals from AUS started the surveys and continued to the end. Those with actual experience who reportedly decided not to evacuate, and therefore did not

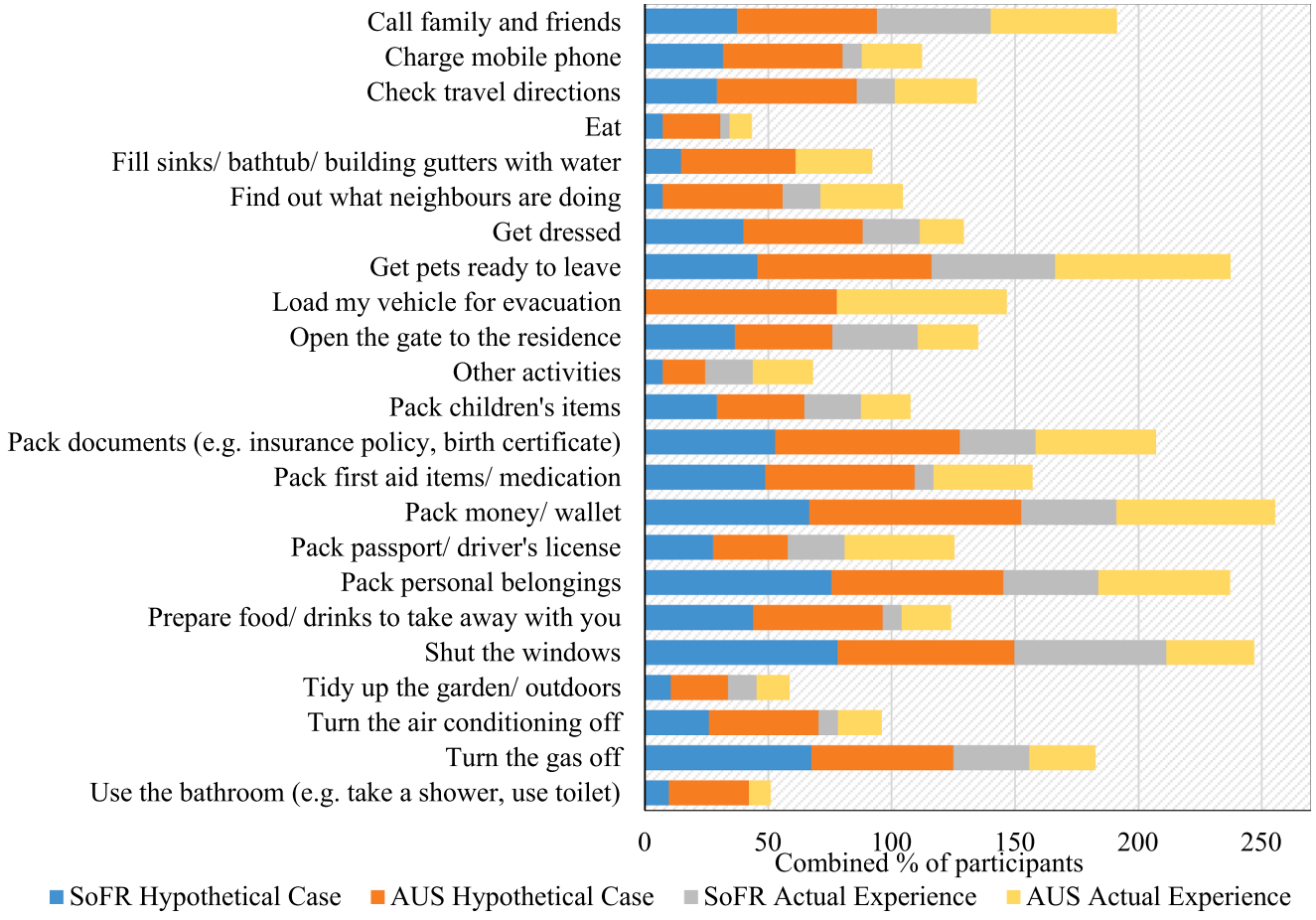

Fig. 1. Behavioural itinerary actions: frequency of selection by SoFR and AUS AE and H participants.

Table 3
Behavioural itineraries: top 10 most frequently selected response actions.

