AN EXAMINATION OF CULTURAL INFLUENCES ON TEAM COGNITION AND
INFORMATION SHARING IN EMERGENCY CRISIS MANAGEMENT DOMAINS: A
MIXED METHODOLOGICAL APPROACH

A Dissertation in
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by
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ABSTRACT

The consequence for better understanding and facilitating teamwork during crisis and disaster response in the coming years is significant. It becomes clear that environmental and situational complexity requires a reliance on teams to carry out response efforts. Crises, regardless of the type of event, require complex decision-making and planning under uncertainty within a high stress environment. Furthermore, the complexities of crisis and disaster environments can be compounded by the cognitive complexities of diversity present in multinational teams or even in international response efforts.

In complex crisis management and disaster response environments, designing effective systems that facilitate teamwork and improve team cognition presents significant challenges, given the nature of crisis events as disruptive to infrastructure, communications, and everyday systems of life. Historically, the utilization of simulations to explore numerous concepts relevant to cognition in sociotechnical systems, such as teamwork, macrocognition, information sharing, hidden knowledge, common operational picture, decision making, planning, etc., has indicated their effectiveness for understanding phenomena in complex sociotechnical systems while maintaining a controlled, safe environment. NeoCITIES is a human-in-the-loop, scaled world simulation centered on emergency crisis response. In the current study, NeoCITIES was used to assess multicultural and national team cognition in complex environments.

From an interdisciplinary perspective, the current study aimed to: 1) identify effective teamwork in crisis and disaster response, facilitating and improving effectiveness of human responses to these events and limiting loss of life and damage to communities; 2) develop the essential tools that will assist in effective crisis response, assisting both teams and individuals; 3) explore the impacts of culture background on cognitive processes, in order to facilitate team work in multicultural settings.
This study presents several major findings from a concurrent mixed methods study. Both quantitative and qualitative methodological approaches were utilized to assess cultural influences on team cognition in emergency crisis management scenarios. Namely this study identified differences in multinational team performance from national team performance on the NeoCITIES simulation task, and lower levels of information sharing overall and for hidden knowledge events by multinational teams. In addition to these findings, several approaches to teamwork in this setting, perspectives on cultural, and potential interventions for teamwork issues were identified qualitatively. Multiple methodological, theoretical, and practical implications of the current study were identified, with contributions made to the fields of Human Factors, Information Science, and Cognitive Systems Engineering.
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Chapter 1

Introduction

Primary Motivation

Teamwork has gone global. Teams are now used in a variety of contexts and for a variety of purposes. Often the work they carry out takes place in cross-national settings, and with multicultural team members. This is often the case with crisis and disaster response teams and coalition military teams, but is also far reaching into business, aviation, intelligence operations, peacekeeping operations, and even crew on the International Space Station, where an array of cross cultural or multicultural teams are consistently relied upon to carry out complex tasks and engage in dynamic problem solving.

Teams are described as “social entities composed of members with high task interdependency and shared and valued common goals,” (Salas, Cooke, & Rosen, 2008, p. 541). For example, crisis response teams share the workload, find solutions to complex problems, and coordinate and collaborate efforts in decision-making and responses (Cooke, Gorman, & Winner, 2007; King, 2002; Salas, et al., 2008). Team researchers have identified several important concepts relevant to a team’s ability to carry out teamwork. Team cognition for example reflects “an emergent state [within a team] that refers to the manner in which knowledge important to team functioning is mentally organized, represented, and distributed within the team and allows team members to anticipate and execute actions (Kozlowski & Ilgen, 2006),” (DeChurch & Mesmer-Magnus, 2010, p. 33). One of the primary ways in which team cognition is evaluated is through an examination of team mental models, which has been linked to team performance.
The ways in which cultural diversity within teams impacts the formulation of shared knowledge structures within teams has been largely unexplored.

In particular, a great number of problems in team performance have been attributed to deficiencies in team cognition, which can then be compounded by differing cultural cognitive perspectives within teams, and by the impact of extreme conditions (such as those characterized by crisis events). As described by Mathieu et al. (2008), the impact of environment alone can dramatically impact the construction of a team cognitive model by limiting how teams communicate and share information.

“However, under conditions in which communication is difficult—because of excessive workload, time pressure, or some other environmental feature—teams are not able to engage in necessary strategizing. In this case, shared mental models become crucial to team functioning because they allow members to predict the information and resource requirements of their teammates. Hence, members are able to act on the basis of their understanding of the task demands and how these will affect their team's response. It is this ability to adapt quickly that enables teams in dynamic environments to be successful” (Mathieu, Goodwin, Heffner, Salas, & Cannon-Bowers, 2000, p. 274).

Adaptability within teams in extreme environments is crucial to team outcomes, however in this context, the development and adaptability of team cognition for teams working in cross cultural settings or within multinational teams may either be limited or encouraged by the diversity of perspectives with which team members must contend. Growing evidence suggests

---

1 In this context, culture refers to national culture, and does not consider political and organizational culture.
that, across cultural groups, there are significant differences in cognition, behavior, and attitudes suggesting people can no longer be thought to experience the world in exactly the same way.

Evidence from a wide body of research has found that cultural differences breed cognitive and behavioral variances in how individuals and groups respond to and carry out decision-making, planning, perception, problem solving and communication (Ambady & Bharucha, 2009; Henrich, Heine, & Norenzayan, 2010; Kitayama & Uskul, 2011). Multidisciplinary evidence for actual cognitive differences amongst cultural and language populations has emerged from cognitive science, cognitive neuroscience, cultural neuroscience, psychology, and psycholinguistics research, intoning cultural influences in areas of:

Table 1-1: Evidence of Cultural Impacts on Cognition.

<table>
<thead>
<tr>
<th>Evidence of Culture in Cognition</th>
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<tbody>
<tr>
<td><strong>Decision Making</strong></td>
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<td><strong>Color</strong></td>
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<tr>
<td><strong>Spatial Reasoning</strong></td>
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<td><strong>Navigation</strong></td>
</tr>
<tr>
<td><strong>Neural Structuring and</strong></td>
</tr>
</tbody>
</table>
The extent to which these cognitive and behavioral aspects emerge as critical features in response to crisis situations is an important area of scrutiny evaluated within the current study.

**The Current Research**

The current research presents a mixed methods study focused on establishing a baseline for understanding the added complexity of culture on team cognition in the complex environment of crisis management. A crisis is defined as an unexpected event that presents a threat to something of value (whether that is people or property) with a limited time to respond using limited or incomplete information and often with limited resources. Often, a disaster “represents the interdependent cascade of failure triggered by an extreme event that is exacerbated by inadequate planning and ill-informed individual or organizational actions,” (Comfort, 2005, p. 338). Many recent events such as the recent bombings of Boston in 2013, Paris in 2015 and Brussels in 2016, the Ebola Crisis in West African countries of Sierra Leone, Liberia, and Guinea (CDC, 2014) in the summer of 2014, the Nepalese earthquakes in 2015, and California wildfires all represent significant crisis events that required teams and teams of teams to effectively respond and manage.

Crises, regardless of the type of event, require complex decision-making and planning within a high stress environment. Crisis management seeks to plan for and mitigate the effects of a crisis on organizational, local, national and international scales. However, as Pearson and Clair (1998) suggest, “differentiating effective from ineffective crisis management has been more difficult in practice” than in theory (p.61). Oftentimes, effective handling of a crisis is multifaceted and complex.
The level of shared culture of team members has been found to influence the team’s effectiveness and efficiency in team activities, particularly when teams of multiple nationalities are compared to those with a single nationality. The current research is motivated to understand how:

- Diverse cultural make up of teams influences team cognition;
- In what ways do diverse and homogenous teams develop team cognition
- Does the crisis setting influence a team’s ability to develop team cognition
- Does a combination of these factors (cultural diversity, crisis environment) shape how teams communicate and share information

In order to evaluate these motivating questions, four primary research questions are explored within this study:

RQ1: What is the relationship between culture and the ways in which 1) National teams 2) Multinational Team a) share information; b) develop shared knowledge; c) Perform; and d) Interact in a crisis situation?

RQ2: How does the cultural composition of teams have an impact on information sharing behaviors during a crisis management simulation?

RQ3: In cases where uniquely held information (hidden knowledge) is present, how does the cultural composition of teams impact when and how teams share information during a task?

RQ4: How can a blended epistemological perspective be used to answer questions about the ways in which culture influence cognitive processes in teams during crisis situations?

**Research Approach**

In order to explore these four research questions, a concurrent mixed methods study was conducted utilizing a team-based scaled world simulation, NeoCITIES, to assess and evaluate
differences across national and multinational teamwork and team cognition in a crisis environment.

Complex environments often reduce the ability of researchers to effectively capture underlying issues. Given the dangerous, chaotic, and emergent nature of most crises, it can present significant challenges for both researchers and those attempting to respond to the event, in which interference by researchers can severely hinder the abilities of emergency responders. Due to the inherent complexity and chaos prevalent in an emergency crisis event, the ability for researchers to effectively observe and capture operations of first responders within the emergency environment is limited. In order to engage with the operational tasks of a crisis event, a scaled world simulation provides an effective mechanism by which to examine the environment by allowing for the preservation of the complexity of the context while allowing for the control of a laboratory setting (Ehret, Gray, & Kirschenbaum, 2000).

The NeoCITIES simulation (McNeese, et al., 2005) presents such a scaled world from which teams and team cognition can be examined during an emergency crisis event from the safety and control of a laboratory setting.

The integration of culture into studies of cognitive and behavioral science allows for the expansion of the exploration of cognitive universals across populations. It also allows for the inclusion of cognitive and behavioral differences amongst populations as a result of culturally mediated structuring of behaviors. In the current dissertation, the notion that culture shapes our cognition will be explored with the view that culture is a dynamical part of the human mind, shaping cognition and being shaped by individual and collective experience.

In this study, cultural aspects of cognition will be explored in the context of teams within the domain of Disaster and Emergency Management and Response through a scaled-world simulation, NeoCITIES, with the goal of significantly contributing to our understanding of ways to support teams in their collaborative and decision-making processes in high stress
environments. The use of a mixed qualitative and quantitative methodological approach allows for an in depth exploration of teamwork phenomena through a shared context. It allows for the findings of one methodological and epistemological approach to be evaluated and expanded within the context of another.

Within this document I present a mixed methodological design composed of two studies:

**Quantitative Study:** The quantitative study consists of teams of three engaging with and interacting through the crisis management simulation, NeoCITIES, in a laboratory setting (McNeese, Mancuso, McNeese, Endsley, & Forster, 2014). Teams were collocated and allowed to speak freely during the simulation. Within this study, differences across national and multinational teams were evaluated across a number of aspects including team performance (McNeese, et al., 2014), the assessment of team mental models (Mohammed, Ferzandi, & Hamilton, 2010), communication (Cooke, et al., 2005), information sharing and hidden knowledge profiles (Stasser & Titus, 2003).

**Qualitative Study:** The nature of this study as an exploratory study makes use of qualitative methods as appropriate. This study involved the triangulation of several sources of data collected during and after participant’s time in the simulation, namely through an analysis of team communications, a questionnaire following the simulation, and researcher observation. The inclusion of qualitative methods allow for richer understanding of team behaviors as well as provide a novel mechanism by which to examine and measure the influence of culture in complex team decision-making processes, such as the sharedness of team mental models.

Both studies were collected concurrently for all participating teams (Creswell, 2014). The integration of the two studies will be evaluated throughout the discussion section in order to create an overarching picture of the phenomena in question within this context.
Dissertation Overview

In the following dissertation, chapters will cover:

**Chapter 2: Literature Review** presents literature from team cognition, emergency crisis management, and present evidence for cultural cognition within teams.

**Chapter 3: Methods** presents a mixed methodological study. It presents the experimental designs for a concurrent mixed methods study in two parts: a quantitative and qualitative study.

**Chapter 4: Quantitative Results** presents the results of the quantitative study.

**Chapter 5: Evaluations of Communication and Information Sharing Processes** presents the results of the communication and information sharing data across national and multinational teams.

**Chapter 6: Qualitative Results** presents the results of the qualitative study. It presents several models of teamwork approaches, and explores the impact of cultural diversity on teams.

**Chapter 7: Discussion** presents a discussion of the results of the quantitative and qualitative studies, and focuses on the integration of findings between these two studies.
Chapter 2

Literature Review

Crisis Response

“Cognitive approaches to the study of an organizational crisis typically are based on three core assumptions. The first assumption is that crises present "wicked problems" (Stubbart, 1987): they are highly uncertain, complex, and emotional events that can play multiple parties' interests against one another. The second assumption is that people are limited in their information-processing capabilities during a crisis. Finally, the third assumption is that crises arise or spiral out of control because executives, managers, or operators have responded irrationally and enacted errors of bias and other shortcomings in their information processing and decision making.” (Pearson & Clair, 1998, p. 62)

Hurricane Katrina, Typhoon Haiyan, the 2005 earthquake in Haiti, September 11th, the Financial Crisis of 2008, the 2014 Ebola Crisis, and the 2015 Nepal earthquake represent a changing world in which the effects of a crisis are widespread and world wide. Importantly, while these are well known events, they represent crises that had profound impacts on local communities. They also represent a growing trend in impactful crisis events that have widespread ramifications for infrastructure, governments and economies, as well as significant loss of life and monetary losses (Altay & Green III, 2006). For example, the very recent 7.8 magnitude earthquake in Nepal on April 25, 2015 the subsequent tremors, and the following second 7.5 magnitude earthquake two weeks later on May 12, 2015 has impacted around 8 million people (Buckley & Ramzy, 2015) through an excess of 8,000 deaths, many injuries, many thousands of displaced persons, millions of dollars in property damage, as well as significant disruption in government and economies (Peralta, 2015). Compounding these issues, a mountainous geography has also presented significant challenges to responders, requiring extensive coordination and navigation of difficult terrain. The scale of the disaster and its effects demonstrate the significance of the impact of crisis and disaster events on communities and
countries around the world. Additionally, the growing emergence of evidence for global warming suggests that these events are projected to increase in frequency and impact over the next ten years (http://climate.nasa.gov/effects/), with significant ramifications for local communities around the world (Coppola, 2011). Additionally, the continuance of political unrest and strife has meant that more communities are susceptible to terrorist attacks. As such the urgency for effective crisis management and response has only increased since the 9/11 events of 2001.

Mitigating and minimizing the damage inherent in an emergency event such as a natural disaster or terrorist event is a significant area of interest. Crisis management, however, requires a notably human element, upon which successful management of a crisis relies on an effective and appropriate preparation and response by the individuals or organizations that are effected.

**Team Cognition in Crisis Events**

Crisis situations, whether natural disasters, health epidemics, or terrorist incidents present unique opportunities for the engagement of teams in dealing with emerging events. These teams are required to provide dynamic responses within a complex environment, as well as interact with diverse groups and populations in order to effectively and efficiently respond to a crisis event. As discussed, crisis events present uniquely complex situations, which require teams, or teams of teams, to effectively manage and respond to the events as they unfold, as they can quickly overwhelm individuals (Cooke, et al., 2007; Salas, et al., 2008). Teams are defined as “social entities composed of members with high task interdependency and shared and valued common goals (Dyer, 1984)…[who] must integrate, synthesize, and share information; and [who] need to coordinate and cooperate as task demands shift throughout a performance episode to accomplish their mission,” (Salas, et al., 2008, p. 541). Teams are often used in variety of operational
contexts– such as business, military and peacekeeping operations, emergency crisis response and other organizational settings– and are expected to perform in complex environments. In teams, multiple factors are often present which, if not appropriately addressed or managed, can influence team cohesion, leading to overarching effects on team performance, and on the effectiveness of the crisis response (King, 2002). Like much of the work done in complex domains, the impact and effect of human error (Reason, 2000) in crisis response can have significant consequences. In the following section, teams will be looked at in greater depth, before moving on to a comprehensive discussion of culture.

