Decision-making in multiagency multiteam systems operating in extreme environments

Sara Waring*, Jami-Louise Moran and Rachel Page
Critical and Major Incident Psychology Research Group, Psychological Sciences, University of Liverpool, UK

Extreme environments such as disasters are often managed by several teams working towards a shared goal but with unique sub-goals at individual and team levels. Whilst these multiteam systems provide potential access to a wide pool of knowledge and resources, public inquiries repeatedly highlight coordination difficulties, leading to conflicting decisions and actions. However, limited research has focused on examining the inter-team processes used to coordinate decisions in situ within extreme environments in order to cross-validate theory. Accordingly, the following study analyses naturalistic observations conducted during two large-scale live disaster response exercises in order to examine (1) what inter-team processes are used to coordinate decisions, and (2) the extent to which they correspond with a linear phase-based ‘Joint Decision Model’ (JDM) introduced to national UK disaster response guidance. Findings show responders frequently either revert to gathering information rather than progressing to take action, or take action without deliberately considering options, powers, and policies to form a plan. These non-linear decision processes remain largely similar across both exercises, indicating that the initial implementation of national JDM guidance has not yet led to substantial changes. Further focus is needed to identify mechanisms for improving coordination in practice, including the form and frequency of training required to maintain such complex skills.

Practitioner points

- Difficulties coordinating information, decisions, and actions are repeatedly identified in multiteam systems operating in extreme environments.
- Limited research has focused on examining inter-team processes used to coordinate decisions in situ within extreme environments, posing implications for developing targeted interventions.
- Findings highlight a tendency for multiagency discussions to either revert back to information gathering rather than progressing to form and implement plans, or moving straight from information gathering to implementing decisions without consciously forming plans.
- Strong leadership is vital for steering multiagency meetings but chairing these complex discussions is a cognitively demanding task.

*Correspondence should be addressed to Sara Waring, Psychological Sciences, University of Liverpool, Eleanor Rathbone Building, Bedford Street South, Liverpool L69 7ZA, UK (email: s.k.waring@liverpool.ac.uk).
Disasters are managed by multiteam systems (MTSs; Marks, Mathieu, & Zaccaro, 2001) comprised of several teams from across emergency services, health, council, and associated agencies working towards a shared superordinate goal but with unique sub-goals at individual and team levels. The flexibility of teams, specialization of skill sets, and potential to access a wide pool of knowledge and resources make MTSs ideal for operating in extreme environments, characterized by turbulence, risk, uncertainty, and need for rapid response (Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005; Shuffler & Carter, 2018). However, public inquiries repeatedly identify difficulties with integrating information and making joint decisions to coordinate disaster response (Kerslake, 2018; Pollock, 2013). Similar problems have also been observed in other MTSs operating in extremis, including medical emergencies (Mathieu et al., 2001) and military operations (DeCostanza, DiRosa, Jiménez-Rodriguez, & Cianciolo, 2014).

To date, however, limited research has focused on examining decision processes in MTSs operating in extremis to understand the underlying causes of these coordination difficulties. Instead, MTS research has predominantly focused on examining two or three dyads with limited goals and specialisms responding to laboratory simulations (Bienefeld & Grote, 2013; Davison, Hollenbeck, Barnes, Sleesman, & Ilgen, 2012; Firth, Hollenbeck, Miles, Ilgen, & Barnes, 2015; Marks et al., 2005). The extent to which such findings translate to large, diverse MTSs operating in extremis is questionable (Shuffler, Jiménez-Rodriguez, & Kramer, 2015). In contrast, field research has tended to focus on how decisions are made by individuals (Cohen-Hatton, Butler, & Honey, 2015; van den Heuvel, Alison, & Crego, 2012), rather than diverse MTSs (Kolfschoten, French, & Brazier, 2014). Where MTSs have been studied in extremis, findings are predominantly based on post-incident reflections, which provide comparatively remote indications in comparison with observations in situ (Healey, Hodgkinson, & Teo, 2009; Power & Alison, 2017).

In the absence of direct evidence, many emergency services have adopted normative, reflective decision models as a basis for national training and guidance (Cohen-Hatton et al., 2015). In the United Kingdom, for example, a linear phase-based ‘Joint Decision Model’ (JDM; Joint Emergency Services Interoperability Programme [JESIP], 2016) has been embedded in national guidance with the aim of improving joint decision-making (College of Policing, 2014; National Ambulance Resilience Unit [NARU], 2015; UK Fire and Rescue Service, n.d.). The extent to which this model is adopted in practice across command levels has yet to be empirically tested. Findings of research conducted in extreme environments show a tendency for individual decision-makers to deviate from linear approaches by avoiding explicit planning (Klein, 1993, 2003), or delaying action (Power & Alison, 2018; Waring et al., 2018). However, research is needed that examines processes used to make joint decisions in situ within MTSs operating in extremis to provide a basis for establishing the utility of the JDM for reducing decision inertia and other pitfalls associated with group decisions (Wilkinson, Cohen-Hatton, & Honey, 2019).

Accordingly, drawing on naturalistic observations conducted during two large disaster exercises, the following study examines (1) processes used to make joint decisions in MTSs operating in extremis at both strategic and tactical levels, and (2) whether the introduction of the national JDM has altered these processes. Findings pose important implications for examining the extent to which existing decision theories explain processes used to make joint decisions in diverse MTSs operating in extremis, along with understanding the underlying causes of coordination difficulties, and developing evidence-based interventions.
Disaster response context

Disasters are complex events that result in mass casualties and major disruptions to communities, including flooding, tropical storms, large fires, and terrorist attacks. In the United Kingdom, responding agencies are split into two categories: (1) category one serve a leading role and are involved with most disasters, including emergency services, health bodies, and local authorities; (2) category two provide support when disasters affect their sector, including utility companies, highway agencies, and local businesses (UK Civil Contingencies Act, 2004). As with other countries, UK disaster response is organized under a three-tiered hierarchical command structure, consisting of strategic, tactical, and operational levels. Strategic commanders are responsible for setting the extent of their own agency’s involvement, strategies, and resource allocation (JESIP, 2017; NARU, 2015). Tactical commanders are responsible for deciding what tactics to adopt to achieve strategic aims and may be required to determine priorities and make important decisions before official strategy is set (JESIP, 2016; Home Office, 2018). Operational commanders are responsible for utilizing resources at the site of an incident to implement tactics.

During a disaster, responding agencies work towards shared superordinate goals such as ‘save life’ and ‘reduce risk’, but with differences, overlaps, and interdependencies in sub-goals. For example, during a firearms incident police may need to remove a live threat by arresting suspects before fire and ambulance can enter the area to extract and treat casualties. Being able to coordinate information, decisions and actions are therefore vital (Marks et al., 2005; Power & Alison, 2017); indeed, UK emergency responders have a legal requirement to do so (Civil Contingencies Act, 2004). It is therefore important for agencies to integrate information to build a common understanding of risk and to make joint decisions to identify and prioritize actions in order to avoid conflict or duplication (Arrow, McGrath, & Berdahl, 2000; DeChurch & Marks, 2006; LePine, Piccolo, Jackson, Mathieu, & Saul, 2008; Waring et al., 2018). In reality, however, difficulties making joint decisions to coordinate responses have been identified in several countries, including the United Kingdom (Kerslake, 2018; Pollock, 2013), United States (Majchrzak, Jarvenpaa, & Hollingshead, 2007), Netherlands (Bharosa, Lee, & Janssen, 2010), Haiti (Patrick, 2011), and Indonesia (Rencoret, Stoddard, Haver, Taylor, & Paul, 2010).