	AE		H: 15 min		H: 30 min		H: 60 min	
Rank	SoFR	AUS	SoFR	AUS	SoFR	AUS	SoFR	AUS
1st	Shut windows (62%)	Get pets ready (71%)	Pack belongings (85%)	Pack money (93%)	Shut windows (76%)	Get pets ready (81%)	Shut windows (83%)	Pack money (91%)
2nd	Get pets ready (50%)	Load vehicle (69%)	Shut windows (75%)	Pack passport (90%)	Pack belongings (71%)	Load vehicle (76%)	Pack belongings (71%)	Load vehicle (91%)
3rd	Call family (46%)	Pack money (64%)	Pack money (75%)	Pack documents (67%)	Turn gas off (64%)	Pack money (76%)	Turn gas off (68%)	Pack documents (81%)
4th	Pack money (38%)	Pack belongings (53%)	Pack passport (73%)	Load vehicle (67%)	Pack money (62%)	Pack documents (76%)	Pack money (63%)	Shut windows (78%)
5th	Pack belongings (38%)	Call family (51%)	Turn gas off (70%)	Shut windows (63%)	Get pets ready (52%)	Shut windows (73%)	Pack first aid (54%)	Pack belongings (75%)
6th	Open gate (35%)	Pack documents (49%)	Pack documents (60%)	Pack belongings (60%)	Pack documents (50%)	Pack belongings (73%)	Pack documents (49%)	Get pets ready (72%)
7th	Pack documents (31%)	Pack passport (44%)	Pack first aid (55%)	Check directions (57%)	Prepare food/drink (43%)	Turn gas off (62%)	Call family (46%)	Turn gas off (66%)
8th	Turn gas off (31%)	Pack first aid (40%)	Get dressed (50%)	Pack first aid (57%)	Pack first aid (38%)	Pack first aid (59%)	Pack children's items (44%)	Get dressed (66%)
9th	Get dressed (23%)	Shut windows (36%)	Prepare food/drink (48%)	Get pets ready (57%)	Check directions (36%)	Check directions (57%)	Get pets ready (44%)	Pack first aid (66%)
10th	Pack children's items = Pack passport (23%)	Check directions (33%)	Get pets ready (40%)	Prepare food/drink (57%)	Charge phone (33%)	Call family (57%)	Prepare food/drink (41%)	Call family (66%)

compile a behavioural itinerary, were excluded from the analysis reported in this paper. Also excluded were those who responded about either an actual or hypothetical wildfire but did not answer every question relevant to this analysis. Thus, the remaining numbers were a total of 149 participants from SoFR and a total of 144 participants from AUS (see Table 2 for further details). The mean age of SoFR participants was 43.99 years (SD = 13.49), with ages ranging from 18 to 70 years, while for AUS it was 44.82 years (SD = 12.40), ranging from 22 to 76 years of age. Genderwise, 45% (SoFR) and 27% (AUS) of participants were male, and 55% (SoFR) and 73% (AUS) were female; two participants refused to specify their gender. In SoFR and AUS respectively, the majority of participants reported having households consisting of 2–3 persons (52% and 65%), having no medical conditions (91% and 85%), and living in a house, i.e. a detached, semi-detached or terraced dwelling (58% and 86%). As the number living in apartments and mobile homes/trailers was often very small, they were subsequently merged and recoded as living in an 'other type of dwelling'. The majority of H participants had never experienced a wildfire before (SoFR: 73%, AUS: 82%). Preliminary statistical analysis comparing H participants with some historical experience vs. those without any experience showed similar responses, so the two groups were merged for the following analysis. All AE participants confirmed that they had experienced a wildfire at least once; most AE participants indicated that their responses were related to fires from the previous 3–4 years.

2.3. Data analysis

Data was analysed using SPSS statistics v25 software. Results of independent samples t-tests, Mann-Whitney U tests, and Pearson's and Spearman's correlation tests are reported, along with effect sizes (*r* and rho). An alpha level of 0.05 for all statistical tests was used.

3. Results

3.1. Behavioural itinerary: discrete actions

Behavioural itineraries were not limited to just a few response actions. In SoFR, AE participants undertook a mean number of 4.92 actions (SD = 2.17) prior to commencing evacuation, while H participants intended undertaking around twice as many actions on average (15 min: M = 8.95, SD = 4.77; 30 min: M = 7.79, SD = 4.34; 60 min: M = 8.66, SD = 4.89). In AUS, AE participants undertook a mean number of 8.33 actions (SD = 5.01), while H participants did not differ so greatly, and intended undertaking on average more actions when more time was available (15 min: M = 10.77, SD = 5.39; 30 min: M = 12.08, SD = 6.01; 60 min: M = 14.03, SD = 5.95).