**Teams**

Salas, Dickinson, Converse, and Tannenbaum (1992) define a team as "a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/object/mission, who have each been assigned specific roles or functions to perform, and who have a limited life span of membership" (p. 4). Many researchers make the distinction between groups and teams. While groups and teams may share many of the same characteristics, groups do not have the shared goals as teams do, may not have the same level of division of labor, such as assigned roles as teams and may be varied in their responsibilities, (Cooke, et al., 2007; Klimoski & Mohammed, 1994). Teams are distinguished by their interdependency as described in the definition above, as well as by the division of tasks to carry out a shared objective. It is important to note that while all teams are groups, it is not always the case that a group will be a team (Klimoski & Mohammed, 1994).

Teams are often deployed across many contexts and across domains. Teams are used in a variety of situations and for a variety of different purposes, and can include members who are distributed geographically, or even virtually, and can include non-human team members, such as
intelligent agents or robots. As Salas, Cooke, and Rosen (2008) suggest, “Teams are used when errors lead to severe consequences; when the task complexity exceeds the capacity of an individual; when the task environment is ill-defined, ambiguous, and stressful; when multiple and quick decisions are needed; and when the lives of others depend on the collective insight of individual members” (p.540).

In order for teams to be successful, appropriate and dynamic coordination and cooperation amongst team members is required. Successful teams are able to meet their goals by negotiating shared team processes. Team processes are often described as either taskwork or teamwork. Salas, Cooke, and Rosen (2008) describe taskwork as the non-interdependent component of team performance. Teamwork deals specifically with the interdependent actions and activities required by team members to effectively accomplish goals (Salas, et al., 2008). Salas et al. (2008) go on to define teamwork as “nested within team performance and is a set of interrelated cognitions, attitudes and behaviors contributing to the dynamic processes of performance” (p.541). Understanding the processes that lead to overall team performance has lead to a general consensus on the role of team cognition, which is seen as a fundamental team process.

Cooke et al (2007) articulate that historically, the need to understand the role of team cognition emerged from several crisis events - the Three-Mile Island incident and Chernobyl and the USS Vincennes incidents in the 1970’s- 1980’s. These crisis and disaster events presented cognitively demanding environments from which it became clear that team cognition plays a pivotal role in team outcomes from which cognitive deficiencies can lead to failures, accidents and even deaths. An individual and group level assessment of cultural impacts on cognition with intergroup processes is essential for understanding overall team cognition (Connaughton & Shuffler, 2007; Cooke, Gorman, & Rowe, 2009, p. 157; McHugh, Smith, & Sieck, 2008; Strauch, 2010; van Vliet & van Amelsfoort, 2008).
**Team Processes**

There are many constructs that have been found relevant to team processes and for team performance. The following section will give a brief overview of several of these processes integral to the formation of team cognition.

Table 2-1: Description of Team Processes.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Team</td>
<td>Two or more people who are interdependent and share a common goal</td>
<td>Salas, Dickinson, Converse, and Tannenbaum (1992)</td>
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<tr>
<td>Team Performance</td>
<td>Multilevel process by which team members manage individual and team level taskwork and teamwork. Team cognition is linked to team performance</td>
<td>Salas, Cooke and Rosen (2008); Cooke et al (2004)</td>
</tr>
<tr>
<td>Teamwork</td>
<td>The interdependent actions and activities required by team members to effectively accomplish goals</td>
<td>Salas, Cooke, and Rosen (2008)</td>
</tr>
<tr>
<td>Taskwork</td>
<td>The non-interdependent component of team performance.</td>
<td>Salas, Cooke, and Rosen (2008)</td>
</tr>
<tr>
<td>Team Cognition</td>
<td>State of shared team functioning in which knowledge is organized and represented mentally across team members.</td>
<td>Fiore &amp; Salas (2004); Cooke, Gorman, and Winner (2007)</td>
</tr>
<tr>
<td>Team Mental Models</td>
<td>Shared representation of the environment.</td>
<td>Klimoski &amp; Mohammed (1994); Mohammed, Ferzandi, Hamilton (2010)</td>
</tr>
<tr>
<td>Team Situational Awareness</td>
<td>The degree to which every team member possesses the SA required for his or her responsibilities (p.39) is predictive of team performance.</td>
<td>Endsley (1995); Endsley &amp; Jones (2011)</td>
</tr>
<tr>
<td>Shared Understanding</td>
<td>The ability of team members to coordinate behaviors for a common goal</td>
<td>Smart et al. (2009)</td>
</tr>
<tr>
<td>Team Communication</td>
<td>Team communication content and flows reveals cognitive processing at the team level.</td>
<td>Cooke et al (2004); Cooke et al. (2012); Weick (1995)</td>
</tr>
<tr>
<td>Collaborative Information Seeking</td>
<td>Collaborative Information Seeking is process of planning and re-planning, and can have an</td>
<td>N. McNeese, Reddy, Freidenberg, (2014)</td>
</tr>
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</table>
The topic of team cognition has been viewed as a very prominent part of team performance, and for the past 30 years has been extensively studied (Fiore & Salas, 2004; Salas, Fiore, Letsky, & Warner, 2010). Fiore and Salas (2004) describe three benefits to studying team cognition, 1) It allows researchers to look at team processes within a complex environment, 2) By looking at team processes, it may be predictive of team performance, 3) Understanding team cognition allows researchers to design interventions that will mitigate issues experienced by teams (Fiore & Salas, 2004, pp. 235-236).

Cooke, Gorman, Myers and Durand (2013) describe team cognition as emergent within a the context involving interdependent activity between team members who share common goals (Cooke, Gorman, Myers, & Duran, 2013; Salas, et al., 2008). DeChurch and Mesmer-Magnus (2010) describe team cognition as “an emergent state that refers to the manner in which knowledge important to team functioning is mentally organized, represented, and distributed within the team and allows team members to anticipate and execute actions” (DeChurch & Mesmer-Magnus, 2010, p. 33). Team cognition requires the development of common ground amongst team members, in order for team members to effectively organize their actions (Mancuso & McNeese, 2012). Clark and Brennan (1991) describe common ground as a fundamental part of communication, which teams need in order to coordinate and collaborate activities (Jefferson, Ferzandi, & McNeese, 2004; Mancuso & McNeese, 2012). For teams to effectively function, anticipate, and execute actions, a shared state of understanding and knowledge must emerge amongst team members.

How team cognition is constructed and the factors that influence the development of team cognition have produced much discussion. It is important to note that team cognition is not
simply an aggregation of individual cognitions; it is in fact emergent within a team in a given context. One perspective presents team cognition as a constructed activity that arrives “through distributed, emergent activities [of actors] using various sources,” (McNeese, 2003, p. 519). Though communication articulates some aspects of the development of shared cognition in a team, the ability for team members to develop a shared operational picture (McNeese, et al., 2006a) extends beyond the capabilities of individual team members to verbally articulate information and share knowledge verbally.

Cooke et al. (2009) suggests that in order for successful team cognition to occur, unique perspectives must be coordinated, and the team must respond to an issue at hand as a coordinated whole. This requires teams to have shared knowledge and adaptation within their team processes; “…assuming that the various unique perspectives are coordinated, a team may be able to enact a solution that overcomes a roadblock by responding as a coordinated whole. It is crucial, however, to point out that this sort of team-level awareness is not purely introspective or knowledge-based, it is predicated on adaptation via team member interaction,” (Cooke et al. 2009, p173). One of the primary requirements for the development of team cognition is that of adaptability within team interactions. A static perspective of team problem solving and decision-making is failingly representative of how teams are able to effectively coordinate actions.

A great number of problems in team performance have been attributed to deficiencies in team cognition. In order to carry out tasks in complex environments, team members need to collaborate and engage in cooperative actions, however many factors have been found to affect teams’ ability to do so. Deficiencies in team cognition have been found due to effects of team member moods, such as negative affect (McNeese & Pfaff, 2010; Pfaff, 2012); time stress (Pfaff, 2012); team training (Salas, et al., 2008); and team leadership (Cuevas & Bolstad, 2010) as well as the nature of team formation, i.e. distributed teams (vs. Co-located) (Jefferson, et al., 2004), and ad hoc teams.
A large body of research has been devoted to the study of team performance, and on team cognition in particular. The following sections briefly discuss several factors that have an impact on team cognition.

**Shared Knowledge**

As a construct within team cognition, shared knowledge is often presented as a significant element of team cognitive processes. Shared knowledge suggests that, within a specific context or situation, and in some way members within a team need to aggregate their disparate or distinct knowledge to develop an overall picture of what is happening in their

<table>
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<tr>
<th>Influences on Team Cognition</th>
<th>Description</th>
<th>References</th>
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<tr>
<td>Affect</td>
<td>Negative Affect of team members led to a decrease in team performance, suggesting that emotion plays a role in team cognition</td>
<td>Pfaff (2012);</td>
</tr>
<tr>
<td>Time pressure</td>
<td>Time Pressure creates high levels of psychological stress, impacts team cognition.</td>
<td>Pfaff (2012); Bowman &amp; Wittenbaum (2012)</td>
</tr>
<tr>
<td>Team Knowledge Structures</td>
<td>Broader knowledge structures versus integrated knowledge structures amongst team members impacts performance</td>
<td>Mancuso &amp; McNeese (2012)</td>
</tr>
<tr>
<td>Team Training</td>
<td>Builds shared mental models of the situation, promotes teamwork, improves team performance increases a team’s ability to function effectively under high levels of stress.</td>
<td>Cannon-Bowers &amp; Salas (1998); Salas, Cooke, Rosen (2008)</td>
</tr>
<tr>
<td>Team Leadership</td>
<td>Leadership style influences development of team cognition, coordination.</td>
<td>King (2002); Cuevas &amp; Bolstad (2010)</td>
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</table>
environment in order to effectively accomplish the team’s goals, whatever they may be. The convergence of this common operational picture is a significant contributor to overall team performance (McNeese, et al., 2006b). Researchers suggest that shared knowledge is constructed through several mechanisms of individual and team cognitions. These include team mental models (Klimoski & Mohammed, 1994; Mohammed, et al., 2010), team situational awareness (M.R. Endsley & Jones, 1997; A.R. Wellens, 1993), transactive memory, common operational picture (McNeese, et al., 2006a), and macrocognition (Fiore, Rosen, et al., 2010; Fiore, Smith-Jentsch, Salas, Warner, & Letsky, 2010), which allow for cohesion of team processes such as collaborative decision-making, planning, and performance. Within the following sections, a specific look at team mental models, and Team SA will be examined in greater detail.

**Team Mental Models**

While initially used as a metaphor to explain human-system interactions rather than a construct of team cognition, over the past 25 years an emergence of team mental models in team literature has helped to create an understanding of processes in teams (DeChurch & Mesmer-Magnus, 2010; Klimoski & Mohammed, 1994; Mohammed, et al., 2010). A mental model is described as representational knowledge of the environment that is accompanied by expectations in behaviors (Klimoski & Mohammed, 1994). It provides the conceptual framework through which individuals “describe, explain, and predict” future states of the system (Klimoski & Mohammed, 1994).

What then are Team Mental models? Team mental models have been used to understand the ways in which teams are able to form into a unit and effectively meet their goals. Strong team mental models are indicated when members have a shared operational picture and are able to predict and anticipate team member needs as well as environmental factors (things going on in
the outside world) and that team members develop a similar explanation for events (Mohammed, et al., 2010). Team mental models are defined as “team members’ shared, organized understanding and mental representation of knowledge about key elements of the team’s relevant environment” (Klimoski & Mohammed, 1994; Mohammed, et al., 2010, p. 879). The creation of common ground through perceptual anchors, “create a shared experience of the problem (i.e., jointly, mutually agreed upon recognition of advantages, functions, and constraints) that becomes the basis for distilling a shared mental model,” and is pivotal for “integrating disparate beliefs,” (Jefferson, et al., 2004, pp. 649-650). Mohammed and colleagues have described several characteristics of team mental models, namely that they are “emergent characteristics that derive from the cognition of individuals but manifest as collective phenomena” (Mohammed, et al., 2010, p. 879). As a collective phenomena, individual mental models are aggregated and used to understand team processes in complex, dynamic environments (Mohammed et al. 2010), however, the knowledge of team members is complementary with in a team rather than identical or overlapping (Cooke, et al., 2007).

As shared representations of the environment in which the team operates, team mental models include taskwork, teamwork, and temporal elements (Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015), which are used to describe aspects of team processes and the ways in which team mental models develop. Team mental models are measured as features of similarity and accuracy (for discussion see Mohammed, et al., 2010). Accurate Team Mental Models have been contributed to higher performance, whereas similarity describes the level of convergence of individual member’s mental model of the situation that is shared (Lim & Klein, 2006). Team mental models are measured as content in levels of taskwork, teamwork, and temporal mental model accuracy and similarity (Mohammed, et al., 2010; Mohammed, et al., 2015).
**Shared SA**

One of the primary goals for crisis managers and responders lies in the development of situation awareness for the current environment of an emerging crisis. It is presented as a fundamental need amongst responders in order to effectively manage the impacts of a crisis event. Important to the development of team cognition is the concept of Situation Awareness (SA). Situation Awareness is described as the awareness of what is going on in the environment around you coupled with “an understanding of what that information means… now and in the future” (M. R. Endsley & Jones, 2011, p. 13). At the individual level, Endsley’s (1988) model of SA presents 3 stages to SA: (1) Perception, (2) Comprehension, and (3) Projection. Stage 1 SA involves an ability to perceive the environment around you; Stage 2 SA involves the comprehension of the current environment or situation; and stage 3 SA is the ability to project the future status of the situation (M. R. Endsley & Jones, 2011).

Team SA is the shared awareness team members have of a situation. Team SA is "the degree to which every team member possesses the SA required for his or her responsibilities” (M. R. Endsley, 1995, p. 39). Every team member is required to have their own SA requirements met, in order for high levels of team performance to emerge (M. R. Endsley, 1995; M. R. Endsley & Jones, 2011). As interdependency is a feature of teams, team SA constitutes that individual SA will overlap somewhat, and through the process of team coordination individual SA emerges as shared SA across team members, even though no two team members may have identical individual situational awareness for a particular situation.

Shared Situation Awareness (Snyder, Wellens, Brown, & McNeese, 1989; A.R. Wellens, 1989; A.R. Wellens, 1993) relies on a shared understanding of the environment, as it relates to individual and, in which the team is working. Smart et al. (2009) describe shared understanding as “the ability of multiple agents to coordinate their behaviours (sic) with respect to each other in
order to support the realization of common goals or objectives (italics included)” (p.3). Team members can have several layers of understanding, which are negotiated via collaboration and communication amongst team members. Significantly, shared SA allows for the development of varied and diverse perspectives of a situation, however, it requires that these divergent perspectives of the environment (individual SA) be appropriately revealed so that teams can work through discrepancies (M. R. Endsley & Jones, 2011). “The two constructs of shared mental models and team SA are theoretically linked in that shared mental models of a long-term shared understanding of the task, team, or equipment are thought to be important factors in team SA, and specifically the construction of a team situation model” (Cooke, et al., 2007, p. 254).

In order to have a common operational picture, the development of Shared Situation Awareness in teams “involves knowledge of the status of other team members’ task to the degree that they impact on one’s own tasks and goals (italics included)” (M. R. Endsley & Jones, 2011, p. 201). As such, Shared SA requires effective and timely sharing of information in order to create a common picture of the environment.