Part of this difficulty stems from features such as agencies typically working independently on a daily basis (Shuffler et al., 2015), membership being fluid due to shift changes (Allison & Shuffler, 2014), and expertise needing to be combined in new ways to tackle unique challenges (Goodwin, Essens, & Smith, 2012; Luvison & Marks, 2012). This limits the development of facilitators that are traditionally associated with improved coordination such as familiarity (Ren & Argote, 2011), trust (Jarvenpaa & Keating, 2011), and shared knowledge of ‘who knows what’ (transactive memory; Heavey & Simsek, 2015; Wegner, Guiliano, & Hertel, 1985). Whilst agencies engage in preparation activities to increase procedural familiarity, such as joint training exercises, these often rely on voluntary actions and can be costly to implement, limiting frequency and participation (Scholten, 2008). For example, category two agencies tend to be less regularly involved.

Another factor affecting the ability for groups to make joint decisions is the cognitive effort required, which is much greater than working in isolation (Dillenbourg & Bétrancourt, 2006; Kolfschoten et al., 2014). The idea that cognitive resources are limited and cognitive overload hinders performance has been well established in psychology (Besedes, Deck, Sarangi, & Shor, 2012, 2015; Deck & Jahedi, 2015; Miller, 1956; Rydval, 2011). For emergency responders operating under increased cognitive load caused by contextual complexity, including time pressure, risk, uncertainty, and accountability
pressure (Alison & Crego, 2008; van den Heuvel et al., 2012; Waring et al., 2018), cognitive resources available for other activities are likely to be limited. This poses implications for decision-making, as reflective approaches require greater cognitive effort than reflexive (Feldon, 2007; Hogarth & Karelaia, 2007; Lipshitz, Omodei, McLennan, & Wearing, 2007; Okoli, Weller, & Watt, 2016). These implications may differ for each command level as a result of variations in demands affecting the availability of cognitive resources (Schmidt & DeShon, 2007; Waring et al., 2018). For example, tactical responders are required to undertake cognitively demanding tasks such as making rapid decisions, processing large amounts of information from various sources, and presenting strategic responders with filtered summaries (Alison & Crego, 2008; Waring et al., 2018). To date, however, limited research has compared decision processes between command levels in extremis. The following study seeks to contribute by comparing strategic and tactical levels.

**Joint Decision Model**

In 2012, the UK Home Office commissioned the national Joint Emergency Services Interoperability Programme to improve disaster response coordination (JESIP, 2016). JESIP introduced a reflective phase-based JDM to encourage responders to bring together available information, and coordinate goals, decisions, and actions. In effect, the JDM seeks to provide a common structure or frame for supporting responders to adapt cognitive processing to jointly consider single and inter-agency goals (House, Power, & Alison, 2014). Whether the JDM improves coordination has not been empirically tested but research shows the value of common frames for improving consistency in interpretation of problems and information, reducing misunderstanding, and freeing up cognitive capacity for other activities (Firth et al., 2015; Schmidt & DeShon, 2007). Feedback from emergency responders also suggests that the JDM may serve a similar role in terms of providing a common frame for organizing discussions (Waring, Alison, Humann, & Shortland, 2019; Waring et al., 2018).

Overall, the JDM frame is comprised of five linear phases: (1) ‘Gather information and intelligence’ to establish situational awareness and a multi-dimensional understanding of events; (2) ‘Assess risks and develop a working strategy’; (3) ‘Consider powers, policies and procedures’ relevant to the situation, and whether these may assist or constrain decisions; (4) ‘Identify options and contingencies’; and (5) ‘Take action and review what happened’ to feed into situation assessment and amending plans if necessary (JESIP, 2017). This idea of following a linear sequence is by no means new (Bales & Strodtbeck, 1951; Dewey, 1933). Field observations of firefighting (Klein, 1993), policing (van den Heuvel et al., 2012), and military contexts (Thunholm, 2005) have generated several ‘optimal’ decision models with a linear structure that share a common notion of the importance of collecting, confirming, and analysing information for problem solving (Cook & Tattersall, 2008). These commonalities have been integrated into a four-phase SAFE-T model (van den Heuvel et al., 2012), which shares many parallels with the JDM. For example, ‘SA’ situation assessment corresponds with (1) gathering information. ‘F’ formulate a plan corresponds with (2), (3), and (4), considering alternatives and having a clear rationale for implementing a course of action. The combination of ‘E’ execute plan and deploy resources, and ‘T’ team learning through reflection, correspond with (5) taking action and reviewing.

The JDM is now recommended in UK national guidance as the standing agenda for both strategic (SCG) and tactical (TCG) coordinating group meetings to ‘bring together
available information, reconcile objectives and then make effective decisions together’ (jesip.org.uk). SCGs and TCGs are comprised of representatives from across relevant agencies, providing a key platform for coordination (Civil Contingencies Act, 2004). SCGs are tasked with setting strategic direction, prioritizing resources, monitoring goal progress, formulating media and communication strategy, and horizon scanning to aid incident recovery (Wilkinson et al., 2019; www.jesip.org.uk/command). TCGs are tasked with interpreting strategic direction, developing tactical plans, and coordinating actions and resources.

Whilst the JDM is enshrined in national guidance, the extent to which it is used in practice in both SCGs and TCGs has yet to be examined. However, as will be discussed below, research suggests that decision-making can deviate from linear models such as the JDM in two ways in extreme environments, resulting in delayed action or committing to action without explicitly planning.

**Decision-making in extreme environments**

Findings from an emerging body of research into decision-making in extreme environments show that decision-makers can be derailed from a linear approach by factors such as accountability pressure, anticipated regret, uncertainty, and effort–accuracy trade-offs (Anderson, 2003; Gollwitzer & Moskowitz, 1996; van den Heuvel et al., 2012). Worry about the potential for all available options to result in negative outcomes, along with how actions may be judged post-event, can lead to inertia – a process of continual yet redundant deliberation over choice for no positive gain (Power & Alison, 2017). In effect, effort is invested to gathering and assessing information, and considering options, but without progressing to take action. The decision-maker is trapped, continually re-evaluating the situation in an attempt to trade-off salient competing goals, options and anticipate potential consequences (Alison et al., 2015; Power & Alison, 2018). Limited understanding of roles and use of agency-specific technical language can also encourage redundant, repetitive deliberation rather than adaptive discussion of action (Waring et al., 2018, 2019). Delay and inertia have been observed in many disasters, including the Manchester Arena bombing and Grenfell fire, but research is largely based on static post-incident accounts and requires further focus to examine behaviours *in situ*.

A second body of research shows that decision-makers operating in extreme environments often show a lack of explicit planning. For example, operational fire commanders have been observed to progress straight from situation assessment to plan execution without deliberating strengths and weaknesses of alternatives (Cohen-Hatton et al., 2015; Klein, 1993, 1997, 2003, 2008). One explanation is that they use reflective processes to reliably formulate and evaluate plans but do not explicitly manifest this planning in behaviour (Cohen-Hatton et al., 2015). An alternative explanation is that they rely on reflexive recognition-primed decision (RPD) processes, pattern matching environmental cues to prior experiences to rapidly identify a workable solution (Doya, 2008; House et al., 2014; Klein, 1993, 2008). These reflexive approaches are beneficial in time critical situations (Klein, Snowden, & Pin, 2010) and require less cognitive effort than reflective processes (Feldon, 2007; Hogarth & Karelaia, 2007; Lipshitz et al., 2007; Okoli et al., 2016). However, there is potential for cues to trigger actions that are unsuitable for the entire situation (Cohen-Hatton & Honey, 2015), or to become trapped in anticipated outcomes that do not arise (McLennan & Omodei, 1996). Regardless of the cause of this lack of explicit planning, there are many benefits to encouraging responders to make planning explicit in diverse MTSs, including improved knowledge of one another’s roles,
mutual support, information sharing (Waring et al., 2018), shared situation awareness, and coordination (House et al., 2014; Stanton, Salmon, & Walker, 2015).