As Fig. 1 shows, the actions were of various kinds. 'Pack money/wallet' was the action selected most frequently by participants overall, while 'eat' was the least frequent action selected overall. The percentage of participants in each sample selecting 'other activities' was somewhat low (7–24%) suggesting that the list of 20+ response actions encompassed most, but not all, of what participants did or intended to do prior to evacuating.

A closer examination of responses revealed a more nuanced picture (Table 3). For instance, 'shut the windows' was in the top 2 of all SoFR groups but ranked much lower in the top 10 of each AUS group. Similarly, 'get pets ready to leave' was in the top 2 for AE participants but typically ranked much lower in the top 10 for H participants. 'Pack personal belongings' was always in the top 3 of SoFR-H participants, while AUS-H participants were less inclined to undertake this action if facing greater time pressure (i.e. if they were told they had only 30 min or even just 15 min before they must commence evacuation). 'Pack money/wallet' was always in the top 4, regardless of what region participants were in, what questionnaire they completed, or what time pressure they were faced with. In contrast, the pattern of responses for 'Pack documents (e.g. insurance policy, birth certificate)' was less

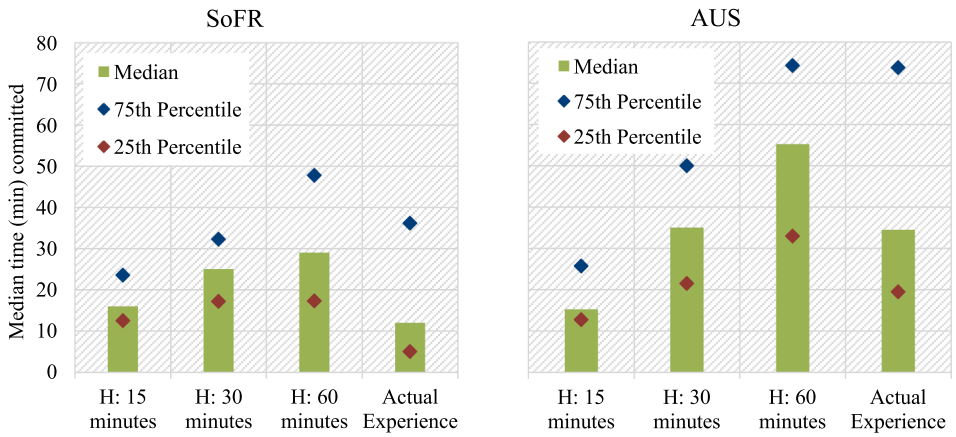

Fig. 2. Overall BI time by H and AE participants in each region; error bars represent the interquartile range.

consistent: i.e. it regularly ranked lower than 5th for most groups but ranked much higher for AUS-H participants.

However, while the priorities of various groups sometimes differed, overall their top 10 s tended to include the same discrete actions. One notable exception to this was 'call family and friends', which ranked 3rd and 5th for SoFR and AUS AE participants, respectively, but only appeared in the top 10 for the 60 min H groups and the 30 min AUS-H group, at the lower end. Another notable point was that the actions comprising top 10 s were always selected less frequently by SoFR participants than by AUS participants in the AE sample (mean frequency difference per ranked action = 10%). This kind of difference between SoFR and AUS was also observed across the H groups, reducing when facing greater time pressure (mean frequency difference for 60 min = 21%, for 30 min = 15%, for 15 min = 5%).

3.2. Behavioural itinerary: action categories

All of the 20+ listed actions were then clustered into their aforementioned five categories. SoFR and AUS AE participants matched closely in terms of the percentage of their actions falling within each category (Seeking Information = SoFR 17%, AUS 20%; Gathering Belongings = SoFR 33%, AUS 35%; Protecting Property = SoFR 16%, AUS 13%; Protecting Life/Health = SoFR 30%, AUS 26%; Other Miscellaneous = SoFR 5%, AUS 6%). The two region's H samples were also similar, to each other and to their AE equivalents, in terms of the percentage of actions falling within each category (Seeking Information = SoFR 13%, AUS 19%; Gathering Belongings = SoFR 37%, AUS 32%; Protecting Property = SoFR 16%, AUS 15%; Protecting Life/Health = SoFR 30%, AUS 27%; Other Miscellaneous = SoFR 3%, AUS 7%).