**Team Communication**

Communication within a team is pivotal for the transmission of shared knowledge structures, and for understanding team cognition as a whole. Cooke et al (2004) suggest that analyzing team communication data is a means by which to evaluate team cognition. As a ubiquitous behavior, communication captured between team members during task specific activities can lead to a rich, descriptive depiction of team cognition (Cooke, Duchon, Gorman, Keyton, & Miller, 2012). Through an examination of communication flow and communication content between team members, a rich understanding of contextual information at the team level can be extracted (Cooke, Salas, Kiekel, & Bell, 2004). “Data derived from communication
studies provide an excellent resource for understanding the propagation of peoples’ reasoning and decision making in complex task environments” (Cooke, et al., 2012, p. 485). At the team level, this propagation of reasoning and decision-making can be exploited by examining flow and content of team communication patterns. This enables the researcher to explore the dynamic aspects of team behaviors qualitatively—effectively the underlying reasons, the “whys” of observable team activities. This can be particularly salient when examining differences in success and failures across teams, bringing to light intergroup conflicts, coordination processes, leadership styles, and information sharing behaviors, particularly in terms of cultural differences, for example.

Traditional theories of communication suggest that information is a signal transmitted between a sender and a receiver and that it goes through some element of noise. The Shannon-Weaver model is a well-known mathematically defined theory that reflects these principles in which information is shared in order to reduce uncertainty (Cooke, et al., 2005). It is necessary to consider both context of the communication, as it provides a richness that creates salience to the communication structures of a group or team, as well as the networks or patterns of conversation that may emerge specific to that context (Cooke, et al., 2005). As Cooke et al. (2005) describe many features of context may be salient to a communication “Factors thought to influence communication include culture (Merrit & Helmreich, 1996), context of the communication, the size of the group or team, and group identity (Beebe & Masterson, 1997)” (Cooke, et al., 2005, p. 12).

As Merrit and Helmreich (1996) explore, cultural backgrounds at the national level can shape and drive communication structures with in a team, as was suggested in their study of Pilots’ and flight attendant attitudes towards team work and the role of communication in defining their behaviors and actions in both emergency and everyday situations. Understanding
and exploiting these communication structures can help to facilitate a better process for engaging routine and non-routine responses and behaviors amongst diverse teammates.

**Methods for examining Communication in Context**

Both quantitative and qualitative mechanisms of analysis provide cogent information for assessment of team communication. *Communication flow* and *communication content* are two typical points of analysis for communication data (Cooke, et al., 2005). Quantitatively, methods include the duration of communications, counting the number of utterances in a given time frame, or “encoding the communication into prescribed content categories” (Cooke, et al., 2005). Through an examination of such aspects of information flow, features of team performance and workload can be revealed, even devoid of actual content (Cooke, et al., 2012). Communication content evaluates patterns of communication through the development of a coding scheme that features salient categories for the evaluation of the actual content of the communication, looking at such details of interactions, information sharing, and interpersonal features.

**Information Sharing**

Information sharing represents one of the most significant challenges for teams and organizations in crisis environments (Bharosa, Lee, & Janssen, 2010). The dynamic, complex, and unpredictable nature of the crisis environment coupled with significant time pressure presents one of the key barriers to effective information sharing (Bharosa, et al., 2010; Ritchie, 2004). In addition to the inherent chaotic nature of crisis type events, there is the prevalence for inaccurate or outdated information to swarm crisis managers and responders, leading to cognitive overload (Bharosa, et al., 2010). Information sharing, however, is significant in influencing outcomes of
crisis management, and for crisis responders to effectively develop a common operational picture of the situation (McNeese, et al., 2006a).

Several team processes have been found to facilitate effective information sharing amongst team members. Namely, the coordination and development of team cognition amongst team members encourages information sharing when trust is established amongst team members and communication is effectively facilitated (Altschuller & Benbunan-Fich, 2008; Cooke, et al., 2004; Salas, et al., 2008). Additionally, there has been an increased focus on the development of technologies that assist responders in information sharing during crisis events, such as live video chat (Bergstrand & Landgren, 2009), social media, information visualization, for example, have helped improve information sharing across organizations (Bharosa, et al., 2010; Bolstad & Endsley, 2003).

Mesmer-Magnus & DeChurch (2009) describe uniqueness and openness as constructs of information sharing. Uniqueness is described as the amount of sharedness in information amongst team members, and in particular describes how teams capitalize on distinctive knowledge sets for the betterment of team performance. Openness in information sharing literature refers to the exchange of information via communication of team related tasks, “goals, progress, coordination and the like, independent of the initial distribution pattern of information among team members” (Mesmer-Magnus & DeChurch, 2009, p. 535). In their meta-analysis of seventy-two studies looking at team information sharing, Mesmer-Magnus & DeChurch (2009) discuss the moderating effects of discussion structure (high/ low) and member similarity on information sharing, with higher levels of structure and member homogeneity influencing an increase in information sharing behaviors. As Mesmer-Magnus & DeChurch (2009) discuss, teams are more likely to share information when “(a) all members already know the information (biased information sampling), (b) members are all capable of making accurate decisions independently
(informational independence), and (c) members are highly similar to one another (member similarity)” (Mesmer-Magnus & DeChurch, 2009, p. 543).

Information uniqueness during team decision-making presents significant challenges. Stasser & Titus (1987) discovered an unconscious bias for team members to discuss information that is common rather than unique. This bias is described as hidden knowledge. While there are often significant barriers to information sharing across organizations during a crisis or disaster event, there are also significant barriers for information sharing amongst individuals within teams delegated to respond to emergent crises. One such barrier to information sharing within teams, are hidden knowledge profiles. Hidden knowledge profiles represent a significantly interesting aspect of knowledge sharing in teams; previous studies (Jefferson, et al., 2004) have revealed that hidden knowledge profiles are operative in information sharing. These will be will be explored in the following section.

**Hidden Knowledge**

Given the type of complex and emergent events many crisis management and response teams face, team decision-making can be said to have an advantage over individual decision-making (Jefferson, et al., 2004). Teams allow for the allocation of specific tasks to go to specific team members, thus reducing labor, and allowing for greater expediency (Stasser & Titus, 1987). However, for the advantage of teams to be realized over that of the sole individual, appropriate sharing of individual information about the situation, so that other team members may update their Situational Awareness and mental model of the environment, must occur. It is often the case that individuals will have distinct knowledge from their team members, and that information is not always shared at appropriate times (or at all) (Stasser & Titus, 1987). These hidden knowledge profiles can have a dramatic effect on the outcomes of team decision-making. Stasser
and Titus (1987) state, “the way in which unshared information was distributed among members could significantly bias their pre-discussion preferences and that discussion in their groups rarely countered or corrected this initial bias” (Stasser & Titus, 1987, p. 82). Stasser and Titus (2003) discuss their 1985 study, which revealed that when participants were given partial information, they did not always share it, and as such, teams did not always make the optimal decision, instead teams tended to discuss common information over individually held information (Lu, Yuan, & McLeod, 2012).

Hidden knowledge profiles restrict information that is available to the whole team, diminishing a team’s ability to develop a common operational picture. “In a hidden profile, information that supports the optimal decision alternative is largely unshared, whereas information that supports the less desirable option is mostly shared” (Bowman & Wittenbaum, 2012, p. 296). Mesmer-Magnus & DeChurch (2009) go on to suggest that “less knowledge-redundant teams, precisely those teams who stand to gain the most from sharing information, actually share less information than do more knowledge-redundant teams. This redundancy effect reflects a divergence in what teams actually do (normatively) and what they should do in order to be maximally effective (prescriptively), and it has particularly meaningful implications for expert decision-making teams, like those employed for emergency response and medical decision-making (Burke, Salas, Wilson-Donnelly, & Priest, 2004),” (Mesmer-Magnus & DeChurch, 2009, p. 543).

In spatially distributed teams, the failure to share task salient information negatively impacted the development of team mental models (Jefferson, et al., 2004). Spatial location of teams—whether collocated or distributed—can create the difference between “knowledge convergence and knowledge divergence,” (Jefferson, et al., 2004, p. 649). However, this distinction is often overlooked in much of the literature, as there is a tendency to focus on teams in collocated spatial environments rather than those distributed in space (i.e. geographically) and
time (i.e. time zones). The added complexity resulting from the distribution of team members coupled with hidden knowledge, “can hinder performance on everyday cognitive tasks,” (Jefferson, et al., 2004, p. 649). This reduces a team’s ability to develop a shared operational picture of what is going on and what needs to be done. To emphasize the impact that hidden knowledge profiles can have on team decision making processes, in a meta-analysis review, Lu, Yuan, and McLeod, found that hidden profile groups were “8 times less likely to find the solution” than were groups possessing full information (Lu, et al., 2012, p. 54).

Further, time stress was found to have significant impacts on team performance in hidden knowledge conditions. For example, time pressure was found to impair team decision-making in hidden profile contexts (Bowman & Wittenbaum, 2012). Bowman and Wittenbaum (2012) present findings which suggest that time pressure decreases team discussion time, limits their discussion of decision alternatives and the actual amount of information that is shared amongst individual team members. However, increasing the saliency of and access to unshared information within the task improved both information sharing and decision quality (Bowman & Wittenbaum, 2012; Lu, et al., 2012).

Types of Teams

The nature of team composition can have an impact on the ability of a team to develop overall team cognition. For example, the challenges for the development of shared understanding inherent to ad hoc teams are different than those of co-located, long-term teams from those of geographically or virtually distributed teams. When seeking to understand teams, it is important to consider the nature of the teams that are being used, so that any adjustments can be made. In the following section, two different types of teams often encountered in emergency crisis
management will be examined: ad hoc teams, and distributed teams, with a specific look at the impact on team cognition.

**Ad Hoc Teams**

Ad hoc teams have emerged as a common type of team in a variety of situations, namely because they are flexible and adaptive relative to a specific context. “Ad-hoc teams consist of individuals brought together temporarily for the achievement of short term goals, who are likely to have little, or no previous experience of working together” (Pascual, Blendell, & Mills, 1997, p. 169). Importantly, ad hoc teams arise out of the needs of a situation, and team membership may span across organization, sectors, professions, etc. (Strater, Cuevas, Connors, Ungvarsky, & Endsley, 2008). As such, it is likely that team members will have had little to no experience working with one another (i.e. no previous relationship), divergent perspectives on the problem space, and little time to achieve mission goals. These issues can effect the development of team cognition, trust, and shared SA (Strater, et al., 2008). First, with ad hoc teams, the time available for the development of common ground and trust is very compressed, due to the typical nature of ad hoc teams as emergent, transient, and dynamic (Strater, et al., 2008). Second, an overarching shared goal is a common driver of ad hoc teams (Strater, et al., 2008). Because ad hoc teams do not typically receive the benefit of shared training, backgrounds, mutual trust typical of ‘traditional’ teams, they must negotiate any individual goals, agendas that may be present within the team setting. As many ad hoc teams may consist of members from different organizations, the negotiation of individual agendas can often create dissonance within the team (Strater, et al., 2008). Finally, ad hoc teams may not experience the same level of cohesion as long standing teams; it may be the case that operational knowledge is not shared across all members of the team.
as a result of transient team members, underlying goal conflict, or varying information exchange strategies (Strater, et al., 2008).

In response to many crisis type events, the use of ad hoc teams is commonplace. Teams are brought together for a specific purpose and for a small period of time. In order to solve an emergent problem such as a disaster type event, it requires the mobilization of often disparately composed teams, who have little or no prior experience with one another. The type of complex problem present within a crisis can put significant stress on team members to perform, coupled with a limited time to respond, which can impact the development of an ‘adhesive’ team cognition.

**Distributed Teams**

The advent of technology in our everyday lives has extended to the work that teams are asked to carry out. It has become commonplace that distributed, and often virtually distributed, teams are used for a variety of tasks; however there can be significant impacts on the development of team cognition resulting from the nature of using distributed and virtual teams which is not present in geographically co-located teams (Hinds & Mortensen, 2005). Distributed teams are defined as teams who are physically separated. This physical, geographical separation of team members leads to “structural and psychological” distance amongst team members (A.R. Wellens, 1978), affecting team member’s ability to develop a shared understanding of context, and which may be cognitively isolating (Connaughton & Shuffler, 2007, p. 404; Hinds & Mortensen, 2005). Virtual teams are mediated though the context of technology, and are typically distributed in some way.
Hinds and Mortensen (2005) discuss that issues such as the development of trust and the formation of unhealthy subgroups\(^2\) emerge for distributed teams during team coordination. Within distributed teams, intergroup conflict can be harder to mitigate and the formation of team mental models and shared situational awareness can be severely diminished, ultimately impacting team performance. As when teams are ad hoc in nature, distributed teams present significant challenges to the development of team cognition. In particular, the ability to develop a shared understanding of the operational environment is hindered by distribution of team members across geographical space. It may be difficult for team members to develop a shared mental model, or shared SA of the situation, as team members may not be receiving the same input, and thus be able to respond to the stimulus simultaneously (M. R. Endsley & Jones, 2011). Technology and collaborative tools, such as social networking platforms like Twitter, YouTube, and Facebook; instant messaging, video chat (such as Skype), or shared displays, help bridge these potential gaps within teams (Bolstad & Endsley, 2003) and are often used by teams to navigate across distributed spaces and communicate to large groups.

Discussion

While there are many things that influence team performance, much of current research can help uncover the ways in which team processes emerge and impact crisis response and

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\(^2\) Carton and Cummings (2012) define a subgroup as “a subset of team members that are each characterized by a form or degree of interdependence” (p.441). Subgroups emerge from the nature of a team’s composition. Research aimed at understanding the impact of team characteristics on team dynamics, processes and outcomes has identified the development of subgroups as having a strong impact on the overall performance of the superordinate group (the team as a whole). Subgroups form from naturally occurring ‘faultlines’ (Lau & Murnighan, 1998) that are contextually emergent depending on group configuration as well as external forces. Lau and Murnighan (1998, 2005), utilizing an analogy from geographic tectonic movements, propose a holistic approach to understanding diversity and its effects in teams by suggesting that there are hypothetical “break off” points for members of teams based on perceived differences in physical (demographical), imposed (managerial), mental (knowledge), or personality characteristics that could potentially lead to the development of subgroups within a team (Lau & Murnighan, 2005).
management. Crisis contexts present complex states of interactions, where multiple elements are often present that can have overarching effects on team performance. As crisis management and response is heavily reliant on teams, it is important to evaluate and examine the ways in which teams function to better inform future activities.

It is important to study teams within the situated context of crisis response and management. Team cognition emerges in context, and the ways in which teams create shared knowledge structures, such as a team mental model, or a shared understanding (SA) may by constructed by the perspectives and expectations of the individual team members. The development of a shared operational picture may be influenced significantly by the cultural context in which the team operates, whether multicultural or unicultural. Cultural processes of behaviors, norms, expression of dissent, and ability to communicate, may present significant contextual boundaries. Within the following section the role of culture in influencing and shaping cognition will be explored first in general, and then as it relates to teams and the crisis management domain.

In the event of a crisis, our responses prior to and during an event can make for an ineffective or effective response (Pearson & Clair, 1998). Oftentimes, human nature can lead to errors and failures (Reason, 1990, 2000), emerging into a chain of events that can make an event go from bad to worse. Crisis management seeks to plan for and mitigate the effects of a crisis on organizational, local, national and international scales. However, as Pearson and Clair (1998) suggest, “differentiating effective from ineffective crisis management has been more difficult in practice” than in theory (p.61). Oftentimes, effective handling of a crisis is multifaceted and complex. It requires effective planning and management throughout the emergence of an event. Crisis Management, however, often occurs at the level of an organization, or a government, but requires the efforts of individuals and teams to carry out responses.
Emergency crisis management involves responses to non-routine events (Faulkner, 2001). How people are able to respond is dramatically shaped by several elements throughout the cycle of response. It often requires the use of ad hoc teams to coordinate efforts for a limited time due to the unpredictable nature of most events (Schraagen, Huis in ’t Veld, & de Koning, 2010). Before discussing the ways in which to address the human element of crisis management and response, it is important to characterize the nature of crisis events.