Although research focusing on joint decision processes in MTSs operating in extremis is rare, one recent study shows evidence of both inertia and lack of explicit planning (Wilkinson et al., 2019). Wilkinson et al. observed SCGs responding to simulated disasters and identified between-group differences, with some multiagency strategic groups more prone to inertia whilst others were more likely to act without deliberately considering alternatives. The authors suggested these differences might be influenced by the disposition of the meeting chair. This is likely to play a factor given the power chairs have to shape discussions (Asmussen & Svennevig, 2009), and to improve team effectiveness by summarizing and providing clear and comprehensive commands to avoid ambiguity (Orasanu, 1994; Uitdewilligen, 2011; van der Haar, Koeslag-Kreunen, Euwe, & Segers, 2017). However, this is a difficult role to undertake in large diverse teams such as SCGs and TCGs. Chairs can become overwhelmed if they empower members with the freedom to raise numerous items, hindering ability to provide meaningful summaries and directions (Tallberg, 2010). Adopting an authoritative approach to control speaking turns can help chairs keep discussions focused but at a cost to creative problem solving (Holmes, Schnurr, & Marra, 2007). This approach also requires the chair to have detailed knowledge of roles and responsibilities to solicit pertinent information (Holmes & Stubbe, 2003).

Overall, this collection of evidence suggests that the extent to which the JDM is utilized in practice is influenced by a combination of environmental factors and leadership style. Building on these findings, the following study seeks to compare processes used to make joint decisions at both strategic and tactical levels in MTSs operating in extremis. We compare joint decision processes prior to and after the introduction of national JDM guidance in order to examine the utility of this reflective linear model for reducing decision inertia and improving explicit planning. Findings pose important implications for understanding decision-making in MTSs operating in extremis, in addition to developing targeted interventions to improve coordination within these challenging contexts.

**Method**

Naturalistic observational methods allow rich contextual data to be collected *in situ* (Bashir, Afzal, & Azeem, 2008; Lipshitz, Klein, Orasanu, & Salas, 2001), which is beneficial for exploring how human cognition adapts to complexity (Gore, Flin, Stanton, & Wong, 2015). The following study draws on naturalistic observations of SCGs and TCGs conducted during two large exercises that physically and psychologically replicated the conditions of man-made disasters (Waring et al., 2018). The number of meetings held is not set by protocol but agencies must strike a balance between meeting frequently enough to coordinate activities but not too frequently that actions cannot be implemented. Exercise one took place the year before the JDM was introduced into national guidance, and exercise two occurred 3 years later, allowing comparisons to be made of processes used before and after the JDM was introduced.

**Scenarios and participants**

*Exercise one* was a 5-hr exercise that took place in the North of England and involved practitioners from three UK regions. The scenario consisted of a ferry colliding with a large
cargo vessel on a river, resulting in 70 passengers, played by members of the public, being injured and contaminated by the release of an unknown substance. A chemical, biological, radiological, nuclear (CBRN) response was activated, and mass decontamination procedures were implemented. The incident was managed through a three-tiered command response that included in excess of 250 responders from Police, Fire, Ambulance, Local Council, NHS England, rail and ferry travel, and Maritime and Coast Guard agencies. Operational responders and the Fire tactical commander were based at the incident site, whereas strategic and tactical command levels for all other agencies were based at a command centre five miles from the site, along with a Fire tactical liaison. To maintain anonymity and avoid disruption, detailed information regarding responder demographics was not captured.

Across the course of the incident, two TCGs took place, both lasting 19 min. Four SCGs took place, lasting between 17 and 47 min ($M = 32.3, SD = 12.3$). Table 1 below provides details of the representatives present in meetings for each exercise.

**Exercise two** was a 9-hr, Home Office-funded exercise that took place in the North of England and involved practitioners from six regions across the United Kingdom. The scenario consisted of a train derailing from its tracks, crashing into a shopping parade and several vehicles and power lines, resulting in a bus colliding with an adult learning centre. The exercise was comprised of two sites, a physical construction of the train derailment and a command centre. The incident was managed by a three-tiered hierarchical response that consisted of 1,000 practitioners from Police, British Transport Police, Fire and Rescue, Ambulance, NHS England, Local Council, Environment, Royal Air force and Ministry of Housing, Communities and Local Government, in addition to gas, electricity, and water companies. In total, 175 members of the public, Amputees in Action, and actors played the role of casualties. As with exercise one, operational responders and the Fire tactical commander were based at the site of the incident, and strategic and tactical responders and a Fire tactical liaison were based at the command centre.

Overall, four TCGs took place, lasting between 19 and 37 min ($M = 26.2$ min, $SD = 9.4$). Four SCGs also took place, lasting between 17 and 47 min ($M = 32$ min, $SD = 12.5$).

**Data collection and coding**

Data consist of transcribed recordings of SCGs and TCGs, which were recorded using dictaphones and video cameras in order to identify the agency that each speaker belonged to. Transcripts provide an accurate, in-depth account of what took place within meetings, including what was said, by whom, when and what choices and actions were taken.

| Table 1. Representatives present in strategic and tactical meetings for each exercise |
|-----------------------------------|-----------------------------------|
| **Exercise one**                  | **Exercise two**                  |
| 1 × Police, 1 × Fire and Rescue   | 3 × Police, 2 × Fire and Rescue   |
| 1 × Ambulance, 1 × NHS England    | 1 × Ambulance, 1 × NHS England    |
| 2 × Local Council, 1 × Coastguard| 1 × Local Council, 1 × Highways Agency, 1 × |
| 1 × Environment, 1 × Travel       | Environment, 1 × British Transport Police, 1 × |
| Company, 2 × Ferry Company        | Power Company, 1 × Ministry of Defense |
|                                   | 1 × Public Health England, 1 × Government |
Adopting an unobtrusive observational method allowed data to be collected more organically than if researchers had attempted to manipulate the phenomena under observation (Bashir et al., 2008), providing a more realistic representation of joint decision processes in extreme environments. Drawing on data from two disaster exercises at strategic and tactical levels also provides a more holistic view of joint decision-making (Turner, 2010), allowing findings from different sources to be triangulated to identify consistencies and differences (Bekhet & Zauszniewski, 2012; Gelo, Braakmann, & Benetka, 2008). For example, processes that were used to make joint decisions at a strategic level in each of the two exercises were compared to identify whether the frequency and sequence of decision phases were similar.

Meeting transcripts were read and coded according to the five JDM phases highlighted in Table 2 below (definitions are taken directly from jesip.org.uk). Each utterance was coded as belonging to only one phase (examples provided in Table 2). In total, 228 phases were coded for exercise one (38%), and 376 were coded for exercise two (62%), which corresponds with the increased length and number of meetings that took place in exercise two. In order to test the reliability of analysis, a second rater independently coded 20% of transcripts using the same JDM phases. Cohen’s $K$ revealed strong agreement for both TCGs ($K = .80, 95\% CI [0.96, 0.54], p < .001$) and SCGs ($K = .84, 95\% CI [0.09, 0.30], p < .001$) (Altman, 1991). Discussion of discrepancies between the first and second rater resulted in complete agreement.

**Data analysis**

Analysis examines joint decision processes used to coordinate actions in MTSs operating in extreme environments and whether the sequence of phases corresponds with the national JDM. If responders adopt the JDM, there should be a linear sequence with discussions progressing from ‘(1) Gathering information’ to ‘(2) Assessing risk’, ‘(3) Considering powers’, ‘(4) Considering options’, and ‘(5) Taking action’, which should then progress back to ‘(1)’. Responders reverting to the first phase rather than progressing to phases two, three, four, and five would indicate decision inertia. If processes are reflective of RPD, responders should proceed straight to ‘(5) Taking action’ after either ‘(1) Gathering information’ or ‘(2) Assessing risk’, with little evidence of phases three and four.