As for the 15, 30 and 60 min H groups, the results were also closely matching: Seeking Information = SoFR 14%, AUS 18% (15 min), SoFR 14%, AUS 20% (30 min), SoFR 12%, AUS 19% (60 min); Gathering Belongings = SoFR 41%, AUS 40% (15 min), SoFR 36%, AUS 29% (30 min), SoFR 35%, AUS 29% (60 min); Protecting Property = SoFR 15%, AUS 12% (15 min), SoFR 16%, AUS 17% (30 min), SoFR 18%, AUS 17% (60 min); Protecting Life/Health = SoFR 28%, AUS 24% (15 min), SoFR 31%, AUS 29% (30 min), SoFR 32%, AUS 28% (60 min); Other Miscellaneous = SoFR 3%, AUS 6% (15 min), SoFR 3%, AUS 5% (30 min), SoFR 3%, AUS 8% (60 min).

3.3. BI times: overall and by action category

As Fig. 2 shows, with the exception of the 15 min H group, overall, SoFR participants tended to commit far less time to their behavioural itineraries than did AUS participants. For example, SoFR-AE participants committed 12.00 min (median time, IQR = 5.00–36.13) to their behavioural itineraries; this was around one third of the time committed by AUS-AE participants (Mdn = 34.50 min, IQR = 19.50–73.75). While the AE groups' median times were shorter than some of the H groups', it is nonetheless important to note that the interquartile ranges show some actually took much more time before commencing evacuation. That is, the middle 50% of SoFR-AE participants took up to around two-thirds of an hour while the middle 50% of AUS-AE participants took up to around one hour and a quarter.

Regardless of what region they were in, what questionnaire they completed, or what time pressure they were faced with, participants always committed a relatively greater amount of time to Gathering Belongings (i.e. this category was always first in the sequence of action

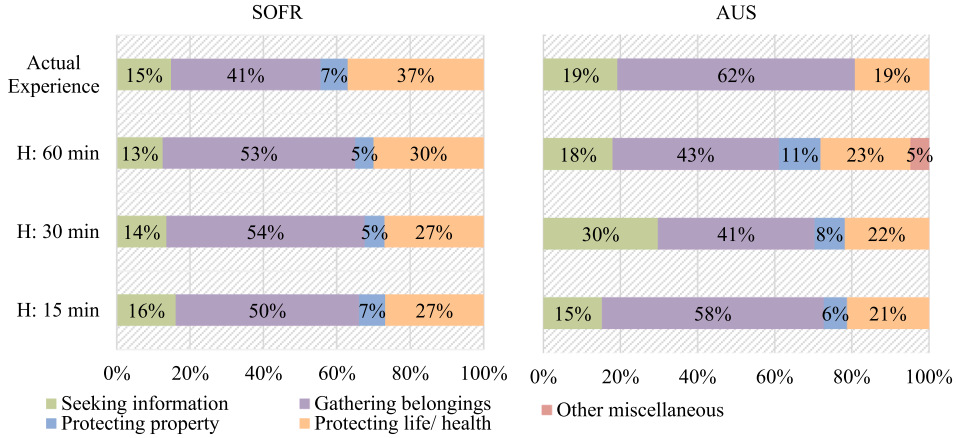

Fig. 3. BI time (%) per action category by H and AE participants in each region.

categories to which they committed most to least time; see Fig. 3 and Table 4). Additionally, Protecting Property and especially Other Miscellaneous activities never dominated participants' time (i.e. these categories always came fourth and fifth in the sequence). In SoFR, the second most time was always committed to Protecting Life/Health, and the third most time to Seeking Information, regardless of group. In AUS, the 15 and 60 min H groups followed this same sequence, although the 30 min H group prioritised time for Seeking Information over Protecting Life/Health while the AE group committed equal time to both categories.

3.4. BI times vs. assigned evacuation commencement times

Fig. 2 also shows that, often, H participants complied with the time they were told was available to them before evacuation had to commence (15/30/60 min). Nonetheless, some deviations were present. When assigned just 15 min, participants exceeded the time slightly in both SoFR (Mdn = 16.00 min, IQR = 12.50–23.50) and AUS (Mdn = 15.25 min, IQR = 12.75–25.75). Also, when assigned 30 min, AUS participants were excessive with their time (Mdn = 35.00 min, IQR = 21.50–50.00). The interquartile ranges are again worth noting as they show a substantial percentage of additional participants committed even longer times – in this case, greater excesses – than these medians indicate.