**Crisis Events**

When characterizing a crisis event, there is often an element of surprise that is present. Even in natural disasters which are forecasted, the extent of the damage may be unexpected as was the case in the 2005 Katrina hurricane in New Orleans, or unknown as it was in parts of the Philippines after Typhoon Haiyan in 2013, where Tacloban was one of the hardest hit villages, but did not receive aid for days. A crisis event emerges when current systems break down or infrastructure fails to some extent following an unprecedented event. Often times this requires urgent response with little or incomplete information by teams and organizations.

Crises involve high risk (Carrithers, DeHart, & Geaneas, 1998; Shaluf, Ahmadun, & Aini, 2003) and, as such, require a high level of group coordination to reach the best outcomes. Regardless of the type of disaster, whether natural or man-made, preparedness, response, and reaction are key for the successful management of the situation. In crisis management situations, a sense of “urgency” is a central tenant required for managing complexities and unknown outcomes and making fast-paced decisions in a chaotic environment, (Farazmand, 2007, p. 149; Shaluf, et al., 2003).

The failures of systems, whether human, operational, technological, or of infrastructure makes a crisis apparent. In addition to natural disasters, a crisis can also emerge because training
failures, technological failures, decision and sense making failures, or other human error has occurred. A cascading crisis occurs when an event (or multiple events) escalates into a “domino effect” of damage causing failures across a system or series of systems (Veil, 2013). Richie (2004) describes three types of crisis events: 1) Immediate Crises; 2) Emerging crises; and 3) Sustained crises (Parsons, 1996; Ritchie, 2004). Each type of crisis, while maintaining the general characteristics of a crisis, are differentiated by varying time constraints (Parsons, 1996). In an immediate crisis, little or no warning exists; in an emerging crisis, the development of the crisis situation is slower, and occasionally mitigatable; finally sustained crises may unfold over time and last for weeks to years (Parsons, 1996; Ritchie, 2004, p. 671). Ritchie (2004) discusses “crises are difficult to resolve due to time pressure constraints, limited control and high uncertainty” (Ritchie, 2004, p. 672). This presents significant pressure on emergency crisis managers to resolve crisis situations.

Emergency crisis management itself presents a complex system. The emergency crisis environment is intense, unstable, and rapidly changing (Disaster Relief 2.0). Crises emerge “Out of short chains of events, often unpredicted and unexpected, but they develop with dynamic and unfolding events over months, days, hours, and even minutes. They disrupt the routine events of life and governance, disturb established systems, and cause severe anxieties; they produce dynamics that no one can predict or control,” (Ritchie, 2004, p. 672).

**Human Responses to Crisis Events**

In crisis response efforts, there exists a high necessity for group coordination, collaboration, and communication (described in table 4 below) when dealing with routine and non-routine responses, particularly for assessing an emerging environment, allocating resources
in an effective and appropriate manner, and carrying out specific roles. During team responses, there is a need to support these three factors.

Table 2-3: Description of Key Concepts in Crisis Management.

<table>
<thead>
<tr>
<th>Key Concepts</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination</td>
<td>Partnerships across organizations aimed at working towards mutual goals.</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Cooperation between levels of government (i.e. local, state, national), non-profit, private sector and the public to effectively respond to crises.</td>
</tr>
<tr>
<td>Communication</td>
<td>Interactive and social process which supports the needs of crisis management through its many stages.</td>
</tr>
</tbody>
</table>

During responses to and mitigation of a crisis event, responders must deal with significant amounts of information, which may often be imprecise or may be too overwhelming for individuals to process on their own (Faulkner, 2001, p. 136). Additionally, there is significant time decay on the information that may be collected leading up to and following a crisis event. As Manoj & Baker (2007) suggest in disaster settings, “sharing and dissemination of information is both critical and problematic, beginning with whom to trust in unfamiliar settings. Even after a level of trust is established, security issues must still be considered. Another important factor is the emotional volatility of the victim population. Fear, stress, and other emotions are aggravated by the lack of information” (p.52). The opportunity for misinformation is also high (Coppola, 2011; T. Endsley, Wu, & Reep, 2014) and can have detrimental effects on crisis response capabilities.

Response efforts require an understanding of processes involved in successful management of the complex state of affairs within emergency crises and the efforts of collaborative teams in dealing with the crises. Habermas, suggests that “[T]he crisis cannot be

3 From The Encyclopedia of Crisis Management
separated from the view-point of the one who is undergoing it” (Habermas, 1975, p. 58; from Pearson & Clair, 1998, p. 62). This is important and relevant to the examination of how individuals and teams respond to emerging crisis events (Manoj & Baker, 2007; Militello, Patterson, Bowman, & Wears, 2007), and has distinct implications for sense making, decision-making and overall response of both individuals and teams.

There is the potential for crises to emerge at any time, whether as a result of a natural disaster, terrorist attack, and political or regional conflicts. Crisis management can be very reliant on the perspectives and perceptions of individuals who are carrying out the response, or experiencing the event, which can be very dominant despite prior training. For example, several accidents and failures have been attributed to cultural misunderstandings and differences that have emerged during an event. A very recent example, the Asiana Airlines Flight 214 that crashed on a runway at the San Francisco international airport in July of 2013, has been attributed to a possible impact of the pilots’ Korean cultural background (Howard, 2013).

In local crisis events, there is a reliance on crisis management teams to respond to events, however, those responses are often shaped by the cultural context of the individuals who are assigned to them. Complications arise when cultural processes do not align well with objectives, or when teams engage in contexts outside of their native culture or with teams from different cultures, as is often the case in crisis management or disaster responses, which occur on an international and multinational level. As such, this study seeks to improve the understanding of how teams function, make complex decisions, manage risk, and improve outcomes in this complex environment with a unique consideration of the influence of cultural background on outcomes.
Culture in teams

As discussed by Strauch (2010), “differences in cognitive and perceptual styles can affect team performance by leading to differences in the way operators perceive and comprehend system cues, differences that can affect situation awareness and subsequent decision making” (p.251). If cultural norms dictate that subordinate team members do not overtly challenge authority or leadership, they may not share information, which may be pertinent to the task at hand (McHugh, et al., 2008; Strauch, 2010). As discussed in the section above, the Asiana Airlines Flight 214 which crashed on a runway at the San Francisco International Airport in July of 2013, presents an example of failure of a team to effectively respond to changes in their descent, which some researchers have attributed to a possible impact of the pilots’ Korean cultural background, which emphasizes that challenges to authority are not culturally attuned (Howard, 2013).

Culture provides a rich avenue by which to examine the aspects of cognitive differentiation amongst populations, as it shapes and structurally impacts cognition through an individual’s experience with cultural behaviors and practices. Culture has been a decidedly difficult concept to pin down; it has multiple layers, multiple dimensions, and is a dynamic aspect of human experience. Culture is often described as shared knowledge, values, and norms that are “transmitted from one generation to the next, which….includes the knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society,” (D'Andrade, 1981, p. 179; Donald, 2000; Triandis, 2001). However, it is important to note than some perspectives highlight culture as contextually emergent and dependent.

While often used for real world problem solving, multinational teams simultaneously provide an urgent area in need of study as well as a rich context for examining and understanding the role culture plays on cognition and team cognitive processes. Cultural differences in
processes, values, etc. most often emerge clearly in juxtaposition to other cultures and their processes of doing things. Additionally, multinational team composition requires management of conflict and the negotiation of shared team perspectives by all of the team members. Due to the extensive use of mixed cultural teams to carry out tasks in everyday life, it is important to understand processes of multinational teams.

Multinational teams will, by the nature of their composition, have many unique perspectives and team cohesion may be automatically limited as team members polarize towards the group of their social identity and, importantly, against members that do not share their identity (Shokef & Erez, 2008; Tajfel, 1982). When teams are composed of members with radically different decision-making processes, the potential for subgroup formation based on contentions of what that culture values in the decision making process increases, and leads to a reduction in team cognition, particularly when that diversity is not navigated effectively. A growing body of literature has focused on the issues and benefits that emerge from the use of multinational teams across operational contexts, as they have been increasingly used.

It is often the case in multinational teams that information about culturally defined team processes emerges, as cultural style and conflict and must be overcome to achieve team or mission goals. Poteet et al. (2009), describe fundamental errors that have emerged as a result of communications and shared context awareness failures between U.S. and U.K. military coalition teams, resulting in accidental fatalities by friendly fire (Poteet, et al., 2009). Many of these failures were discussed as resulting from communication failures and linguistic differences such as “acronyms, jargon, slang, and colloquialisms” which created ambiguity issues amongst the British and American military teams, and created issues for them in theatre (Poteet, et al., 2009, p. 3). Poteet et al. (2009) point out two important findings from their study: “(1) it is important to look at miscommunication in ‘context’. (2) It is crucial to have a shared common understanding of the context” (p.4). It is doubly important from an examination of these coalition teams to
realize the role that shared understanding of context plays in team performance and the ways in which culture emerges as a potential factor in influencing that development of common ground (Poteet, et al., 2009).

In multinational teams, aspects of cultural differences seem to create issues for the development of shared team mental models, particularly when members align on subgroup fronts, where they are unlikely to engage in appropriate coordination activities, or simply not know that they are missing anything at all. In multinational teams, the nature of team composition can have an enormous effect on group processes and outcomes, in which heterogeneity can affect trust, group commitment, communication and cohesion.

Additionally team situation awareness may be affected by attention differences amongst cultural populations, and what is viewed as a priority during team operation processes. If the focus of attention across cultural populations isn’t shared cognitively (i.e. where an individual from a ‘collectivist culture’ views a scenario ‘holistically’ and another from an ‘individualistic culture’ views only specific features, things could mistranslate and be missed), there will be an outcome on team SA and on overall team cognition (Kitayama & Uskul, 2011; Strauch, 2010). However the direct outcomes of these cognitive differences will need to be explored empirically.

One aspect of team cognition is knowledge sharing. Across cultures, these processes of knowledge sharing can be significantly different, and certain styles can inhibit or impact what kind of information is shared and how others view that information. For example, McHugh et al (2008) discuss that in many cultures, there is a desire to save face during group meetings. As such differing styles of sharing ideas and opinions emerge in team settings, where many ‘collectivist’ cultural groups will not outwardly challenge leadership or ideas of other team members in the ways in which are common in the US culture. “Members of East Asian and Asian Indian cultures, for example tend to avoid public conflict, disagreement, or criticism that may be
considered hallmarks of the divergence” process in US decision making teams (McHugh, et al., 2008, p. 148).

First hand evidence for the effect of culture on dynamic team processes becomes transparently clear from accounts of coalition teams, across many settings. Coalition teams are often used in the battlefield theatre, or in crisis situations (Phillips, Ting, & Demurjian, 2002). A coalition is often an alliance of international cooperation of “governmental, military, civilian, and international organizations,” (Gibson & Vermeulen, 2003). Working in coalitions is a pivotal aspect of U.S. operations and strategy (Phillips, et al., 2002, p. 87), and from reports of coalition teams in theatre (i.e. Military or NATO teams) anecdotal evidence presents a compelling case for the need to incorporate and include culture as an impacting factor on cognition, and importantly, on team performance (Poteet, et al., 2009). Even cultures that may typically be seen as culturally close or similar on some scales of cultural measures (i.e. Hofstede’s dimensions), such as the U.S. and the U.K., presented dramatic differences in the field for coalition teams seeking to work together (Phillips, et al., 2002; Poteet, et al., 2009). Where, during operations, teams felt the effects and the “repercussions of substantive differences,” which indicating that a deeper look into the role of culture, definitions and overall scope/ depth of impact of culture on cognition may need to be re-evaluated as a part of team interactions (Rasmussen, Sieck, & Smart, 2009).

McHugh et al. (2008) discuss that in team settings, when laying out a plan in Asian Indian cultures, the process of collaborative decision making occurred in more private interactions, as many of their Indian participants related that they would share their opinions and ideas about a project directly in private meetings with project leaders, as would other members of the team. At the actual meeting, the leader would announce the project direction. This is described as emerging from a desire for their leader to save face, and not have their authority out rightly challenged. In a US team decision meeting, team members out rightly challenge one another and voice their opinions at the meeting.
Additionally, McHugh et al. (2008) discuss an interesting finding about the nature of information sharing within teams, which suggests that while there is a more ‘collaborative’ emphasis within teams from collectivist societies, there exists also a lot of covert competition prevalent amongst team members (p.151). For example, McHugh et al. (2008) present findings from one interviewee, “…People tend to find out from each other how far along they moved in their goals. If I ask someone that, they don’t give me the true picture of where they are though. And they know I don't give the true picture of where I am either,” (McHugh, et al., 2008, p. 151).

**Culture in Collocated Teams**

Many findings from real-world cases suggest that culturally based norms can have an adverse effect on knowledge sharing amongst team members, reducing their overall situational awareness, and development of team mental models. For example, Strauch (2010) outlines a study from Helmrich (1994), which suggests that cultural factors may have been in play when a Colombian Aircraft crashed on approach to New York City due to fuel exhaustion in 1990. Airline personnel failed to clearly indicate the state of their distress to air traffic controllers (level of fuel tanks, which were at emergency lows) when asked to circle the NYC airspace. Despite the Captain issuing an emergency to one of his officers in Spanish, there were communication failures in indicating the severity of the fuel levels to the air traffic controllers, and the flight was not given priority. Information regarding the state of the plane, its fuel levels, and the urgency of its need were not properly conveyed by all parties, from the Captain speaking in Spanish, and the officer communicating in English the state of situation was not effectively shared with air traffic control, and as such the development of a shared SA model of the situation did not occur (Strauch, 2010). This example demonstrates one of the potential issues in a shared cognitive
picture of the problem space where culture is involved, in that in can also impact how people will react to a situation based on their cultural perspective.

Summary

Through our varied and engaged interactions with groups and teams within a variety of contexts, it becomes clear that many unique cognitive processes emerge across populations. In the context of Emergency crisis management, interactions across populations make it clear that the differences in situational interpretations, particularly across teams employed to deal with the wicked problems that they present to modern day society, can have a strong impact on outcomes. As such, understanding the role that culture plays within cognition of teams will allow for better understanding of best practices in dealing with crisis situations. How culture emerges as an influencing factor towards structuring cognition and influencing teams in crisis situations can help to mitigate failures by allowing for a greater understanding of underlying processes which shape actions, behaviors and decision making processes.
Chapter 3

Methods

In this chapter an experiment is described. It was conducted to evaluate cultural influences on team cognition and information sharing via mixed methods. To recap, in this study four primary research questions were explored:

RQ1: *What is the relationship between culture and the ways in which 1) National teams 2) Multinational Team a) share information; b) develop shared knowledge; c) Perform; and d) Interact in a crisis situation?*

RQ2: *How does the cultural composition of teams have an impact on information sharing behaviors during a crisis management simulation?*

RQ3: *In cases where uniquely held information (hidden knowledge) is present, how does the cultural composition of teams impact when and how teams share information during a task?*

RQ4: *How can a blended epistemological perspective be used to answer questions about the ways in which culture influence cognitive processes in teams during crisis situations?*

To test each of these research questions the *NeoCITIES* human-in-the-loop crisis management simulation, as described in this chapter, was used as a basis for evaluation. For the current research, several hypotheses will be tested. These are described in the following section.
Methodology

Research Foundations

This research proposes an innovative examination of team cognitive behaviors through an examination of culture in co-located teams within a scaled world simulation. This experiment utilizes concepts of team mental models to examine the formation of shared understanding of teamwork, taskwork, and temporality during crisis response amongst team members from differing cultural groups or the same cultural group in a co-located context. An additional goal is to assess processes of information sharing and the occurrence of team mental models.