Chi-square analysis is used to test whether there are significant differences in the frequency of phases that follow one another. Multinomial logistic regression is used to test phase sequence – whether any phase is significantly more likely to precede another. Analysis is conducted for strategic and tactical levels within both exercises in order to make comparisons. All data meet relevant assumptions, including case specificity, nominal dependent variables, and multicollinearity (Hoffmann, 2003).

**Results**

Across both exercises and command levels, the most frequent decision phase was ‘(1) gathering information’, and the least frequent was ‘(3) considering powers’ (see Table 3). These patterns indicate a consistent focus on sourcing information, but a lack of explicit planning. There were some small differences however. For exercise one, both SCGs and TCGs showed a greater focus on ‘(5) taking action’ as the second most frequent phase. In
| Table 2. Examples of decision phases |

| JESIP definition of phase | Example |
|---------------------------|---------|
| 1. Gathering information and intelligence | This stage involves gathering and sharing information and intelligence to establish shared situational awareness. Police: ‘At approximately ten hundred hours this morning we’ve had the Ferry vessel carrying approximately a hundred passengers making north of the river towards [location] and then a second vessel has experienced a loss of engine and steering power after clearing the [dock location] and it’s collided with [Ferry] on the port side’. |
| 2. Assessing risk & developing a working strategy | Commanders jointly assess risk to achieve a common understanding of threats and hazards, and the likelihood of them being realized. This informs decisions on deployment and the required risk control measures. Fire: ‘Is there any risk that they could still cause shore-based damage or water pollution damage?’ Coast Guard: ‘Well tide is flooding at the present time so it’s still going up river. It could make landfall because it’s variable to the current. The Port Authority can close the river-way so there’s less threat of other vessels striking those and of course we’ve got a marine fire rescue that can act like a guard vessel’ |
| 3. Considering powers, policies, and procedures | This stage relates to any relevant laws, procedures, or policies that may impact on the response plan and the capabilities available to be deployed. Fire: ‘So we will as normal procedure – this has been asked before by a colleague – we will be taking a full log of everyone’s details so no-one will be going through and then just disappearing. I mean we’ll have everyone’s address, age and everything’ |
| 4. Considering options and contingencies | There will almost always be more than one way to achieve the desired end state. Commanders should work together to evaluate the range of options and contingencies rigorously. . . . Contingencies relate to events that may occur and the arrangements that will be put in place if they do occur. Police: ‘Without power there is some suggestion at this stage that there might be a rest center stepping up with the Local Authority to support residents who might be displaced. We’ll look into that straight away’. |
| 5. Taking action and reviewing | Once the decision-makers are satisfied, collectively and individually, that the decision controls validate the proposed actions, then these actions should be implemented. As the joint decision model is a continuous loop, it is essential that the results of these actions are fed back into the first box – ‘gather and share information and intelligence’ – which sets out the need to establish and sustain shared situational awareness. Local Council: ‘We are providing all the support we can to our partner agencies. We are setting up a survivor reception center and a family and friends center at [location name]. Recovery worker’s group is already been scheduled to start looking at the medium term. We are also engaging with the school and care homes some vulnerable adults that we are aware of who are in the immediate location and has already been picked up. We’ll liaise with colleagues from BTP on the Coroner issue and on [disaster victim identification]’. |
contrast, SCGs and TCGs showed a greater focus on ‘(2) assessing risk’ in exercise two as the second most frequent phase.

**Analysis of decision phase frequency**

Chi-square analysis was conducted to examine whether there were significant differences in the frequency of phases that immediately followed on from one another (see Table 4). Analysis focuses on the progression between different phases rather than whether discussions remained within a phase (e.g., from phase one to phase one). Analyses were not conducted for ‘(3) consider policies’ in SCGs for both exercises due to the limited occurrence of this phase.

**Tactical coordinating groups**

There were no significant differences in the frequency of phases that followed one another across both exercises ($p > .05$). Responders were equally likely to moved back and forth rather than following a linear progression. However, observation of frequencies in Table 4 shows the most common pattern to be one of reverting to gathering information after most phases.

**Strategic coordinating groups**

For exercise one, there were significant differences after decision phase one, $\chi^2(2) = 12.77$, $p = .005$, with responders frequently either progressing to ‘(2) assessing risk’ or ‘(5) taking action’. There were significant differences after decision phase five, $\chi^2(2) = 9.33$, $p = .01$, with responders frequently progressing to ‘(1) gathering information’. For phases two, three, and four, there were no significant differences, with responders equally likely to move back and forth across other phases. However, observations of frequencies in Table 4 also show a common pattern of reverting to gathering information after most phases.

For exercise two, there were significant differences after phase one, $\chi^2(2) = 13.34$, $p = .001$, with responders frequently progressing to ‘(2) assessing risk’ or ‘(4) considering options’. There were significant differences after phase two, $\chi^2(2) = 7.24$, $p = .03$, with
| Preceding decision phase | Exercise | Decision phase                                      | Tactical | Strategic |
|-------------------------|----------|----------------------------------------------------|----------|-----------|
|                         |          |                                                    | Obs  | Exp | Resid | $\chi^2$ | Obs  | Exp | Resid | $\chi^2$ |
| 1. Information and intelligence gathering |          | 2. Assess risk and develop working strategy | 8    | 6.80 | 1.30  | 1.59    | 11   | 6.50 | 4.50  | 12.77*** |
|                         |          | 3. Consider powers, policies, and procedures       | 4    | 6.80 | -2.80 | 1.11    | 1    | 6.50 | -5.50 |         |
|                         |          | 4. Consider options and contingencies              | 8    | 6.80 | 1.30  | 1.59    | 3    | 6.50 | -3.50 |         |
|                         |          | 5. Take action and review                          | 7    | 6.80 | 0.30  | 1.11    | 11   | 6.50 | 4.50  |         |
|                         | Exercise two | 2. Assess risk and develop working strategy      | 13   | 7    | 6     | 7.14    | 17   | 11.70| 5.30  | 13.34*** |
|                         | Exercise two | 3. Consider powers, policies, and procedures       | 4    | 7    | -3    |         | -    | -    | -     |         |
|                         | Exercise two | 4. Consider options and contingencies              | 5    | 7    | -2    |         | 14   | 11.70| 2.30  |         |
|                         | Exercise two | 5. Take action and review                          | 6    | 7    | -1    |         | 4    | 11.70| -7.70 |         |
| 2. Assessing risk and developing a working strategy |          | 1. Gather information and intelligence             | 10   | 5.50 | 4.50  | 6.00    | 8    | 4.70 | 3.30  | 4.00    |
|                         |          | 3. Consider powers, policies, and procedures       | 5    | 5.50 | -0.50 |         | -    | -    | -     |         |
|                         |          | 4. Consider options and contingencies              | 2    | 5.50 | -3.50 |         | 2    | 4.70 | -2.70 |         |
|                         |          | 5. Take action and review                          | 5    | 5.50 | -0.50 |         | 4    | 4.70 | -0.70 |         |
|                         | Exercise two | 1. Gather information and intelligence             | 10   | 6.50 | 3.50  | 3.85    | 12   | 10.70| 1.30  | 7.24*   |
|                         | Exercise two | 3. Consider powers, policies, and procedures       | 7    | 6.50 | 0.50  |         | -    | -    | -     |         |
|                         | Exercise two | 4. Consider options and contingencies              | 6    | 6.50 | -0.50 |         | 14   | 10.70| 3.30  |         |
|                         | Exercise two | 5. Take action and review                          | 3    | 6.50 | -3.50 |         | 6    | 10.70| -4.70 |         |
| 3. Consider powers, policies, and procedures |          | 1. Gather information and intelligence             | 6    | 5    | 1     | 0.40    | -    | -    | -     |         |
|                         |          | 2. Assess risk and develop working strategy       | 4    | 5    | -1    |         | -    | -    | -     |         |
|                         |          | 4. Consider options and contingencies              | 5    | 5    | 0     |         | -    | -    | -     |         |
|                         |          | 5. Take action and review                          | 5    | 5    | 0     |         | -    | -    | -     |         |
|                         | Exercise two | 1. Gather information and intelligence             | 5    | 3.80 | 1.30  | 2.87    | -    | -    | -     |         |
|                         | Exercise two | 2. Assess risk and develop working strategy       | 5    | 3.80 | 1.30  |         | -    | -    | -     |         |
|                         | Exercise two | 4. Consider options and contingencies              | 4    | 3.80 | 0.30  |         | -    | -    | -     |         |
|                         | Exercise two | 5. Take action and review                          | 1    | 3.80 | -2.80 |         | -    | -    | -     |         |
| 4. Consider options and contingencies |          | 1. Gather information and intelligence             | 7    | 5    | 2     | 4.80    | 3    | 4.50 | -1.50 | 1.00    |
|                         |          | 2. Assess risk and develop working strategy       | 1    | 5    | -4    |         | -    | -    | -     |         |
|                         |          | 3. Consider powers, policies, and procedures       | 5    | 5    | 0     |         | -    | -    | -     |         |