3.5. Behavioural itinerary actions and BI times: socio-demographic characteristics

Socio-demographic characteristics did not appear to have much association with either the number of actions comprising behavioural itineraries or with BI times. For example, age was not significantly correlated with the mean number of actions (for SoFR-AE, AUS-AE, and each region's H groups combined, all ps > 0.311, all rs < 0.11). Nor was age significantly correlated with median BI time (all ps > 0.194, all rhos < -0.13). Gender played a significant role in the mean number of actions in behavioural itineraries but only for the SoFR-AE group (Table 5), where females performed significantly more actions than males ($t(24) = -2.59$, $p = .016$, $r = 0.47$; for all other groups, ts < 1.47, ps > 0.146, rs < -0.14). There was no significant association between gender and median BI time (all Us < 1664.00, all ps > 0.054, all rhos < 0.39). Household size was significantly positively correlated with the mean number of actions, but only for the SoFR-H group ($p = .008$, rho = 0.24; for all other groups, ps > 0.309, rhos < 0.22); it was not significantly correlated with median BI time (all ps > 0.128, all rhos < 0.16). In addition, medical conditions were neither significantly associated with the mean number of actions (all ts < 1.06, all ps > 0.298, all rs < 0.20), nor with median BI time (all Us < 735.00, ps > 0.242, all rhos < 0.20). Finally, dwelling type had a significant association with the mean number of actions, albeit only for the SoFR-AE group ($t(24 = -2.11$, $p = .046$, $r = 0.40$; for all other groups, ts < -1.42, ps > 0.164, all rs < 0.22). It also had a significant association with median BI time, but only for the SoFR AE ($U = 88.00$, $p = .019$, rho = 0.46) and H ($U = 2271.50$, $p = .048$, rho = 0.18) groups (for all other groups, Us < 823.00, ps > 0.112, rhos < 0.26). So, those SoFR participants who resided in a house performed significantly more actions and/or had significantly longer BI times compared to residents of other dwelling types.

4. Discussion

As described earlier, there may be limited time to act in response to a wildfire and commence evacuation movement to a place of relative safety. Thus, it is important that what people do prior to commencing evacuation is minimal, necessary and not time-consuming. This study revealed that individuals will undertake a number of actions prior to commencing evacuation. Studies of building evacuations that have quantified such behaviour have suggested similar, with the reported mean totals ranging from 4.9 actions (averaged across two World Trade Center buildings in the USA; Day et al., 2013) to between 8.6 and 13.1 actions (across four university libraries in Turkey, UK, Poland and the Czech Republic; Galea et al., 2015). These figures are similar to the mean number reported by the SoFR-AE (4.9 actions), AUS-AE (8.3 actions), and H groups (between 7.8 and 14.0 actions) studied here. This suggests three things: (i) that the number of response actions undertaken in wildfire evacuations may be of the same order as that in building evacuations; (ii) that hypothetical scenario questionnaires might be able to capture a realistic figure for the number of actions; and (iii) regional differences in the mean number of actions may be likely. However, while the mean number of actions may be similar, this may not result in similar response times. For example, a typical action in the library and World Trade Center cases was packing personal belongings into a bag. The same action may be undertaken in wildfire scenarios but may require significantly longer due to the nature and location of the items packed. Furthermore, there may be very different types of actions in the different evacuation scenarios. As a result, it is perhaps not surprising that the response time in building evacuations can be in the region of one or more minutes (Day et al., 2013; Galea et al., 2015) while in wildfire evacuations it can be in the region of one or more hours.

The results also showed that, despite some variation in priorities, the top 10 discrete actions were similar across the study regions as well as the types of questionnaire (AE and H). This indicates that the behavioural itineraries captured here might therefore be quite generalisable. It also indicates, again, that hypothetical scenario questionnaires might be useful tools to utilise when conducting research in areas with little or no prior wildfire evacuation experience. Participants were most frequently focused on Gathering Belongings, e.g. packing personal belongings, money/wallet, and documents such as insurance policies and birth certificates. While the personal belongings might not always be essential items, taking funds and copies of important documentation reassuringly shows that individuals will likely be mindful of their longer-term as well as short-term needs.

Actions also frequently fell into the category of Protecting Life/Health, e.g. getting pets ready to leave and shutting windows. Preparing pets for evacuation has been noted in other studies of wildfires and also hurricanes (Christensen, Richey, & Castaneda, 2013; Clode, 2010; Folk et al., 2019; Haynes, Handmer, McAneney, Tibbits, & Coates, 2010). The fact that this finding arises repeatedly in disaster research means it is an

Table 4
BI time (median and IQR, in minutes) per action category by H and AE participants in each region.