The current study utilizes a mixed methods approach to evaluate the occurrence of team mental models and processes of information sharing in culturally diverse teams during a crisis response simulation. For this study, the use of a mixed qualitative and quantitative methods approach allows for the limitations of one epistemological perspective (positivist) to be addressed by another approach (Interpretivist) (Kaplan & Duchon, 1988). As suggested by Fritze (2004), “Mixed-Methods studies are a practical way of dealing with the complexity of real world settings by ‘borrowing’ the methods of the other paradigms to collect information and solve a problem” (p.3). This will allow for the examination of this problem space at a deeper level than offered by one approach alone.
In addition to the quantitative aspects of the study, several qualitative measures were collected. The current research will focus particularly on the role that culture plays across several populations during crisis response and coordination activities through qualitative exploration. Because culture is a highly complex and difficult concept to pin down, inclusion of a qualitative approach will allow for a richer understanding of the concept of culture as well as provide a novel mechanism by which to examine and measure the influence of culture in complex decision-making processes, such as the occurrence of team mental models. The nature of this study as an exploratory study makes the use of qualitative methods appropriate.

The objectives of the study are to report on:

1) Develop and validate measures of Team Mental Models in a context of diversity (composition) within teams

2) Present and assess a blended epistemological perspective in the study of culture in team cognition
Within the following sections, a mixed methods approach as discussed above is outlined. Following this, the processes and procedures, details of the experiment, hypotheses will be described. NeoCITIES will be employed with teams in a co-located context, which will be composed of members from a single culture or members from multiple cultures.

Overview: Mixed Methods Approach

In the current study a mixed methods approach to the exploration of teamwork, and a process to examine the way that culture emerges as a feature of human cognitive processes is described. Fritze (2004) notes, “the combination of methods within a single study provides a richer understanding of a topic,” (p.3). A mixed methods approach is deemed most suitable for the current project as it is rooted in an authentic real world problem space (Fritze, 2004) such as crisis response in which cultural ‘quirks’ can emerge to have significant impact on a teams’ ability to carry out work in multinational contexts. Furthermore, this type of research design is based on “the assumption that collecting diverse types of data best provides a more complete understanding of the research problem than either quantitative or qualitative data alone” (Creswell, 2014, p.19). Pragmatism reflects a distinct epistemological perspective inherent to mixed Methods research (Johnson & Onwuegbuzie, 2004). Where an empirical study from a positivist perspective seeks to “explain and predict by looking for regularities and causal relationships between variables,” the incorporation of interpretivism in the methodologies allows for the input of the multiple perspectives of the stakeholders to be included (Fritze, 2004, p. 3). Pragmatism focuses on the use of methods that are beneficial to a particular problem space, and “the goal of mixed methods research is not to replace either of these approaches [quantitative or
qualitative] but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies” (Johnson & Onwuegbuzie, 2004, p. 14).

The affordances of a pragmatic approach is especially important as it allows cultural diversity to be explored on its own terms rather than as an imposed construct, limited by dimensions and reductionist theories. Aligning with Mason’s (2006) position for mixed methods, the current research seeks to 1) Evaluate holistically the dynamics of each case to make comparisons at the “level of analysis”; and 2) Use a situated and contextual approach to understanding processes (p.16-17). Moreover, a mixed methodological approach will allow the researcher to “both generalize the findings to a population as well as develop a detailed view of the meaning of a phenomenon or concept for individuals” (Creswell, 2014, p. 20).

In conclusion, supported by the Living Lab Framework, discussed below (McNeese, Mancuso, McNeese, Endsley, & Forster, 2013), this study will present a blended epistemological approach, as a research study in two parts:

**Quantitative methods** will involve an empirical study. It will be a 2x2 factorial design, and will be discussed in greater detail in later sections.

**Qualitative methods** As suggested by Trauth and Jessop (2000) an Interpretivist epistemology “facilitate[s] deeper probing into the subtleties of context” (p.44). Qualitative methods involve an exploration of the role of culture in multinational and national teams during responses to a micro-crisis. This allows for “a deeper understanding of phenomena within its context, which may be used to inform other contexts” (Fritze, 2004, p. 3). An open-ended questionnaire and observation were used to elicit the constructed cultural realities of each participant across the empirical conditions.

As a concurrent mixed method procedural design (Creswell, 2003) both forms of qualitative and quantitative data were collected during the study and will be integrated for the overall interpretation of the results (presented in figure 3-2 below).
A mixed methods approach can be viewed as mutually supportive, in which one method can complement another (Trauth & Jessup, 2000, p. 45). The inclusion of such mixed methodology will allow for team members perspectives and mental models of the simulation task to be effectively explored in context. In the following section, the NeoCITIES simulation will be described in detail.
Overview of NeoCITIES 3.1

Since its inception nearly 10 years ago, NeoCITIES has been through several iterations and many thousand participants (Jones, 2006). The figure below (adapted from McNeese, et al., 2013) presents the design of each of these versions. Built from the ground up using web 2.0 technologies, NeoCITIES 3.1 is the most recent version of the emergency crisis management simulation. NeoCITIES 4.0 (or Team NETS) was developed in order to simulate cyber security attack type events and analyze the responses of teams in the abstract realm of cyber attacks such as transactive memory (Mancuso & McNeese, 2012) and provided data for several dissertations.

Within the NeoCITIES simulation, participants are assigned to teams of three and assigned to the role of Police, Fire, or HazMat. They are tasked with allocating resources (police cars, ambulance, bomb squad, etc.) to various emergency events in a virtual city. The simulation records observations of the timeliness and accuracy of their resource allocation responses, and transcripts of the text-based chat used to communicate with other team members. These chat transcriptions do not carry any unique personal identifiers (such as PSU user ID), but are simply labeled by the role the individual is playing in the simulation (“Police,” “Fire/EMS,” “HazMat”).

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
<th>Theories</th>
<th>Technologies</th>
</tr>
</thead>
</table>
| 1.0     | First version of NeoCITIES. Informed by original CITIES simulations and ethnographic study of emergency dispatch centers | • Team Mental Models  
• Situation Awareness  
• Stress and Mood | • Intelligent Group Interfaces  
• Fuzzy Cognitive Maps |
| 2.0     | Updated version of 1.0 with new technologies. Designed as a part of collaboration with Geo-Visualization researchers. | • Team collaboration  
• Situation Awareness | • Geo-Collaborative interface  
• Shared workspace |
| 3.0     | Streamlined previous simulations for experimental research. Greater emphasis on mechanisms to study varying aspects of team cognition | • Information Overload  
• Situation Awareness  
• Team Mental Models | • Collaborative Interfaces  
• Virtual Storytelling |
Living Lab Framework

The Living Lab Framework, developed by McNeese and colleagues (McNeese, et al., 2013), establishes the research approach that will be used within this study. Built on perspectives of ecological psychology, the living lab framework seeks to provide an integrative framework methodology across work domains. The living lab framework represents a multistep research process in which researchers can test realistic problems in controlled laboratory settings (McNeese, et al., 2013), as well as carry out laboratory tested results and implement them in the actual work environment. “While presented visually and described as a cyclical process, the Living Lab Framework is flexible enough that one can move between the components forwards, backwards, crosswise, or even perform them in conjunction with each other” (McNeese, et al., 2013). Presented in Figure 3 below, the Living lab framework seeks to integrate theory and practice through knowledge elicitation, scaled world simulations, ethnographic study and development of prototypes. It presents a problem-based approach through which the processes of practice and theory are integrated.

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NeoCITIES 3.1 simulation is used as a test bed for the living lab approach. It is a human-in-the-loop, scaled world simulation platform that has been used to study complex decision making in crisis response. NeoCITIES 1.0 simulation emerged from the CITIES simulation (A.R. Wellens & Eigener, 1988) through ethnographic study and knowledge elicitation research of 911 dispatch centers (I. S. Terrell, 2006; I. S. Terrell, McNeese, & Jefferson, 2004). Over the past ten years, several iterations of the NeoCITIES simulation have emerged. All have been centered on emergency crisis management type events, and have included features such as geovisualization, intelligence, and teams of teams.

In the past five years, a minimalistic user interface has been used to study distributed teams in crisis response scenarios (Hellar & McNeese, 2010). The simulation interface has the use of a chat console (D), and ways to keep track of one’s own as well as team members’ actions, the dispatch panel (E), the team monitor (A), the unit monitor (B), an event tracker (C), and a briefings panel (F) (Mancuso, Parr, et al., 2011).

Within the simulation, participants must interact with their team members to effectively respond to events. The scenarios were designed to present users with a dynamic environment, in

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which they would need to sort through a high information load to figure out what information is relevant. Additionally, different roles were provided with unique information and unique capabilities as well as shared information and capabilities (i.e. only the Fire role can dispatch fire engines; however all three roles can dispatch inspectors). Events are either classified as independent, in which only one team member is required to respond, and interdependent in which two members or all three members must coordinate their responses in a particular order and within a certain time frame (Mohammed, McNeese, Mancuso, Hamilton, & Tesler, 2012).

Figure 3-5: NeoCITIES Interface.
Experiment

Research Design

To best test the research questions, the current experiment used a 2x2 factorial design. Team composition (multiple or single nationality) is a between subjects design and Hidden Knowledge (HK) is a within subjects design. To account for ordering effects, the Hidden Knowledge variable was counterbalanced across both national and multinational teams. These ordering effects are documented in the Manipulations and Measures section, table 3-1 below.

Table 3-1: Experimental Design.

<table>
<thead>
<tr>
<th>Co-located Teams</th>
<th>National</th>
<th>Multinational</th>
</tr>
</thead>
<tbody>
<tr>
<td>HK Present</td>
<td>20 Teams</td>
<td>23 Teams</td>
</tr>
<tr>
<td>HK Absent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The facilities allowed for only one team per session. In general a maximum of three experimental sessions were held per day, meaning no more than three teams per day went through the experiment; however in the last week of data collection four experimental sessions were organized, meaning that no more that four teams per day participated in the experiment.

Manipulations and Measures

For the current experiment, two independent variables (IV) were manipulated. First, team composition was manipulated. Teams are composed of either multinational members (i.e. 3 members from different nations) or members of a single nationality (i.e. 3 members from the
U.S.). Second, a within-subjects independent variable of Hidden Knowledge Profiles for an event in each NeoCITIES scenario was manipulated.

**Nationality**

Teams were composed as either multinational or national teams. Multinational teams were composed of team members from multiple self-identified cultural groups. The teams in the national condition were composed of only team members from the US.

**Hidden Knowledge**

Hidden Knowledge profiles is a within subjects design. Hidden knowledge profiles were manipulated within the simulation scenarios. During the course of the scenarios, each of the team members was given access to unique information (via briefings), which contained information regarding the requirements of team response to a specific kind of event such as order of response, number of units, and timing (Mohammed, et al., 2015; Stasser & Titus, 1987). In this condition, team performance on the relevant event would be adversely affected if the team member did not communicate their hidden knowledge effectively. Hidden Knowledge profiles will be measured as either being present or absent within an event during the simulation performance tasks. In the non-hidden knowledge condition, team members will all be given the same information needed to solve the simulation scenario. The hidden knowledge condition was counterbalanced across each of the performance scenarios as well as the ordering of the scenarios. The counterbalancing is presented in Table 3-2 below.
Dependent Variables

Team Performance

Following each training and performance scenario, the NeoCITIES simulation presents the team with their team performance results for each event, and total scores for the scenario overall. An overall damage score and time score for each performance scenario was calculated out of the total damage possible (if no action was taken) (Hellar & McNeese, 2010). Within the simulation, overall team performance scores are objectively measured as a percentage of successfully completed interdependent tasks coupled with the time taken to complete the those tasks (Hellar & McNeese, 2010). Higher percentages are considered indicative of higher performance are require participants to respond to events in the correct order, with the appropriate number of resources and in an effective time. It also requires participants to prioritize their responses (a chemical explosion should be attended to before a trash can fire; however, the trash can fire should not be left unattended due to potential escalation) (Hellar & McNeese, 2010, p. 1030). For an more in depth examination of the scoring model, the event growth formula (A.R. Wellens & Eigener, 1988), see Hellar and McNeese (2010) for an extended discussion. For the purposes of this study, team performance was calculated as a percentage of completed events out

---

Table 3-2: Hidden Knowledge Condition Counterbalancing.

<table>
<thead>
<tr>
<th>First Scenario</th>
<th>Second Scenario</th>
<th>National n</th>
<th>Multinational n</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 No HK</td>
<td>Scenario 2 HK</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Scenario 2 No HK</td>
<td>Scenario 1 HK</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Scenario 1 HK</td>
<td>Scenario 2 No HK</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Scenario 2 HK</td>
<td>Scenario 1 No HK</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
of a total number of events. The following section reflects on the measures collected within the NeoCITIES simulation.

**Team Mental Models**

Team mental models emerge over time through the interactions of team members. As Mohammed et al. (2015) suggest, growing from individual cognitions, “TMMs are expected to converge over time through interaction and socialization… TMMs develop through processes such as communication, negotiation, and information sharing” (p.5). This allows for team members to understand how their roles coordinate, what the situation is, and negotiate unique perspectives so that a collective and shared understanding can emerge (Mohammed, et al., 2015). “Team effectiveness will improve if team members have an adequate shared understanding of the task, team, equipment, and situation” (Mohammed, Klimoski, & Rentsch, 2000, pp. 123-124). 

Team effectiveness, then relies on the effective coordination of a shared understanding amongst all team members of “what” (taskwork), “how” (teamwork) and “when” (temporal) in relation to a team activity (Mohammed, et al., 2015). In order to examine the occurrence of team mental models at the structural level, data collection via pairwise grids was used to look at these specific elements of team mental models (Mancuso, Hamilton, et al., 2011). The use of pairwise grid comparisons presents a good mechanism by which to examine the occurrence of team mental models in a diverse group of team members (i.e. the multinational team condition). Pairwise comparisons rely on the participant “to rate the similarity between pairs of concepts and statements,” which are supplied by the researcher (Mohammed, et al., 2010, p. 886). As a method, pairwise comparisons assess teamwork, taskwork, and temporality independently, and captures “declarative knowledge (knowledge of what)” (Lim & Klein, 2006; Mohammed, et al.,
2010, p. 885). For the current experiment, the teamwork and temporality aspects of the team mental models were examined.

Typically, the assessment of team mental model accuracy is engaged through the use of subject matter experts (usually three) who often are given the same measure as the participants (Mohammed, et al., 2010). The difficulty with this assessment of TMM accuracy is that it introduces a normative perspective, suggesting that there is only one correct team mental model to achieve high performance. However, it may be that there are “multiple equally good yet different mental models” (Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2005, p. 39; Rasmussen, et al., 2009).

As Mohammed et al. (2010) suggest, “the multidimensional nature of TMMs warrants the simultaneous use of multiple measures to comprehensively capture varied cognitive content,” (p.888). In addition to pairwise comparisons, the Team Member Schema Similarity (TMSS; Rentsch & Hall, 1994) measurement can be used to elicit the degree of team schema (shared team knowledge) overlap (McNeese, Rentsch, & Perusich, 2000). TMSS can be used to examine the levels at which relevant information is shared and understood by team members, through the components of team member schema accuracy and team member schema agreement (Rentsch & Klimoski, 2001). In TMSS, ‘Team Member’ refers to the individual level of the team; ‘Schema’ refers to the interconnected mental structures that help us organize and understand phenomena in the world around us; and ‘Similarity’ articulates that schemas will not be identical across team members, they will instead refer to the similarity or comparability of team related knowledge structures (Rentsch & Klimoski, 2001, p. 108). Rentsch and Klimoski (2001) describe team member schema similarity as “the degree to which team members have similar or compatible knowledge structures for organizing and understanding team-related phenomena” (p.108).