Continued
### Table 4. (Continued)

| Preceding decision phase | Exercise | Decision phase | Tactical | | Strategic |
|--------------------------|----------|----------------|----------|---|----------|
|                          |          |                | Obs | Exp | Resid | $\chi^2$ | Obs | Exp | Resid | $\chi^2$ |
| Exercise two             | 5. Take action and review | 7 | 5 | 2 | 6 | 4.50 | 1.50 |
| Exercise two             | 1. Gather information and intelligence | 7 | 4 | 3 | $\chi^2(3) = 5.00$ | 6 | 8.50 | -2.50 | $\chi^2(3) = 32.75^{***}$ |
| Exercise one             | 2. Assess risk and develop working strategy | 1 | 4 | -3 | 8 | 8.50 | -0.50 |
| Exercise one             | 3. Consider powers, policies, and procedures | 3 | 4 | -1 | - | - | - |
| Exercise two             | 5. Take action and review | 5 | 4 | 1 | 19 | 8.50 | 10.50 |
| Exercise two             | 1. Gather information and intelligence | 6 | 5.50 | 0.50 | $\chi^2(3) = 0.91$ | 12 | 6 | 6 | $\chi^2(2) = 9.33^{**}$ |
| Exercise two             | 2. Assess risk and develop working strategy | 7 | 5.50 | 1.50 | 2 | 6 | -4 |
| Exercise two             | 3. Consider powers, policies, and procedures | 5 | 5.50 | -0.50 | - | - | - |
| Exercise two             | 4. Consider options and contingencies | 4 | 5.50 | -1.50 | 4 | 6 | -2 |

Notes. — indicates that analysis could not be conducted due to low frequencies. 

*p < .05; **p < .01; ***p < .001.
responders frequently reverting to ‘(1) gathering information’ or progressing to ‘(4) considering options’. Significant differences after phase four, $\chi^2(3) = 32.75, p < .001$, show responders frequently progressing to ‘(5) taking action’. Finally, there were significant differences after phase five, $\chi^2(2) = 8.00, p = .02$, with responders frequently ‘(1) gathering information’.

**Analysis of decision phase sequence**

Multinomial logistic regression was conducted to test the sequence of decision phases (see Table 5), with phase five adopted as the reference category due to the frequency of this phase consistently representing a mid-point.

**Exercise one**

In both SCGs and TCGs, no decision phase was significantly more likely to predict any other. Responders were equally likely to move back and forth across phases rather than following a linear progression.

**Exercise two**

In TCGs, the occurrence of phase one was significantly more likely to predict phase two, $b = 1.78$, Wald $\chi^2(1) = 5.98, p < .01$, with responders progressing from ‘(1) gathering information’ to ‘(2) assessing risk’.

In SCGs, phase two was significantly more likely to predict phase one, $b = 1.45$, Wald $\chi^2(1) = 6.78, p < .01$, and phase four, $b = -0.999$, Wald $\chi^2(1) = 5.10, p < .05$, indicating a tendency for responders to either revert to ‘(1) gathering information’ or progress straight to ‘(4) considering options’ after ‘(2) assessing risk’. Phase four was significantly more likely to predict phase five, $b = 1.32$, Wald $\chi^2(1) = 5.52, p < .05$, indicating a tendency for responders to progress from ‘(4) considering options’ to ‘(5) taking action’.

**Discussion**

Difficulties with making joint decisions to coordinate responses have repeatedly been identified in MTSs operating in extreme environments, including disasters (DeCostanza et al., 2014; Kerslake, 2018; Mathieu et al., 2001; Pollock, 2013; Waring et al., 2018). To date, however, limited research has examined joint decision processes *in situ* within MTSs operating in extremis to understand the underlying causes of these difficulties within the context they occur. In the absence of direct evidence, the United Kingdom has embedded the linear phase-based JDM into national emergency guidance with the aim of improving joint decision-making (JESIP, 2017). Whether the JDM has altered joint decision processes in practice has yet to be examined across command levels. Accordingly, drawing on naturalistic observations of multiagency SCGs and TCGs during two large disaster exercises, the current study examined (1) processes used to make joint decisions in MTSs operating in extremis at strategic and tactical levels, and (2) whether the introduction of the JDM has altered these processes. Findings are discussed below, along with implications for developing evidence-based interventions to improve joint decision-making.
Table 5. Parameter estimates for predictors of each decision phase for KMAF Warrior and JE

| Exercise | Level    | Predictor variable                      | Outcome variable | Exercise | Level    | Predictor variable                      | Outcome variable |
|----------|----------|-----------------------------------------|------------------|----------|----------|-----------------------------------------|------------------|
|          |          | 1. Gather information and intelligence  | OR (CI)          |          |          | 2. Assess risk and develop a working strategy | OR (CI)          |
| Tactical | one      | 2. Assess risk and develop a working strategy | OR (CI)          |          |          | 3. Consider powers, policies, and procedures | OR (CI)          |
| Strategic|          | 4. Consider options and contingencies   | OR (CI)          |          |          |                                          |                  |
|          | Tactical | 1. Gather information and intelligence  | OR (CI)          |          |          | 2. Assess risk and develop a working strategy | OR (CI)          |
|          | Strategic| 3. Consider powers, policies, and procedures | OR (CI)          |          |          | 4. Consider options and contingencies   | OR (CI)          |
| Exercise | two      | 1. Gather information and intelligence  | OR (CI)          |          |          | 2. Assess risk and develop a working strategy | OR (CI)          |
| Tactical |          | 3. Consider powers, policies, and procedures | OR (CI)          |          |          | 4. Consider options and contingencies   | OR (CI)          |
| Strategic|          |                                          |                  |          |          |                                          |                  |

Continued
Table 5. (Continued)

| Exercise Level | Predictor variable | Outcome variable |
|----------------|-------------------|------------------|
|                |                   | 1. Gather information and intelligence | 2. Assess risk and develop a working strategy | 3. Consider powers, policies, and procedures | 4. Consider options and contingencies |
|                |                   | OR (CI) | SE | p | OR (CI) | SE | p | OR (CI) | SE | p | OR (CI) | SE | p |
| 2. Assess risk and develop a working strategy | \(4.25 (1.43, 12.63)\) | 0.56 | .01** | – | – | – | \(0.37 (0.16, 0.88)\) | 0.44 | .02* |
| 3. Consider powers, policies, and procedures | – | – | – | – | – | – | – | – |
| 4. Consider options and contingencies | \(3.75 (1.25, 11.30)\) | 0.56 | .02* | \(2.33 (0.90, 6.07)\) | 0.49 | .08 | – | – | – |

Note. CI 95%; – indicates that analysis could not be conducted due to low frequencies. *p < .05; **p < .01.
**Decision phases**

Across strategic and tactical levels for both exercises, responders were predominantly focused on gathering information. Indeed, they engaged in this activity more than twice as often as any other. This may be unsurprising given that multiagency meetings provide a platform for sharing and requesting information. Indeed, accessing relevant, timely information is vital for ensuring that understanding of a dynamic situation remains up-to-date so that decisions and actions can be tailored and revised as the situation alters (LePine *et al*., 2008; Waring *et al*., 2018). However, making joint decisions not only requires information to be shared. Responders must also integrate this information to develop a common understanding of the situation and risks, and align and prioritize goals and actions that are suitable for the situation in order to avoid conflict and duplication (Arrow *et al*., 2000; Healey *et al*., 2009).