	GROUP	Seeking information	Gathering belongings	Protecting property	Protecting life/health	Other miscellaneous
SoFR	H: 15 min	2.25 (0.00–7.50)	7.00 (5.00–9.50)	1.00 (0.00–2.38)	3.75 (2.13–7.38)	0.00 (0.00–0.00)
	H: 30 min	2.50 (0.00–10.25)	10.0 (4.88–15.13)	1.00 (0.00–3.50)	5.00 (2.50–8.75)	0.00 (0.00–0.00)
	H: 60 min	2.50 (0.00–10.00)	10.50 (5.00–17.00)	1.00 (0.00–3.25)	6.00 (3.75–10.50)	0.00 (0.00–0.00)
	Actual Experience	1.00 (0.00–5.00)	2.75 (0.00–8.50)	0.50 (0.00–1.00)	2.50 (0.75–5.50)	0.00 (0.00–0.25)
AUS	H: 15 min	2.50 (1.00–5.13)	9.50 (6.00–10.63)	1.00 (0.00–3.13)	3.50 (2.00–6.00)	0.00 (0.00–2.50)
	H: 30 min	9.50 (1.75–18.0–0)	13.00 (9.00–19.00)	2.50 (0.50–7.75)	7.00 (4.50–8.50)	0.00 (0.00–2.00)
	H: 60 min	7.50 (5.00–21.25)	18.00 (12.25–28.00)	4.50 (1.00–16.00)	9.75 (7.00–11.75)	2.00 (0.00–6.75)
	Actual Experience	5.00 (1.00–21.25)	16.00 (8.75–25.25)	0.00 (0.00–5.00)	5.00 (1.00–10.00)	0.00 (000–2.25)

Note: SoFR = South of France; AUS = Australia; AE = Actual Experience; H = Hypothetical scenario; IQR = interquartile range; BI = behavioural itinerary.

Table 5
Number of actions and BI time according to socio-demographic characteristics.

	Sample	Gender		Household size				Medical conditions		Dwelling type	
		Male	Female	1	2–3	4–5	6+	Yes	No	House	Other
Mean no. actions (SD)	SoFR-AE	3.29 (1.70)	5.53 (2.04)	3.00 (2.00)	5.00 (2.26)	5.83 (1.72)	4.86 (2.34)	5.57 (1.62)	4.68 (2.33)	5.33 (2.03)	3.20 (2.05)
	SoFR-H	9.08 (5.30)	7.85 (3.93)	7.17 (3.73)	7.97 (4.46)	10.32 (5.34)	10.50 (0.71)	8.00 (3.65)	8.48 (4.72)	8.71 (4.42)	8.16 (4.94)
	AUS-AE	9.31 (7.09)	7.94 (3.95)	9.00 (7.38)	7.64 (4.38)	9.40 (5.50)	7.00 (3.46)	6.33 (2.80)	8.64 (5.22)	8.56 (5.00)	3.50 (2.12)
	AUS-H	12.85 (6.50)	11.99 (5.62)	14.60 (7.27)	12.07 (5.70)	13.10 (6.28)	7.00 (5.66)	13.13 (6.33)	12.16 (5.83)	12.16 (5.90)	13.00 (6.00)
Median BI time (IQR)	SoFR-AE	9.00 (4.00–12.00)	25.50 (5.50–44.00)	4.50 (2.50–8.00)	17.00 (8.50–27.63)	47.50 (10.25–59.63)	9.00 (4.00–34.50)	25.50 (9.00–41.00)	10.50 (5.00–34.50)	22.00 (6.75–42.50)	5.00 (1.75–10.00)
	SoFR-H	22.00 (14.50–35.00)	22.00 (14.50–28.63)	22.00 (14.50–32.00)	21.50 (13.50–30.00)	27.00 (14.50–41.50)	22.00 (15.50–28.50)	12.50 (10.50–26.00)	22.00 (15.13–32.00)	24.25 (15.50–36.25)	20.00 (12.25–29.00)
	AUS-AE	31.50 (16.00–64.25)	40.75 (21.38–97.38)	100.00 (25.75–245.00)	33.25 (17.00–70.63)	34.50 (22.50–89.50)	23.50 (13.00–49.50)	31.75 (18.50–83.00)	34.50 (18.00–75.00)	34.50 (21.00–75.00)	13.25 (3.50–23.00)
	AUS-H	26.50 (14.88–55.63)	34.00 (17.00–54.38)	34.00 (18.25–43.75)	33.00 (16.00–55.50)	29.50 (20.25–58.25)	14.75 (8.50–21.00)	35.75 (18.63–53.63)	32.00 (15.50–56.00)	33.50 (18.25–55.00)	29.75 (12.50–58.75)

Note: SoFR = South of France; AUS = Australia; AE = Actual Experience; H = Hypothetical scenario; SD = standard deviation; IQR = interquartile range; BI = behavioural itinerary.