In its suitability for use as a measurement tool in the current study, Rentch and Klimoski (2001) found that lower diversity in team composition led to higher levels of shared team member
schema similarity. “Theorists have proposed at least three likely antecedents of team member teamwork schema agreement: team composition, team membership acquisition mode, and team size” (Rentsch & Klimoski, 2001, p. 108). Furthermore, life experience and team experience were found to impact the levels of team member schema agreement (Rentsch & Klimoski, 2001). Thus it is hypothesized that teams with higher levels of diversity (the multinational team condition) will have lower levels of shared schema similarity.

TMSS provides a good mechanism by which to assess schema congruency given the task environment that has been chosen for the experiment. The additional ease provided by the TMSS questionnaire (see Appendix C) to be distributed to participants as part of a larger questionnaire suits the experiment in timing and practicality.

Previous studies have shown that the construct of TMMs are covariates of Team performance, as suggested by Mohammed et al. (2000) “a common theoretical assumption is that they [team mental models] are precursors to effective team performance,” so the analysis will incorporate TMSS and TMM as covariates of team performance (p.125).

**Demographic survey**

A demographic survey was given to participants as a part of the questionnaire battery. This probed into demographic characteristics such as age, gender, level of education, and asked some preemptory questions regarding their cultural background and experience, such as languages spoken and amount of time lived in the U.S. for non-U.S. participants. A full list of questions is included in the Appendix C.
Other Measures

Several potential sources of variance were assessed within the current study and included in the analysis to control such variability. First, the population included in the study is that of diverse cultural backgrounds.

*Video game proficiency* (Number of hours spent playing video games) was recorded. As NeoCITIES is a computer simulation, it is important to control for any effects that video game playing experience may have on participant performance.

*Emergency Management experience* also recorded as a potential factor of influence on team processes of response. Participants were asked to list their previous experience in any emergency management profession (i.e. as a police office, fire fighter, health services worker, emergency manager, NGO volunteer, etc.) in number of years and months (total to be converted into months of experience) (Mohammed, et al., 2015). This was assessed at a team level as teams containing members with emergency management or military experience or not.

Participants

For this study, 135 participants (45 three person teams) were recruited at Pennsylvania State University. For their participation, subjects were compensated $20. In accordance with IRB regulations, participation in the research was voluntary; participants who did not wish to participate in the experiment were not recruited or asked to be a part of the current study. In order to coordinate the teams, an initial survey was conducted via Qualtrics (see Appendix B for a description of questions requested), in which interested participants were asked to provide identifying nationality information. Teams were then generated into one of the nationality conditions. Approximately 386 responses were received from the registration email/ link
provided during recruitment. Following this, an email with a link to a Doodle poll corresponding to their respective condition was sent to the participants requesting for them to register for a time and date convenient for their schedules. Approximately 135 participants made up the teams that actually participated in the experiment. The recruitment process is outlined in greater detail in the following section.

Recruitment

Participants for this study were recruited several different ways. Students were recruited via 11 undergraduate classes at the Pennsylvania State University, and via a mass email to both the graduate and undergraduate list-servers in the College of Information Sciences and Technology. In order to recruit International students for the study, an email was sent out to a list of 1,000 randomly generated international students via the Global Programs office on Campus, and a Facebook recruitment message went out to several International student groups on campus. Random, yet purposive sampling was used to recruit participants to this study (Creswell, 2007; Medin, Unsworth, & Hirschfeld, 2007). Purposive sampling is often used to select participants for inclusion in a study because they can “purposefully inform an understanding of the research problem and central phenomenon in the study” (Creswell, 2007, p. 125). In cultural research it is often better to select a sample that “is most likely to reveal some cultural process of interest” (Medin, et al., 2007, p. 619).

Equipment

Participants used the NeoCITIES 3.1 simulation, where participants were tasked with allocating resources (police cars, ambulance, bomb squad, etc.) to various emergency events in a
virtual city. For the current study, teams were made up of three participants, who were randomly assigned to the role of Police, Fire, or Hazardous Materials (HazMat).

**Setting**

Teams of three were seated together around a conference table in a laboratory space, pictured in figure 3-3 below (314 IST Building). Participants were randomly assigned to the roles of Police, Fire or Hazardous Materials. While NeoCITIES has historically been used as a distributed team simulation with console separated by partitions (pictured in figure 3-2 below), for the purposes of this experiment, the simulation was adapted to a co-located setting. Individual consoles (laptop computers) were arranged on one side of the table to facilitate a collocated team interaction. The conference table setup enabled team members to communicate verbally as well as through the chat window within the simulation with the aim of encouraging members to work through the simulation in a collaborative space. These sessions were voice recorded and transcribed for use in the data analysis. Only one team participated in the study at any given time.

![Distributed Team Lab Space](image)

Figure 3-6: Distributed Team Lab Space.

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*The distributed lab space was not used in the current study.*
Tasks and Procedures

Once assigned to conditions, participants were presented with multiple scripted emergency crisis events within the simulation. In order to successfully respond to each scenario, they must resolve the emergency events through coordination and communication with their team members, via resource allocation and timely responses. Scenarios were scripted to range in severity, requiring participants to effectively manage resource allocation.

Following successful completion of the IRB informed consent form, participants were asked to take part in an experiment lasting approximately two hours. The expected average duration of the experiment was 1 hour 45 minutes. However, owing to specific differences in teams the range of the actual duration of the experiment ran from 1 hours and 30 minutes to 2 hours.

Participants needed to work together with teammates to solve simulated crisis events. Each NeoCITIES scenario lasted 5-20 min, and each team participated in a total of 4. The process of the experiment and estimated completion times are listed in the table below:
Participants were asked if he or she has participated in a NeoCITIES simulation as part of the exclusion criteria. During recruitment, participants were prescreened for their participation in NeoCITIES, however this was included in the experimental procedure as a precaution. Following this, the participant was given informed consent for their review, as well as given their own copy of the informed consent form. For the experiment, participants were assigned a unique and random personal-identification number that is not associated with his/her respective University ID. This was their unique identifier throughout the entirety of the experiment. No personal information was attached to the data, which was stored on a secure server. During the instructional phase of the task, participants were verbally briefed about the nature and purpose of the experiment.

The training sessions were provided for participants to familiarize themselves with the experimental task. Two training sessions with two video presentations provided the participants with adequate experience and familiarization with the task. The video training materials included

<table>
<thead>
<tr>
<th>Description of Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consent collected, Instructions given</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Training Scenario 1</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Training Scenario 2</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Performance Scenario 1</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Performance Scenario 2</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Pairwise grids (Pen and paper)</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Demographic and Control variable Battery (Digital)</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Team Member Schema Similarity (Digital)</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Questionnaire (Digital)</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

Table 3-3: Description of Experimental Activities and Estimated Time.
information delivered through a voiced demonstration with Microsoft PowerPoint slides. The slides are specific for each role of an individual team member. Following the two training scenarios, each completed two performance scenarios that the participants will be asked to complete.

**Teams**

Participants were semi-randomly assigned to teams. As described above, teams were constructed through the recruitment process. Interested participants provided identifying nationality information via a Qualtrics survey (see Appendix B for a description of questions requested). Teams were then generated into one of the nationality conditions based on their responses. Approximately 386 responses were received from the registration email/ link provided during recruitment. Following this, an email with a link to a Doodle poll corresponding to their respective condition was sent to the participants for them to register for a time and date convenient for their schedules. For each experimental session, 4 people were recruited to account for attrition. In the event that all four volunteers came to the experimental session, the last person to arrive was asked to wait in the hall, excused from participation and separately paid for their attendance. Approximately 135 participants made up the teams that actually participated in the experiment. Participants were randomly assigned to roles, within their team.

**Culture, Context and Situated Cognition**

“Behavior must be attended to, and with some exactness, because it is through the flow of behavior--or, more precisely, social action-that cultural forms find articulation” (Geertz, 1973, p. 17).
As Geertz (1973) suggests, culture itself finds articulation through human processes. “Culture is best seen not as complexes of concrete behavior patterns—customs, usages, traditions, habit clusters—as has, by and large, been the case up to now, but as a set of control mechanisms—plans, recipes, rules, instructions (what computer engineers call “programs”)—for the governing of behavior” (Geertz, 1973, p. 44). In this way culture finds articulation within specific contexts, and acts as “a set of control mechanisms” for processes of behavior. Culture, essentially should be studied within a specific context, so that the flows of behavior attributable to and articulated as cultural can emerge.

Medin, Unsworth, and Hirschfeld (2007), articulate a perspective of culture that steps away from the traditional views of culture as merely “shared ideas and beliefs” (p.616). They suggest, “instead of considering cognitions to be embedded exclusively in individual minds, with “culture” as just one component of individual cognition, these theorists maintain that human cognitions should be properly situated in a cultural–historical context and “practical activity” (Cole, 1996; cf. Vygotsky, 1978)” (Medin, et al., 2007, p. 615). Medin et al. (2007) go further in their analysis of culture and suggest that it represents “distributed patterns of mental representations, their public expressions, and the resultant behaviors in given ecological contexts” (p. 618). In social settings, these “patterns of mental representations” interact with other patterns of mental representations, and through the medium of an ecological context, emerge (Medin, et al., 2007, p. 618).

By viewing culture as a dynamic process of cognition, in which it influences and is mutually influenced by cognition and the world, culture can also be viewed as contextually situated, where “cognitive labor may be distributed across both individuals and artifacts,” (i.e. team members and computer simulations) (Medin, et al., 2007, p. 617). Ed Hutchins, in *Cognition in the Wild* (1994), defines culture as a “human cognitive process that takes place both inside and outside the minds of people,” and proposes “an integrative view of human cognition in which a
major component of culture is a cognitive process…and cognition is a cultural process” (Hutchins, 1995, p. 354). It is important to refine our knowledge of the role of culture on cognition and then to assess the impact of culture on team practices. Through the inclusion of a situated, contextually dependent, naturalistic view of cultural cognitions, this study will seek to improve on our current understanding of team processes through the examination of the influence of culture on cognitive processes.

As in an ethnography, where the aim is often to construct a detailed description of “how a cultural group works and to explore the beliefs, language, behaviors and issues such as power resistance, and dominance” (Creswell, 2007, p. 70), the aims of the current study are to engage with the underlying cultural assumptions of individuals participating in the experiment and to explore further where areas of conflict and resolution of that conflict emerge in teams composed of multiple cultural perspectives (whether a national team or a multinational team). In phenomenological research, “the researcher identifies the "essence" of human experiences concerning a phenomenon, as described by participants in a study” (Creswell, 2003, p. 15). The aims of this aspect of the current research is to phenomenologically understand patterns and themes as they emerge across teams, rather than to apply preconceived expectations (such as dimensions of individualism and collectivism) to each of the participants.

Qualitative Study

The role of the qualitative interpretive portion of the research project was to examine the way that culture leads to differing interpretations of reality in relation to, among other aspects, teamwork, taskwork, and timework and to build a “rich, thick description” with no apriori lens (Geertz, 1973, p. 6; Trauth & Jessup, 2000). As Rentsch et al. (2007) explain, “One goal of phenomenological study is to understand the other’s meanings (understandings).
Phenomenological study is based on the notion that reality (including ones’ self) is subjectively defined,” (Rentsch, Gunderson, Goodwin, & Abbe, 2007, p. 26). The aim of this effort was to provide a portal through which participants can essentially explain culture from their own subjective viewpoint, and through such mechanisms, convey meaning as they find it in a situated context and within team processes. The use of qualitative methods such as ethnography and phenomenology facilitate the exploration and a “deeper probing of the subtleties of context,” (Trauth & Jessup, 2000, p. 44).

Specifically, it sought to take a prescriptive (as opposed to normative) role in understanding individual and unique perspectives in deriving meaning from the tasks carried out in the empirical study as well as examine the ways in which those perspectives coincides and overlaps with those of their team mates.

In order to establish a clear cultural profile, all participants were asked to fill out an open-ended questionnaire following the experimental task, which aimed to identify distinct perspectives that may play a role in team performances. The specific goals of this open-ended questionnaire were to elicit a richer understanding of the underlying cultural perspectives of each participant. In making the questionnaire open-ended, this shifts away from a strictly quantitative use of questionnaires, where participants can only choose from a select number of answers (Patton, 1987). Open-ended qualitative data proves profitable when collected and analyzed in conjunction with the empirical measures and manipulations (Creswell, 2014).

The aims of using this methodology is that it can closely align with a common practice in qualitative research, open-ended interviews, which provides a richness and depth to the information collected, while still fitting within the essence of the design of the empirical side of this study. Questionnaires will allow for the “capture of people’s experiences in their own terms,” (Patton, 1987, p. 10) and will effectively permit the world to be viewed from the perspective of the respondent.
While several downsides to the use of questionnaires become apparent—namely quality of response is predicated on the respondents writing ability (Patton, 1987), and command of the English language—an open-ended questionnaire will allow all participants to respond to questions at their own pace and depth and as part of a general questionnaire that will include measures from the quantitative portion of the study. The practicality of conducting 3 individual interviews in the time frame is contentious, given the length of the simulation and quantitative data collection. A questionnaire will create cohesion between the different aspects of the study without disrupting the participants.

Data Analysis

Thematic Analysis (Braun & Clark, 2006) “is a method for identifying, analysing [sic] and reporting patterns (themes) within data. It minimally organizes and describes your data set in (rich) detail” (p.79). Braun and Clark (2006) have emphasized a six-stage process of thematic analysis approach (table 3-4 below), which facilitates an interactive process from the researcher to familiarize themselves with the data and to systematically develop codes and themes across the whole data set. This approach allows for themes to emerge through a continuous engagement with the data, which can allow for refinement and extension of themes.
Team Communication

Team communication delivers an effective way to examine team cognition processes in context. Through deliberative assessment and evaluation of the content and flow of team communication data, an understanding of team processes and behaviors, successes and failures can emerge. Processes of information sharing were assessed qualitatively via the communication chat within the simulation. A combination of communication mediums (verbal and text based chat) was examined in this study.

An adapted coding scheme (based on Entin and Entin (2001)) was developed to assess several categories of information sharing through an examination of team communication data. In previous studies using this simulation (Hellar & McNeese, 2010; Mancuso, Hamilton, et al., 2011; Mancuso, Parr, et al., 2011), a communications coding scheme has examined information sharing on interdependent events regarding resources required, order, pacing, and deadlines, and others (ONR After action report, 2012).

Table 3-4: Braun & Clark’s Six Phase Thematic Analysis Approach.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description of phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Familiarizing ourselves with the data</td>
<td>Familiarize the data through repeated reading, forming initial ideas (initial pattern searching)</td>
</tr>
<tr>
<td>(2) Generating of initial codes</td>
<td>Label features of the data in a systematic way across the entire data set.</td>
</tr>
<tr>
<td>(3) Searching for themes</td>
<td>Review initial codes and identify preliminary themes</td>
</tr>
<tr>
<td>(4) Reviewing themes</td>
<td>Review preliminary themes to ensure that they made sense across the entire data set.</td>
</tr>
<tr>
<td>(5) Defining and naming themes</td>
<td>Continuously refine each theme, generate clear definitions and names for each theme</td>
</tr>
<tr>
<td>(6) Producing the report</td>
<td>Select compelling extract examples, conduct final analysis of selected extracts to create compelling story of the data.</td>
</tr>
</tbody>
</table>

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In the present study, a combination of quantitative and qualitative assessments was utilized to evaluate the communication structures present within each team. A coding scheme was iteratively developed in accordance with Braun and Clark (2006) thematic analysis process described above. Development of the thematic analysis started with a pre-existing coding scheme, (Pfaff, 2008) which was adapted from Entin & Entin (2001). Codes were further developed via an iterative review of observational data and through review of team communication transcripts. The primary researcher administered all of the experimental sessions and was also able to extrapolate observations of the team behaviors into codes. The coding scheme looked beyond task specific behaviors and also assessed interpersonal interactions, seeking to pull out biases, and cultural perspectives/ approaches within the context. This coding scheme is described in table 3-5 below.