However, across both exercises, findings showed less evidence of these additional activities. In particular, there was limited evidence of explicit planning with regard to considering powers, policies, and procedures of relevance to the situation to inform planning. These findings correspond with Wilkinson *et al*.’s research into decision-making in strategic responders (2019), but also show that this lack of explicit planning was evident in both strategic and tactical responders. The finding that explicit planning was limited across both exercises indicates that the introduction of JDM guidance has not yet led responders to increase their focus on this form of explicit planning behaviour. This poses implications for the effectiveness of multiagency coordination as explicit planning is valuable for improving knowledge of one another’s roles, mutual support, efficient and effective information sharing (Waring *et al*., 2018), shared situation awareness, and coordination (House *et al*., 2014; Kapucu, 2006; Stanton *et al*., 2015).

It is not clear why information regarding powers, policies, and procedures was infrequently discussed during multiagency meetings. However, one potential explanation is that doing so would increase the cognitive load of the speaker by requiring them to deliberately monitor their communications and explicitly provide information that they may not routinely consciously attend to. Another potential explanation is that strategic and tactical responders did not feel that it was necessary or relevant to the decision-making process to share this type of information about their agency’s powers, policies, and procedures during a multiagency meeting. Further research is required to examine the impact of explicitly providing information regarding powers, policies, and procedures on the cognitive load of speakers and recipients, along with focusing on responders’ reasons for not sharing this information. These issues are important to understand if interventions are to be developed to improve explicit planning within extreme contexts.

**Sequence of decision phases**

It is not just the phases that responders engage in that pose implications for joint decision-making, but also the order in which these phases are implemented. Reflective, linear models, such as the JDM (JESIP, 2017) and SAFE-T (van den Heuvel *et al*., 2012), highlight that optimal decision-making consists of taking steps to gather information, use this information to form an understanding of the situation and risks involved, consider options and form and implement a plan, and then review in order to identify whether modifications are required. In contrast, findings of the current study show a tendency for responders to revert to gathering information rather than progressing through stages to take action. These findings parallel Wilkinson *et al*., (2019), who also observed some multiagency strategic groups engaging in redundant deliberation. Similar patterns of
decision delay and inertia have also been observed in real incidents (Kerslake, 2018; Pollock, 2013) and have been highlighted in interviews with emergency responders (Power & Alison, 2017).

Research suggests that redundant deliberation is caused by intuitive concerns regarding possible negative consequences stemming from implementing a decision, potential alternatives or agency reputation (Alison et al., 2015). However, previous research observing SCGs and TCGs also shows that redundant deliberation and repetition can arise from individual agencies interrupting decision processes with agency-specific situation updates (Waring et al., 2018). Strong authoritative leadership is vital in large diverse meetings for keeping discussions focused on the agenda (Asmund & Svennevig, 2009) rather than allowing continuous streams of agency-specific updates that can increase the cognitive load of members (McCarthy et al., 2016; Mosier & Fischer, 2010). It is also important for the chair to show strong leadership over discussions to avoid themselves becoming overwhelmed as this would hinder their ability to provide clear summaries and comprehensive commands needed for improving teamwork and avoiding ambiguity (Orasanu, 1994; Tallberg, 2010; Uitdewilligen, 2011; van der Haar et al., 2017).

However, regardless of whether this tendency to revert to information gathering is caused by worry about future consequences and accountability threats, or by lack of strong leadership, the impact on disaster management remains the same. Delayed decisions and actions can have a devastating impact in extreme environments where rapid response is required to minimize and avoid risks (Alison et al., 2015; van den Heuvel et al., 2012; Waring et al., 2019). The finding that this pattern of reverting to information gathering was present across both exercises at a tactical level indicates little change in the way joint decisions are made in TCGs since the introduction of national JDM guidance.

In contrast, some differences were observed in decision processes at a strategic level since the introduction of the JDM. For example, in the first exercise there was a tendency for strategic responders to progress from gathering information to taking action without explicit planning. There was also evidence of this in TCGs, albeit to a lesser extent. Previous research shows a similar pattern of individual decision-makers taking action without explicitly planning at both operational (Cohen-Hatton et al., 2015; Klein, 1993, 2008) and strategic levels (Wilkinson et al., 2019) in extreme environments. Current findings advance on this previous research by examining whether the implementation of the JDM has led to any changes. Indeed, findings from exercise two provide initial indications that strategic responders are more likely to adopt aspects of a linear approach since the introduction of national JDM guidance, albeit this was not the only set of processes followed as strategic responders also showed evidence of reverting to information gathering. One possible explanation for why SCGs were better able to adopt aspects of a linear approach in practice compared to TCGs is that they operate under less time constraint and receive filtered information, which may free up cognitive capacity for consciously monitor the coordination of discussions.

**Limitations**

Drawing on data from two live disaster exercises, the following study presents a method for evaluating the impact of interventions in practice outside of artificial laboratory settings. It also provides a method for examining consistencies and inconsistencies in processes used in MTSs to make joint decisions across command levels. Observing members of multiagency MTSs operating in real extreme environments is usually infeasible as events occur without warning and pose significant risks to safety. In contrast,
live exercises provide a more robust context for examining practices than laboratory conditions as they are designed by experienced emergency responders to physically and psychologically replicate disasters and the challenges that arise within them (Waring, 2019). However, it is important to note that responders are unlikely to be exposed to the same levels of anxiety, stress, and cognitive load as would be experienced in real disasters where lives are at stake and the level of scrutiny is high. It is therefore possible that derailments from a linear approach to joint decision-making observed within the current study may be more pronounced in real disasters.

It is also important to note that the detailed observations made within this study were conducted during two disaster exercises based on different types of events (e.g., an incident between a ferry and cargo vessel vs. a train derailment). These two exercises also had some differences in the combinations of agencies involved, which needs to be considered when making comparisons in processes adopted before and after the introduction of the JDM. Additional studies adopting a similar methodology across a wider range of live disaster exercises, and indeed, across a wider range of MTSs operating in extreme environments would be beneficial for replicating findings. This would also be valuable for examining how decision processes differ depending on MTS size, number and diversity of agencies involved, and level of goal interdependencies, along with changes in processes across the course of incidents. The findings of such research have important implications for understanding what processes work in practice to improve joint decision-making in different contexts and team structures, and to develop bespoke training to improve practices. In addition to naturalistic observations, it would also be useful to conduct interviews with responders to better understand differences in processes followed across command levels and how this impacts cognitive capacity.

**Implications and recommendations**

Overall, findings highlight two common ways in which processes used to make joint decisions in MTSs derail from linear approaches ‘such as the JDM’ in extreme environments. Strategic and tactical responders often either revert to gathering information, which delays decisions and actions, or they progress straight from information gathering to taking action with little evidence of explicit planning. Previous research shows that reverting to information gathering can be the result of partner agencies providing agency-specific updates that served to interrupt decision-making (Waring et al., 2018). To date, JESIP has predominantly focused on emergency services, leaving wider partner agencies less familiar with national JDM guidance. One step that may help to reduce this pattern of reverting to information gathering and delayed action is to increase familiarity with the JDM across partner agencies in order to improve adherence to this frame during disaster response.