important point to consider: certain pets (e.g. dogs, cats, caged birds) might be relatively quick to gather and easy to transport away from the at-risk area but other kinds of pet or domesticated animal (e.g. horses) would pose more of a challenge, particularly if no motorised vehicle/ trailer was available or able to fit along escape routes and therefore facilitate evacuation movement. Pets might also pose a problem if individuals are evacuating to a shelter rather than another residence already known to them, as shelters may not have the resources to accommodate animals along with humans. So, even if the taking of pets does not considerably delay the start of evacuation (as the BI time results in this study suggested), it could still considerably delay or even prevent individuals from reaching a place of safety. Thus, it is imperative that people plan for evacuation in advance of a disaster, ensuring they have all required equipment and transport to hand, have familiarised themselves with all escape routes, and have checked who would be able to receive them in the event of seeking shelter. When preparing community shelters, it is also important for authorities to consider how they will accommodate or deal with pets – of all kinds.

The AE findings suggest that, when faced with a wildfire and upon deciding to evacuate, many individuals will first spend up to between 12 min and just over 34 min undertaking response actions prior to commencing evacuation, while a substantial number more will spend up to between two-thirds of an hour and one-and-a-quarter hours doing this. In other words, if given the opportunity, individuals will certainly not respond rapidly and hence the start of the evacuation movement phase may be delayed considerably. SoFR-AE participants committed comparatively less time to their behavioural itinerary, which could reflect the policy and practice of the region, albeit perhaps not in the way that was hypothesised. That is, it was envisaged that shorter BI times in SoFR would reflect less consideration of evacuation and therefore what is needed to be done when preparing for evacuation, while longer BI times in AUS would reflect a greater reluctance amongst some to evacuate due to wishing to stay and defend one's property. However, the fact that the main focus of actions and time in both regions was Gathering Belongings rather than, say, Protecting Property suggests otherwise. Instead, it is possible that AUS participants decided early to evacuate, thereby giving themselves time to safely undertake actions first, while SoFR participants decided to evacuate as a last resort, thereby not having as much time to commit.

The H results showed that the more time individuals believe they have to start evacuating, the more time they will take before evacuating. In SoFR, the sequence of action categories to which more to less time was committed was similar whether participants were told they had 15, 30 or 60 min to commence evacuation. So too were these groups' top 10 discrete actions. Thus, the increased BI time was not being committed in a different way or to different actions. It just appeared to reflect a tendency to take longer to do the same things, suggesting that SoFR's policy for staying put might have limited inexperienced people's consideration of what to do in an evacuation situation. However, in AUS, this tendency was less apparent. When faced with less time pressure, participants in that region committed their time to the same actions but sometimes in a different way, e.g. the 30 min H group spent relatively more time on Seeking Information while the 60 min H group spent relatively more on Other Miscellaneous. Such a difference in prioritisation is sensible, as long as the information or activities being forgone when under greater time pressure are not key to survival; a look once more at the top 10 discrete actions suggests that this was the case here (e.g. the 15 min H group focused less on calling friends/family and instead focused on gaining information related to evacuation movement).

Importantly, while the H participants' median BI times showed many complied with their assigned time for evacuation commencement, the results from both regions also showed that a number of individuals may take more time for their behavioural itineraries than they are told is available, especially if the available time is less than one hour. So, on the one hand, authorities may feel somewhat reassured by these findings that people will often respond in a timely manner. On the other hand, an

excessive delay in evacuation could have fatal consequences if individuals are left to self-evacuate. One alternative would be to deploy emergency service personnel to homes in the threatened area to enforce evacuation advice. This, however, would stretch resources, increase traffic on the routes, and also potentially put the deployed personnel at greater risk of hazard exposure. The utilisation of evacuation modelling could be highly beneficial here – allowing authorities to test their capabilities and understand likely outcomes by manipulating aspects of wildfire scenarios (i.e. the location of the hazards, the location and number of homes to visit and evacuating individuals, and the location and number of deployed resources, at any given time).

Another alternative would be for authorities to educate and train the individuals in their communities in ways to minimise BI times. For instance, the time committed to Gathering Belongings could feasibly be reduced by storing belongings somewhere easily retrievable, packed in something portable – sometimes referred to as a 'go bag'. This is not new advice (for example, see advice by NSW Government, 2020; GOUVERNEMENT.fr, 2020), so it would appear that uptake needs improving. One way to do this might be to conduct a community exercise, having individuals complete the H questionnaire – with an assigned evacuation commencement time of 15 min, given this produced results closer to the AE questionnaire in one sense (see Fig. 3) – thereby forcing the individuals to think about their needs but also demonstrating to them the time it would currently personally take to prepare. Tips about go bags and similar items or methods could then be shared, and the questionnaire completed again at a later date to monitor for changes in the intended actions or the BI time committed to each action category/overall. Evacuation modelling could also be usefully deployed to demonstrate, inform and instruct local communities on the importance of rapid response. Using modelling, scenarios could be tailored to meet the unique requirements of the community. The model could then be used to demonstrate a range of 'what-if' scenarios highlighting the importance of rapid response.