Table 3-5: Description of Code Categories.

<table>
<thead>
<tr>
<th>Code</th>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Overall Rate of Comm.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Communications</strong></td>
<td>Total number of communications in the session. Described as number of words in the experimental session</td>
</tr>
<tr>
<td></td>
<td><strong>No communication</strong></td>
<td>Whole session with no communication</td>
</tr>
<tr>
<td>1.1</td>
<td>Information Request</td>
<td>Request for Information</td>
</tr>
<tr>
<td>1.2</td>
<td>Information Transfer</td>
<td>Sharing of Information</td>
</tr>
<tr>
<td>1.3</td>
<td>Unique Information Exchange</td>
<td>Exchange of information pertaining to the Briefings in the Hidden Knowledge condition</td>
</tr>
<tr>
<td>1.4</td>
<td>Clarifying Information</td>
<td>Clarifying questions on shared information</td>
</tr>
<tr>
<td>1.5</td>
<td>Identifying Resources</td>
<td>Identifying the resources that an event needs</td>
</tr>
<tr>
<td>1.6</td>
<td>Status update</td>
<td>Update on the status of a response</td>
</tr>
<tr>
<td>1.7</td>
<td>Timing Information</td>
<td>Dealing with timing aspects of response</td>
</tr>
<tr>
<td>1.8</td>
<td>Acknowledgement of error</td>
<td>Taking blame for the failure of an event, or failure to act for a particular event</td>
</tr>
<tr>
<td>2</td>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Action Request</td>
<td>Request for an action</td>
</tr>
<tr>
<td>2.2</td>
<td>Action Intention</td>
<td>Statement of intended action</td>
</tr>
<tr>
<td>2.3</td>
<td>Action Execution</td>
<td>Statement of action completion</td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>2.4</td>
<td>Action Uncertainty</td>
<td>Uncertainty on a course of action, musing aloud</td>
</tr>
<tr>
<td>2.5</td>
<td>Action Instruction</td>
<td>Direct instruction to send a particular resource by another player</td>
</tr>
<tr>
<td>2.6</td>
<td>Action Instruction request</td>
<td>Request for instruction on what to respond to a particular event</td>
</tr>
<tr>
<td>2.7</td>
<td>Action Suggestion</td>
<td>Suggested instruction to send a particular resource by another player</td>
</tr>
<tr>
<td>2.8</td>
<td>Action Justification</td>
<td>Justifying a chosen course of action</td>
</tr>
<tr>
<td>2.9</td>
<td>Action Agreement</td>
<td>Agreement with a particular action</td>
</tr>
<tr>
<td>2.11</td>
<td>Action disagreement</td>
<td>Disagreement with a particular action</td>
</tr>
<tr>
<td>2.12</td>
<td>Action Status</td>
<td>Request for the status of another person's actions/ confirmation of action completion</td>
</tr>
</tbody>
</table>

**Coordination Behavior**

<table>
<thead>
<tr>
<th>3.1</th>
<th>Request for coordination</th>
<th>Asking for assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>Coordinating action</td>
<td>Agreement to coordinate actions</td>
</tr>
<tr>
<td>3.3</td>
<td>Non Coordinating Action</td>
<td>Refusal to coordinate actions</td>
</tr>
<tr>
<td>3.4</td>
<td>Dyad</td>
<td>2 person action coordination</td>
</tr>
<tr>
<td>3.5</td>
<td>Triad</td>
<td>3 person action coordination</td>
</tr>
</tbody>
</table>

**Assessment**

<table>
<thead>
<tr>
<th>4.1</th>
<th>Evaluation of Performance</th>
<th>Assessment of team performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>Assessment of Behaviors</td>
<td>Assessment of actions (i.e. not sending the right resource; not sending resources in a timely manner)</td>
</tr>
<tr>
<td>4.3</td>
<td>Projection of future action</td>
<td>Discussion of modified future behavior</td>
</tr>
<tr>
<td>4.4</td>
<td>Assessment of Progress</td>
<td>Assessment of team progress in the simulation</td>
</tr>
</tbody>
</table>

**Other**

<table>
<thead>
<tr>
<th>5.1</th>
<th>Encouragement</th>
<th>Expression of positive sentiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>Acknowledgement</td>
<td>Expression of acknowledgement</td>
</tr>
<tr>
<td>5.3</td>
<td>Rapport Building</td>
<td>Non task related utterance, but which facilitates greater interpersonal sentiment</td>
</tr>
<tr>
<td>5.4</td>
<td>Insignificant Utterances</td>
<td>Non task related utterance, filler words</td>
</tr>
<tr>
<td>5.5</td>
<td>Clarification</td>
<td>Questions or requests for clarification on instructions</td>
</tr>
<tr>
<td>5.6</td>
<td>Criticism</td>
<td>Expression of negative sentiment</td>
</tr>
<tr>
<td>5.7</td>
<td>Dismay</td>
<td></td>
</tr>
</tbody>
</table>

**Simulation**
These codes have been adapted and extended from those described in Pfaff (2008), Entin & Entin (2001).

**Credibility (Internal Validity)**

The descriptions generated by the data analysis must “credibly represent the similarity and difference between the various interpretations of the individuals and groups who contributed the data” (Fritze, 2004). In order to establish the credibility of the findings, several steps were taken in order to ensure the Internal validity of the study. First, (1) rich, *thick description* (Geertz, 1973) of phenomena were compiled; Second, (2) *triangulation* of mixed methods (Mason, 2006) strengthens data analysis from multiple sources, which helped to provide a fuller picture of the phenomena; Third (3) *Peer debriefing* (Creswell, 2007; Fritze, 2004) throughout the data collection and analysis process allowed for refinement of interpretations and continuous iterative understanding to emerge.
**Rich thick description:** As a part of the triangulation process (Trauth & Jessup, 2000), observations of each team were recorded by the researcher. This is meant to support data collection in both the quantitative and qualitative portions of the study. Observations are in the form of extensive hand written notes with no personal identifying information to ensure the privacy of participants. These notes were included as part of the thematic analysis. The use of thick description allows for readers “to make decisions regarding transferability” (external validity) of the interpretations and findings as well as the use of this methodological design to explore key elements of interactions within teams and record their interpretations (i.e. the study of culture and the occurrence of team mental models in diverse teams) (Creswell, 2007).

**Triangulation:** Within the study, triangulation is employed as a method to ensure internal validity (credibility) of the data collected (Fritze, 2004). Triangulation of data collection ensures that a variety of methods and a variety of perspectives are obtained and utilized during data analysis (Creswell, 2007). Specifically, the collection of several quantitative measures (Team member Schema Similarity, overall performance) and several qualitative measures via the questionnaire, my personal observations of participants in context, and verbal communication and simulation chat data were examined.

**Peer debriefing:** An external check (Creswell, 2007) by a peer was used to challenge underlying assumptions and interpretations throughout the research process. This is both to keep interpretations in check and to iteratively assess my process by “bouncing ideas” off of a fellow peer.

**Reliability**

Reliability was obtained through the trustworthiness and consistency of data collection and analysis (Fritze, 2004). Guba and Lincoln (1989) propose a naturalistic framework of
qualitative inquiry, which seeks to establish research as defensible in terms of its *trustworthiness* (Fritze, 2004). In order to establish this reliability transparency is provided in the methods and processes of inquiry, collection and analysis. Through the use of a systematic approach to the analysis of the qualitative data, and the process of triangulation of the data from multiple sources and perspectives, establishes consistency within the findings.

In an effort to create transparency within research process, a detailed and rich description of the entire research process has been documented. In the presentation of the research, transparency with regards to any changes made to methodology was made in such a way that it can be “attributed to particular sources, or better insights,” also described as *dependability* (Fritze, 2004, p. 4). I will also make transparent my judgment processes (*confirmability*) when analyzing the data (Fritze, 2004). Additionally, *reflexivity was used as tool* throughout the analysis in order to effectively account for the biases of researcher’s prior experiences, and particularly of my own culture, and honestly represent these within the written paper. Reflexivity is often used by qualitative researchers to articulate their biases, perspectives and cultural experiences that they may bring to the study (Creswell, 2007). Reflexivity is a way of disclosing to the reader how those biases, perspectives and cultural experiences influence their interpretations within the written text (Creswell, 2007). Throughout the analysis, the researcher sought to identify any personal biases, perspectives, emotions and cultural experiences as well as engage in peer debriefing as a mechanism through which the researcher can strategically control and be aware of the impact of any biases she may hold.

**Hypotheses**

It is expected that the cultural composition of teams will have an impact on team communication strategies (i.e. multinational teams relying more heavily on text or voice
communications between conditions), occurrence of shared mental models amongst team members, and overall team performance; however the exact nature of that impact was explored qualitatively. Within the quantitative side of the study it may be possible to distinguish differences in TMM, performance, communications; however without the inclusion of an interpretive side to the study, attributing those differences to culture would be impossible. Furthermore, a blended methods approach will more effectively explore the phenomena in question.

It is expected that the cultural composition (multinational or single nationality) of teams will have an impact on overall team performance, with multinational teams having lower performance than national teams.

_Hypothesis 1:_ It is expected that team performance is lower in multinational teams than in National teams.

One of the primary focuses of this dissertation is to understand the manifestation of team mental models in co-located teams composed of members of multiple cultures as compared to members of just one nationality. Mohammed and colleagues (2010; 2015) find that higher overlap of team mental model similarity and accuracy are predictors for higher team performance. The development of a common operational picture requires that unique information be shared amongst team members so that a full understanding of the context may emerge for all team members. As suggested by Stasser and Titus (1987) there is an unconscious bias for team members to discuss information that is common rather than unique. The initial development of common ground is often minimized by diversity within a team; the bias to not share independently held information might be exacerbated within the multinational team condition. Additionally, the impact of cultural perspectives behind information sharing may also contribute to an unconscious bias against sharing unique information. This will limit the development of
mental models and influence overall team performance outcomes. It is expected that there will be lower convergence of shared team mental models in teams that are multinational in makeup.

*Hypothesis 2: Multinational Teams will have lower convergence of shared mental model similarity and accuracy.*

Additionally, it may be anticipated that another type of diversity, gender diversity, with teams may emerge as an impacting factor on the development of team mental models. Particularly given some of the socio culturally constructed perspectives of gender roles that may emerge as influential in the development of a shared team cognition.

*Hypothesis 3: If teams are composed of a somewhat unbalanced gender make up (i.e. two participants are from one gender, where the third is not), there is expected to be a negative impact on the development of team mental models.*

So that other team members may update their mental models of the environment, appropriate sharing of individual information about the situation must occur. As Mesmer-Magnus and DeChurch (2009) suggest, several factors influence how likely teams are to be open with their information sharing behaviors; with member similarity, sharedness of the information (information overlap), and informational independence as strong moderators of information sharing behaviors. As such it is anticipated that the levels of diversity within a team will impact the development of common ground, leading to a decrease in the amount of information that is shared between team members.
Hypothesis 4: The cultural composition of teams will have an impact on overall team communication, where multinational teams will communicate less than national teams.

For the advantage of teams to be realized over that of the sole individual, communication, coordination, and collaboration are necessary. How teams share information can significantly impact the outcomes of team performance. In the case of information that is uniquely held, it can be a considerable pitfall for a team when that information is not effectively communicated.

Hypothesis 5: In the hidden knowledge condition, multinational teams will share less often uniquely held information than national teams.

One of the secondary goals of this study is to examine the ways in which culture shapes and impacts cognition as it emerges in team contexts. Through the exploration of an individual’s experience with cultural behaviors and practices, this study will seek to examine several facets of cognitive differences amongst populations and relate it to team contexts.

Several possibilities are expected to emerge in the examination of culture. If teams are composed of a somewhat unbalanced cultural make up (i.e. two participants are from a shared cultural group, where the third is not), there is expected to be a negative impact on team performance (Earley & Mosakowski, 2000).

The largest negative impact of culture in polarizing multinational team members emerges when team members face moderate diversity within their team (Earley & Mosakowski, 2000). It seems that faultlines based on culture emerges much more strongly when there are few cultures present within a team, if there are only two, it is possible for there to be a polarizing effect in which individual members will side with their in-group as a part of the self-categorization and self identity process and identify other cultural groups as an out-group in the
face of moderate diversity (as described in Earley & Mosakowski, 2000; Polzer, Crisp, Jarvenpaa, & Kim, 2006). Moderately diverse teams were found to experience greater negative affect and lower performance than either homogenous or extremely diverse teams (Sanchez-Burks & Lee, 2007).

In cases where teams are homogeneous or extremely diverse, previous literature suggests that performance will be greater than moderately diverse teams as both will have a common operational picture of “team-specific norms, rules, and expectations” (Sanchez-Burks & Lee, 2007, p. 356). It is important to note that the processes of establishing those shared norms in the highly diverse teams will emerge over time through the negotiation of a new hybrid culture that adequately bridges the diversity in team processes. “As Earley and Mosakowski (2000) observed, in the absence of any common cultural work styles or schemas, these highly diverse teams created a hybrid culture in which team specific norms, rules, and expectations emerge,” (Sanchez-Burks & Lee, 2007, p. 356). Whether there will be enough time for the diversity to be effectively managed during the simulation is unknown; however if it is, it is expected that the highly diverse teams will perform as well as or better than the homogenous cultured teams. Strongly mixed cultural teams seem to be able to capitalize on the positive benefits of conflict (creativity, better solutions, better decision making), which are created from an exchange of diverse perspectives where moderately heterogeneous teams are not (van Vliet & van Amelsfoort, 2008; Warren, 2008).

**Hypothesis 6:** The level of member diversity (i.e. the number participants are from a shared cultural group) will influence outcomes of 6a) team performance; 6b) level of communication; 6c) information sharing; and, both 6d) teamwork and 6e) temporal 6f) Events mental model development
Summary

Within this chapter, a concurrent mixed methods research design was presented. The tasks and experimental procedures for data collection and analysis in both the quantitative and qualitative studies were outlined. This chapter was concluded by a presentation of the hypotheses being tested in the current experiment.

In the following chapters, the findings of this mixed methods study will be presented. Demographic information for the population sample is presented in the following chapter. Subsequently, the results from the Quantitative analyses are presented. This is followed by Qualitative analyses and results.
Chapter 4

Quantitative Results

In the following chapter, the results of the quantitative experiment in this study are presented. This chapter begins by outlining the descriptive data regarding research participants involved in the conduct of the study. Within the conduct of the experimental sessions, two types of teams are evaluated. At the level of National teams and Multinational teams, description information of the sample is provided.

The quantitative results section will report on the analysis of the team task performances, the results of the hypotheses tests, and will conclude with the examination of results pertaining to the team communications chat data.

Within the current chapter, I present results on:

1) Description of Participant Sample
2) Initial Pilot Study
3) Results of Overall Team Performance
4) Results of Team Performance on Interdependent Tasks
5) Analyses of Team Schema Similarity Metric
6) Analyses of Pairwise Grids
7) Analyses of Team Communications Data

Participants

Forty-five teams of triads (3 members each) participated in the study. Two teams were removed from the study due to prior participation of one member of each team in the NeoCITIES research simulation. A total of forty-three teams of triads are included in the current analysis. One hundred and twenty-nine students ranging in age from 18 to 47 participated in the current study. The mean age of participants was 21.38 (SD= 3.83). Eighty-four were male and forty were
female, one participant was non-binary female. Seventy-two participants were from the United States; fifteen were from India, twelve from China, and three from South Korea. Six students listed dual nationalities, with the US as one country listed, however all indicated that they had lived the majority of their lives in the United States (only one student lived for a year outside the US), hence they were included in the national team condition.