However, current findings suggest that the introduction of national JDM guidance does not necessarily impact joint decision-making. Indeed, the extent to which the JDM has impacted joint decision processes appears to differ between command levels. At a tactical level, there is little evidence of decision processes altering. These responders still demonstrate a tendency to revert to information gathering and display less evidence of explicit planning. In contrast, there is some evidence of joint decision processes altering at a strategic level, with responders showing greater evidence of adopting aspects of a linear approach, albeit still with limited evidence of explicit planning. Given the benefits for improving information sharing, mutual aid, and coordination in MTSs (House et al., 2014; Stanton et al., 2015; Waring et al., 2018), identifying ways to encourage responders...
to engage in explicit planning within the extreme environments they operate is important.

Within the emerging field of decision inertia and delay, research highlights that future policy, guidance, and training may benefit from focusing on promoting goal-oriented thinking to overcome inertia and improve explicit planning (Power & Alison, 2017; van den Heuvel et al., 2012). Indeed, a recent study by Cohen-Hatton and Honey (2015) showed that goal-oriented training improved the ability of individual firefighters to develop explicit plans and demonstrate anticipatory situation awareness. However, further focus is needed to examine whether goal-oriented training can be used to improve joint decision-making in multiagency groups, along with identifying what form and frequency training should take in order to maintain these complex skills in extreme environments.

Finally, findings indicate the importance of strong leadership for maintaining focus on pertinent issues and ensuring discussions follow an appropriate structure to facilitate effective joint decision-making. Responders from several agencies are present during SCGs and TCGs, each with specific goals and concerns. Often, the person chairing meetings is also a key decision-maker, requiring them to both attend to structuring discussions for the collective group as well as making sense of information for their own decisions. Further research is required to test whether delegating the role of chair to an individual without key decision-making responsibilities reduces cognitive load and improves decision-making. Given how important and challenging the role of chair is in diverse MTSs operating in extreme environments, it is vital to ensure that appropriate training is provided for this role. In particular, it would be beneficial for such training to focus on ensuring a good understanding of roles and responsibilities across agencies in order to effectively solicit pertinent information (Holmes & Stubbe, 2003), along with developing skills in summarizing and providing clear and comprehensive commands (Uitdewilligen, 2011; van der Haar et al., 2017).

**Conclusion**

To date, limited research has focused on examining processes used to make joint decisions *in situ* within MTSs operating in extremis. This is despite difficulties repeatedly being identified in making joint decisions to coordinate response within these complex and dynamic environments. In the absence of direct evidence, the United Kingdom has embedded a linear JDM into emergency guidance with the aim of improving joint decision-making during disaster response. Drawing on naturalistic observations of both SCGs and TCGs, this study examined what processes are used to make joint decisions at strategic and tactical levels during disaster response, and whether the introduction of the JDM has altered these processes. Findings show that rather than adopting a reflective linear model, both strategic and tactical responders show evidence of reverting to information gathering instead of taking action, and taking action without explicitly planning. The introduction of the JDM appears to have encouraged a more linear approach at a strategic level, albeit still with limited evidence of explicit planning and signs of reverting to information gathering. At a tactical level, joint decision processes appear to have remained similar, despite changes in national guidance. Previous research provides indications that focusing training on goal-oriented thinking can reduce decision delay and inertia, and improve explicit planning in individual decision-makers. Further research is required in order to test whether this type of training may also encourage these practices in
multiagency groups, and the form and frequency of training needed to maintain these complex skills.

Author contributions
Sara Waring (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Writing – original draft; Writing – review & editing); Jami-Louise Moran (Formal analysis; Writing – original draft); Rachel Page (Formal analysis; Writing – original draft).

Conflicts of interest
All authors declare no conflict of interest.

Data availability statement
The data that support the findings of this study are restricted and cannot be shared.

References
Alison, L., & Crego, J. (2008). Policing critical incidents: Leadership and critical incident management. Cullompton, UK: Willan.
Alison, L., Power, N., van den Heuvel, C., Humann, M., Palasinks, M., & Crego, J. (2015). Decision inertia: Deciding between least-worst outcomes in emergency responses to disasters. Journal of Occupational and Organizational Psychology, 88, 295–321. https://doi.org/10.1111/joop.12108
Allison, B. B., & Shuffler, M. L. (2014). Getting the “I” out of multiteam systems: A case study from the financial services industry. In M. L. Shuffler, E. Salas, & R. Rico (Eds.), Pushing the boundaries: Multiteam systems in research and practice (pp. 187–206). Bingley, UK: Emerald.
Altman, D. G. (1991). Practical statistics for medical research. London, UK: Chapman and Hall.
Anderson, C. J. (2003). The psychology of doing nothing: Forms of decision avoidance result from reason and emotion. Psychological Bulletin, 129(1), 139–167. https://doi.org/10.1037/0033-2909.129.1.139
Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). Small groups as complex systems: Formation, coordination, development, and adaptation. London, UK: Sage Publications.
Asmussen, B., & Svennevig, J. (2009). Meeting talk. Journal of Business Communication, 46(1), 3–22. https://doi.org/10.1177/0021943608326761
Bales, R. F., & Strodtbeck, F. L. (1951). Phases in group problem solving. Journal of Abnormal & Social Psychology, 46, 485–495. https://doi.org/10.1037/h0059886
Bashir, M., Afzal, M., & Azeem, M. (2008). Reliability and validity of qualitative and operational research paradigm. Pakistan Journal of Statistics & Operation Research, 4(1), 35–45. https://doi.org/10.18187/pjsor.v4i1.59
Bekhet, A. K., & Zauszniewski, J. A. (2012). Methodological triangulation: An approach to understanding data. Nurse Researcher, 20(2), 40–43. https://doi.org/10.7748/nr2012.11.20.2.40.c9442
Besedeč, T., Deck, C., Sarangi, S., & Shor, M. (2012). Age effects and heuristics in decision making. Review of Economics & Statistics, 94, 580–595. https://doi.org/10.1162/REST_a_00174
Besedeč, T., Deck, C., Sarangi, S., & Shor, M. (2015). Reducing choice overload without reducing choices. Review of Economics & Statistics, 97, 793–802. https://doi.org/10.1162/REST_a_00506
Bharosa, N., Lee, J., & Janssen, M. (2010). Challenges and obstacles in sharing and coordinating information during multi-agency disaster response: Propositions from field exercises. *Information Systems Frontiers, 12*, 49–65. https://doi.org/10.1007/s10796-009-9174-z

Bienefeld, N., & Grote, G. (2013). Shared leadership in multiteam systems: How cockpit and cabin crews lead each other to safety. *Human Factors, 56*, 270–286. https://doi.org/10.1177/0018720813488137

Civil Contingencies Act. (2004). *Local arrangements for civil protection*. Retrieved from https://www.legislation.gov.uk/ukpga/2004/36/contents

Cohen-Hatton, S. R., Butler, P. C., & Honey, R. C. (2015). An investigation of operational decision making in situ: Incident command in the UK Fire and Rescue Service. *Human Factors, 57*, 793–804. https://doi.org/10.1177/0018720815578266

Cohen-Hatton, S. R., & Honey, R. C. (2015). Goal-oriented training affects decision-making processes in virtual and simulated fire and rescue environments. *Journal of Experimental Psychology: Applied, 21*, 395–406. https://doi.org/10.1037/xap0000061

College of Policing. (2014). *National decision model*. Retrieved from https://www.app.college.police.uk/app-content/national-decision-model/the-national-decision-model/

Cook, T., & Tattersall, A. (2008). *Blackstone’s seniors investigating officer’s handbook*. Oxford, UK: Oxford University Press.