It should be noted that, in this study, it was not possible to discern precisely how much time was available to the AE participants before they needed to commence evacuation movement. While they were able to provide answers that indicated they faced more or less time pressure, from social and environmental sources, attempts to gain further detailed time information (i.e. HH:MM for various critical moments) were unsuccessful. Thus, the AE group's data could not be broken down and compared in a similar way to the H groups' data. In future, researchers may have more success in gaining time information from other involved sources, such as local government officials, police, fire or civil protection officers. However, this would be more feasible for single case studies than studies investigating multiple incidents in multiple regions.

Finally, socio-demographic factors played a lesser role in the number of actions comprising behavioural itineraries and the time committed to them. However, when significant differences were found, they always involved a SoFR group. The finding that SoFR-AE participants completed more actions when female, opens up questions such as whether any gender roles exist in wildfire disaster responses, whether they are culturally-specific, and how they potentially affect individuals' survival. The finding that SoFR females did not additionally have significantly longer BI times suggests that one's gender in this region might not directly influence survival, but it might influence how mindful an individual is of evacuation as an option and how involved they are in preparing for evacuation. Thus, efforts at educating communities might be better targeted at females, as they could be more receptive to evacuation-related information and advice, but the females might then need to train the males in SoFR households to ensure they have an equal understanding of what is required.

SoFR-AE and H participants had significantly longer BI times if they resided in houses. This could, in part, be related to the number of actions, since house-dwelling SoFR-AE participants also did significantly more (perhaps unsurprisingly, given a house is likely to contain more items worth gathering). However, it could additionally be due to houses being more isolated than other dwelling types in this region; i.e. situated further away from other properties, meaning neighbours' movements might not be so easily seen/heard, and thus the definite need for evacuation and the urgency of the situation might not be so clear. The number of people residing in the dwelling was only significant for SoFR-H participants; with them, the larger the household, the more actions they would take. It is possible that, due to lacking experience in both wildfires and evacuation, SoFR-H participants were less able to imagine an emergency situation and so simply decided 'more people, more that must and/or can be done', and thus included a greater number of actions from the provided list in their behavioural itineraries.

Age was not significantly associated with either the number of actions or BI times. Since age was only collected for the participant, it is not possible to make assumptions about the autonomy and needs of the remaining household members (if any) based on how young or old they were. So, age cannot be ruled out completely as being a relevant factor. Despite the non-significant results for age, or medical conditions, it is important that future studies carry out more targeted investigation and in-depth analysis of evacuation preparation among households with age-related and/or medical needs (e.g. specific types of sensory, cognitive or mobility impairment) as this could impact other aspects of evacuation preparation, such as the types and prioritisation of actions, plus transportation requirements (e.g. ambulances).

5. Conclusion

This study provides a useful evidence base concerning what people do and, consequently, how long their evacuation might be delayed in the event of a wildfire. By collecting survey data from a less-well studied wildfire-prone region (South of France) and comparing it to new data from a better-studied wildfire-prone region (Australia), this study represents the first cross-cultural investigation of behavioural itineraries and BI times in wildfire evacuations. Its findings provide insight into which behaviours may be generalisable (e.g. categories of action most frequently undertaken) and which may be more region-specific (mean number of actions undertaken, prioritisation of discrete actions, overall time committed to actions). The current dataset can provide a foundation for evacuation model users in the studied regions, allowing them to apply behavioural itineraries to model agents and more informed time estimates to these itineraries, thereby simulating more realistic, nuanced human behaviour when planning for or managing wildfires in real-time. However, it would seem advisable for any users to collect local data, wherever possible, to account for potential differences. The findings on socio-demographic characteristics suggested that their influence on actions and BI time was also region-specific and could relate not only to geographical aspects but also cultural ones. Thus, future research should focus greater attention on how the physical, social and political-legal environment that defines the geography and safety culture influences individuals' behaviours in the event of a wildfire evacuation. Given the rise in wildfire occurrence across the globe, and the resultant harm and disruption witnessed in recent years, the need for further research is pressing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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