Davison, R. B., Hollenbeck, J. R., Barnes, C. M., Sleesman, D. J., & Ilgen, D. R. (2012). Coordinated action in multiteam systems. *Journal of Applied Psychology, 97*, 808–824. https://doi.org/10.1037/a0026682

DeChurch, L., & Marks, M. (2006). Leadership in multiteam systems. *Journal of Applied Psychology, 91*, 311–329. https://doi.org/10.1037/0021-9010.91.2.311

Deck, C., & Jahedi, S. (2015). The effect of cognitive load on economic decision making: A survey and new experiments. *European Economic Review, 78*, 97–119. https://doi.org/10.1016/j.euroecorev.2015.05.004

DeCostanza, A., DiRosa, G., Jiménez-Rodríguez, M., & Cianciolo, A. (2014). No mission too difficult: Army units within exponentially complex multiteam systems. In M. L. Shuffler, E. Salas, & R. Rico (Eds.), *Pushing the boundaries: Multiteam systems in research and practice* (pp. 61–76). Bingley, UK: Emerald.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Boston, MA: D.C. Heath.

Dillenbourg, P., & Bétrancourt, M. (2006). Collaboration load. In J. Elen & R. E. Clark (Eds.), *Handling complexity in learning environments: Research and theory* (pp. 142–163). Pergamon, Turkey: Advances in Learning and Instruction Series.

Doya, K. (2008). Modulators of decision making. *Nature Neuroscience, 11*, 410–416. https://doi.org/10.1038/nn2077

Feldon, D. F. (2007). The implications of research on expertise for curriculum and pedagogy. *Educational Psychology Review, 19*, 91–110. https://doi.org/10.1007/s10648-006-9009-0

Firth, B. M., Hollenbeck, J. R., Miles, J. E., Ilgen, D. R., & Barnes, C. M. (2015). Same page, different books: Extending representational gaps theory to enhance performance in multiteam systems. *Academy of Management Journal, 58*, 813–835. https://doi.org/10.5465/amj.2013.0216

Gelo, O., Braakmann, D., & Benetka, G. (2008). Quantitative and qualitative research: Beyond the debate. *Integrative Psychological & Behavioral Science, 42*, 266–290. https://doi.org/10.1007/s12124-008-9078-3

Gollwitzer, P. M., & Moskowitz, G. B. (1996). Goal effects on action and cognition. In E. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 361–399). New York, NY: Guilford Press.

Goodwin, G. F., Essens, P. J. M. D., & Smith, D. (2012). Multiteam systems in the public sector. In S. J. Zaccaro, M. A. Marks, & L. DeChurch (Eds.), *Multiteam systems: An organization form for dynamic and complex environments* (pp. 53–80). New York, NY: Routledge Taylor & Francis Group.
Power, N., & Alison, L. (2017). Redundant deliberation about negative consequences: Decision inertia in emergency responders. *Psychology, Public Policy, and Law, 23*, 243–258. https://doi.org/10.1037/law0000114

Power, N., & Alison, L. (2018). Decision inertia in critical incidents. *European Psychologist, 24*, 209–218. https://doi.org/10.1027/1016-9040/a000320

Ren, Y., & Argote, L. (2011). Transactive memory systems 1985–2010: An integrative framework of key dimensions, antecedents, and consequences. *Academy of Management Annals, 5*, 189–229. https://doi.org/10.5465/19416520.2011.590300

Rencoret, N., Stoddard, A., Haver, K., Taylor, G., & Paul, H. (2010). *Haiti earthquake response: Context analysis July 2010*. Retrieved from http://www.alnap.org/pool/files/haiti-context-analysis-final.pdf

Rydval, O. (2011). *The causal effect of cognitive abilities on economic behavior: Evidence from a forecasting task with varying cognitive load*. Working Papers, wp457.

Schmidt, A., & DeShon, R. P. (2007). What to do? The effects of discrepancies, incentives, and time on dynamic goal prioritization. *Journal of Applied Psychology, 92*, 928–941. https://doi.org/10.1037/0021-9010.92.4.928

Scholten, A. (2008). Controlled collaboration in disaster and crisis management in the Netherlands, history and practice of an overestimated and underestimated concept. *Journal of Contingencies and Crisis Management, 16*(4), 195–207. https://doi.org/10.1111/j.1468-5973.2008.00550.x

Shuffler, M. L., & Carter, D. R. (2018). Teamwork situated in multiteam systems: Key lessons learned and future opportunities. *American Psychologist, 73*, 390–406. https://doi.org/10.1037/amp0000322

Shuffler, M. L., Jiménez-Rodríguez, M., & Kramer, W. (2015). The science of multiteam systems: A review and future research agenda. *Small Group Research, 46*, 659–699. https://doi.org/10.1177/10464156053455

Stanton, N. A., Salmon, P. M., & Walker, G. H. (2015). Let the reader decide: A paradigm shift for situation awareness in sociotechnical systems. *Journal of Cognitive Engineering & Decision Making, 9*, 44–50. https://doi.org/10.1177/1555343414552297

Tallberg, J. (2010). Power of the chair: Formal leadership in international cooperation. *International Studies Quarterly, 54*, 241–265. https://doi.org/10.1111/j.1468-2478.2009.00585.x

Thunholm, P. (2005). Planning under time pressure: An attempt toward a prescriptive model of military tactical decision making. In H. Montgomery, R. Lipshitz, & B. Brehmer (Eds.), *How professionals make decisions* (pp. 43–56). London, UK: Lawrence Erlbaum Associates.

Turner, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *Qualitative Report, 15*, 754–760. https://doi.org/10.1177/1077800410376232

Uitdewilligen, S. (2011). *Team aadaptation: A cognitive perspective* (Unpublished doctoral dissertation). Maastricht University, Maastricht, The Netherlands.

UK Fire and Rescue Service. (n.d.). *National operational guidance*. Retrieved from https://www.ukfrs.com

van den Heuvel, C., Alison, L., & Crego, J. (2012). How uncertainty and accountability can derail strategic ‘save life’ decisions in counter-terrorism simulations: A descriptive model of choice deferral and omission bias. *Journal of Behavioral Decision Making, 25*, 165–187. https://doi.org/10.1002/bdm.723

van den Haar, S., Koeslag-Kreunen, M., Euwe, E., & Segers, M. (2017). Team leader structuring for team effectiveness and team learning in command-and-control teams. *Small Group Research, 48*, 215–248. https://doi.org/10.1177/1046496417689897

Waring, S. (2019). Using live disaster exercises to study large multiteam systems: Methodological and measurement fit. *Organizational Psychology Review, 9*, 219–244. https://doi.org/10.1177/204186619892262

Waring, S., Alison, L., Humann, M., & Shortland, N. (2019). The role of information sharing on decision delay during multiteam disaster response. *Cognition, Technology & Work*. https://doi.org/10.1007/s10111-019-00570-7
Waring, S., Alison, L., McGuire, G., Barrett-Pink, C., Humann, M., Swan, L., & Zilinsky, T. (2018). Information sharing in inter-team responses to disaster. *Journal of Occupational and Organizational Psychology, 91*, 591–619. https://doi.org/10.1111/joop.12217

Wegner, D. M., Guiliano, T., & Hertel, P. (1985). Cognitive interdependence in close relationships. In W. J. Ickes (Ed.), *Compatible and incompatible relationships* (pp. 253–276). New York, NY: Springer.

Wilkinson, B., Cohen-Hatton, S. R., & Honey, R. C. (2019). Decision-making in multi-agency groups at simulated major incident emergencies: In situ analysis of adherence to UK doctrine. *Journal of Contingencies and Crisis Management, 27*, 306–316. https://doi.org/10.1111/1468-5975.12260

Received 8 July 2019; revised version received 21 January 2020