An additional breakdown of the nationalities of the remaining 33 participants is provided in Table 4-1 below.

Table 4-1: Description of All Participants Nationality.

<table>
<thead>
<tr>
<th>Country</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>68</td>
</tr>
<tr>
<td>India</td>
<td>15</td>
</tr>
<tr>
<td>China</td>
<td>12</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>Iran</td>
<td>2</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2</td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
<td>1</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1</td>
</tr>
<tr>
<td>Venezuela</td>
<td>1</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>1</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td>1</td>
</tr>
</tbody>
</table>
One hundred and six participants were undergraduates, and twenty-three were graduate students.

Table 4-2 represents the distribution of participant school years. Eighty-one participants came from a major within the College of Information Sciences and Technologies. The remaining 48 students came from various majors across the university.
Sixty-nine participants were in the International team condition. Sixty participants were in the National condition. A break down of the demographic information for both of these conditions will be given in the following sections.

### National Descriptive Statistics

A total of twenty teams participated in the national condition. Sixty students ranging in age from 18 to 29 participated in the current research. The mean age of participants was 20.52 (SD= 1.60). Nineteen were female, one was non-binary female, and forty were male. Fifty-five participants were from the United States. Six students listed dual nationalities, with the US as one country listed, 3 however indicated that they had lived the majority of their lives in the United States (only one student lived for a year outside the US), hence they comprised the national team. This is described in the table below via an asterisk (*) symbol.

<table>
<thead>
<tr>
<th>Year of study</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>11</td>
</tr>
<tr>
<td>Sophomore</td>
<td>31</td>
</tr>
<tr>
<td>Junior</td>
<td>32</td>
</tr>
<tr>
<td>Senior</td>
<td>27</td>
</tr>
<tr>
<td>Fifth-year Senior</td>
<td>6</td>
</tr>
<tr>
<td>First-year (Graduate)</td>
<td>11</td>
</tr>
<tr>
<td>Second year (Graduate)</td>
<td>3</td>
</tr>
<tr>
<td>Third Year (Graduate)</td>
<td>4</td>
</tr>
<tr>
<td>Fourth Year (Graduate)</td>
<td>3</td>
</tr>
<tr>
<td>Fifth-year (Graduate)</td>
<td>1</td>
</tr>
</tbody>
</table>

Sixty-nine participants were in the International team condition. Sixty participants were in the National condition. A break down of the demographic information for both of these conditions will be given in the following sections.
A total of two graduate students and fifty-eight undergraduate students participated. The year of study of those in the national condition are broken out in the table 4-4 below.

Table 4-3: Description of Participants in the National Condition.

<table>
<thead>
<tr>
<th>Country</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>55</td>
</tr>
<tr>
<td>Haitian American</td>
<td>1</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>1</td>
</tr>
<tr>
<td>US/ France*</td>
<td>1</td>
</tr>
<tr>
<td>US/ India*</td>
<td>1</td>
</tr>
<tr>
<td>India*</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

Table 4-4: Description of Year of Study of Participants in the National Condition.

<table>
<thead>
<tr>
<th>Year of Study</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>3</td>
</tr>
<tr>
<td>Sophomore</td>
<td>15</td>
</tr>
<tr>
<td>Junior</td>
<td>19</td>
</tr>
<tr>
<td>Senior</td>
<td>15</td>
</tr>
<tr>
<td>Fifth- year Senior</td>
<td>6</td>
</tr>
<tr>
<td>First-year (Graduate)</td>
<td>1</td>
</tr>
<tr>
<td>Second year (Graduate)</td>
<td>1</td>
</tr>
<tr>
<td>Third Year (Graduate)</td>
<td>0</td>
</tr>
<tr>
<td>Fourth Year (Graduate)</td>
<td>0</td>
</tr>
<tr>
<td>Fifth- year (Graduate)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>
**Multinational Descriptive Statistics**

A total of twenty-three teams participated in the multinational condition. Sixty-nine students ranging in age from 18 to 47 participated in the current research. The mean age of participants was 22.13 (SD = 4.92). Twenty-five were female, and forty-four were male. Thirteen participants were from the United States, fourteen from India, twelve from China, three from South Korea, an additional breakdown of the nationalities of the remaining 27 participants will be provided in table 4-5 below.

Table 4-5: Description of Country of Origin for Multinational Team Condition.

<table>
<thead>
<tr>
<th>Country</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>13</td>
</tr>
<tr>
<td>India</td>
<td>14</td>
</tr>
<tr>
<td>China</td>
<td>12</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>Iran</td>
<td>2</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2</td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
<td>1</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>1</td>
</tr>
<tr>
<td>Venezuela</td>
<td>1</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>1</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td>1</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>1</td>
</tr>
</tbody>
</table>
Twenty participants were graduate students and forty-nine were undergraduate students.

The year of study of those in this condition are broken out in the table 4-6 below.

Table 4-6: Description of Year of Study of Participants in the Multinational Condition.

<table>
<thead>
<tr>
<th>Year of Study</th>
<th>Participants (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>8</td>
</tr>
<tr>
<td>Sophomore</td>
<td>16</td>
</tr>
<tr>
<td>Junior</td>
<td>13</td>
</tr>
<tr>
<td>Senior</td>
<td>12</td>
</tr>
</tbody>
</table>
Video Game Experience

Prior experience with video games was also recorded as a control. Below are the descriptions of typical video game experience by the participants.

Table 4-7: Video Game Experience.

<table>
<thead>
<tr>
<th>Hours/ Week</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Hours/ week</td>
<td>51</td>
</tr>
<tr>
<td>1-2 Hours/ week</td>
<td>27</td>
</tr>
<tr>
<td>3-4 Hours/ week</td>
<td>17</td>
</tr>
<tr>
<td>5-6 Hours/ week</td>
<td>10</td>
</tr>
<tr>
<td>7-8 Hours/ week</td>
<td>9</td>
</tr>
<tr>
<td>9-10 Hours/ week</td>
<td>2</td>
</tr>
<tr>
<td>More than 10 hours/ week</td>
<td>13</td>
</tr>
</tbody>
</table>
Crisis Management Experience

Only thirteen participants (10%) in the current study had any previous Crisis Management experience. This experience ranged from CPR training to boy scouts, social media analysis for the local Emergency operations center (EOC), volunteer fire fighter, an EMT, and Army- ROTC training. One participant served for 20 years in the Brazilian Military. The remaining 90% of participants reported no previous crisis management experience. For analysis, teams were categorized by the number of participating members (0, 1, 2, or 3 team members) with any crisis management experience. Two teams of the 43 included in this sample had two team members with some crisis management experience. Eight teams had one team member with some crisis management experience, the remaining 33 teams had no members with any crisis management experience and no teams had three team members with crisis management experience.

Quantitative Analysis

Pilot Study

Five additional teams (N=15 participants) participated as a pilot study. This pilot study served as a proof of concept for the experiment, and tested materials and experimental layout prior to the primary study. Three National teams (Mean age= 19.5, 1 female) and two Multinational teams (Mean Age=22.3, 4 females) made up the sample. No formal analyses were run on the pilot study participants, however several adjustments to experimental protocol were carried out following observations and generalized evaluations of questionnaire responses. From this pilot study, a few minor changes were made: primarily the use of a shared “master” display of the simulation was initially introduced on a large monitor to serve as a shared reference point
for participants. However, it was observed that no participants utilized this feature (no glancing to it, no verbal references, etc.) and so it was viewed as an unnecessary addition to the current experiment. Second, the pilot study served as a conceptual testing for the use of verbal communication by participants rather than distributed communications. It was observed that the simulation was conducive to verbal communication by participants. Lastly, some small changes were made to the questionnaire to edit for question clarity in both participant groups. No pilot study data was included in the main study analyses.

Quantitative Analyses

Three evaluations of team performance were analyzed. Multinational and National team differences were evaluated for overall team performance and interdependent event performance, as well Hidden knowledge event performance. Following this, a more thorough analysis of the measures of team mental models is presented. This chapter concludes with an analysis of team communications.

Overall Team Performance

A linear model was constructed examining the affect of several factors on team performance as a function of the percentage of completed events across the two performance scenarios (Winter, 2013). To conduct the linear mixed effects model, the statistical packages R (RCoreTeam, 2016), including lme4 (Bates, Maechler, Bolker, & Walker, 2015) were used to analyze predictors of team performance including amount of crisis management experience and team average video game hours played (controls), team type, Gender, hidden knowledge, team mental models. In this model fixed effects were hidden knowledge, team type and scenario
number and were included with interaction terms within the model. The intercept of Team ID, and scenario number were included as random effects. Residual plots did not reveal any obvious deviations from homoscedasticity or normality. Table 4-8 below was generated via the ‘sjPlot’ package in R (Lüdecke, 2016).
Table 4-8: Linear Mixed Effects Model for Predictors of Team Performance.

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Team Performance (% Completed)</th>
<th>Team Performance (% Completed)</th>
<th>Team Performance (% Completed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Conf. Int.</td>
<td>p-value</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.89</td>
<td>0.86 – 0.92</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Team Type</td>
<td>0.04</td>
<td>0.02 – 0.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Team EMC Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Video Game Hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hidden Knowledge Present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork TMM Similarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork TMM Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporal TMM Similarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporal TMM Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events TMM Similarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events TMM Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMSS Congruence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMSS Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team ID</td>
<td>0.0003</td>
<td>0.017</td>
<td>0.0001</td>
</tr>
<tr>
<td>Scenario Number</td>
<td>0.0003</td>
<td>0.071</td>
<td>0.0003</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.326</td>
<td></td>
<td>.309</td>
</tr>
</tbody>
</table>

Model 1 (F (1, 85)=21.44. p<.001); Model 2
**Team Type**

The main effect of team type (national or multinational) on performance was found to be highly significant ($t=4.37$, $p<.001$) across all models, where national teams ($M=0.928$, $SD=0.08$) performed significantly better than multinational teams ($M=0.853$, $SD=0.07$). As anticipated in Hypothesis 1, team performance differed as a function of nationality composition of the teams, thus the null hypothesis is rejected.

![Boxplot Comparison of National and Multinational Team Performance](image)

**Figure 4-1:** Boxplot Comparison of National and Multinational Team Performance.

An additional analysis for team diversity as a function of team composition (teams were homogenous, moderately diverse or completely diverse) revealed no significant difference for team performance ($F(2, 85)=0.65$, $p=0.51$).
**Video Game Experience**

A linear mixed effects model was run to assess the average team video game hours as a predictor of team performance. An ‘average team video game hours’ measure was developed by taking the average video game hours played across all three team members. This score was calculated by taking the higher number in the range that participants responded to in the questionnaire. It was not found to be a significant predictor of team performance across the sample or in interaction with team type (National or Multinational) (see table 4-8).

**Emergency Crisis Management Experience**

A linear mixed effects model (discussed in table 4-8) revealed no significant effects of crisis management experience on team performance, however there were slight trends for teams with two members with crisis management experience to have slightly higher performance than those who had one member or no members, and for team members with one member with crisis management experience to slightly perform better than those teams with no members with crisis management experience.

**Interdependent Event Performance**

A logistic regression analysis using the statistical package R (RCoreTeam, 2016) was conducted to predict the team performance of 43 teams on interdependently oriented tasks (those events requiring all three participants to respond) using as predictors whether one of the events required hidden knowledge to respond, team type (national or multinational), and scenario number (one or two). In scenario 1, 21% of events were classified as interdependent. In scenario
2, 27% of events were classified as interdependent. The rest of the events in each scenario required a dyad (2 person) response or single person response.

A Hosmer and Lemeshow goodness of fit test revealed (Chi-squared = 7.672e-15, df = 6, p-value = 1) indicating that the model is well fit.

While the Hidden Knowledge condition (having a hidden knowledge briefing present within the scenario or having the same briefing shared across all members), team type, and scenario number were not by themselves significantly predictive of team performance on interdependent events, there were several interaction effects of note.

Table 4-9: Team Performance on Interdependent Events.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$ (SE)</th>
<th>z-value</th>
<th>Lower Odds Ratio</th>
<th>Upper Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.81(0.35)*</td>
<td>2.34</td>
<td>1.17</td>
<td>2.25</td>
</tr>
<tr>
<td>Hidden Knowledge Condition</td>
<td>-0.21(0.51)</td>
<td>-0.4</td>
<td>0.29</td>
<td>0.81</td>
</tr>
<tr>
<td>Team Type</td>
<td>-0.75(0.52)</td>
<td>-1.4</td>
<td>0.17</td>
<td>0.48</td>
</tr>
<tr>
<td>Scenario Number</td>
<td>0.34(0.48)</td>
<td>0.71</td>
<td>0.55</td>
<td>1.41</td>
</tr>
<tr>
<td><strong>Hidden Knowledge Condition x Team Type</strong></td>
<td>1.61(0.78)*</td>
<td>2.05</td>
<td>1.09</td>
<td>5.0</td>
</tr>
<tr>
<td>Hidden Knowledge Condition x Scenario Number</td>
<td>1.02(0.72)</td>
<td>1.4</td>
<td>0.69</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Team Type x Scenario Number</strong></td>
<td>3.66 (1.18)**</td>
<td>3.1</td>
<td>5.26</td>
<td>38.9</td>
</tr>
<tr>
<td><strong>Hidden Knowledge Condition x Team Type x Scenario Number</strong></td>
<td>-4.3 (1.47)**</td>
<td>-2.9</td>
<td>0.0005</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Note: $p<.10, *p<.05, **p<.01, ***p<.001$

**Hidden Knowledge Condition x Team Type**

The interaction between Hidden Knowledge Condition and Team Type yielded a significant interaction effect ($\beta$ = 1.61, SE=0.78, p<.05). For interdependent events, both teams...
were impacted by the presence of a hidden knowledge; Multinational teams were more affected than National teams.

Figure 4-2: Interaction Effect of Team and Hidden Knowledge Condition on Mean Team Performance.

*Team Type x Scenario Number*

The interaction between Team Type and scenario number yielded a significant interaction effect ($\beta= 3.66$, SE=1.18, p<.01) as a function of team performance on the interdependent events in each scenario. Indicating that national teams performed much better on scenario 2.
A three-way interaction between Hidden Knowledge Condition, Team Type, and Scenario Number was significant ($\beta = -4.3$, SE=1.47, $p<.01$). National teams performance greatly differed between scenarios that had hidden knowledge compared to when they did not. Performance by both teams in both scenarios was impacted by the presence of hidden knowledge.

Figure 4-3: Interaction Effect of Team and Scenario Number on Mean Team Performance on Interdependent Events.
Predictors of Performance on Hidden Knowledge events

A logistic regression analysis was conducted to predict the team performance of 43 teams on only the hidden knowledge event (completion or failure of those events requiring unique information from all three participants to respond effectively) using as predictors whether teams were provided with hidden knowledge in the condition, team type (national or multinational), and scenario number (one or two). No significant predictors of performance on the hidden knowledge task were found. A Hosmer Lemeshow goodness of fit test revealed that the model was a good fit (Chi squared = 1.0376e-07, df = 6, p-value = 1).
This model shows no significant predictors for how teams actually performed on the hidden knowledge event (i.e. whether they completed it successfully or failed it). However, the two previous models suggest that the presence of a hidden knowledge event in a given scenario was in fact a predictor for how well a team did across the events in the scenarios that were classified as interdependent (i.e. requiring all three team members to respond). One possible explanation for this is that while poor performance on the hidden knowledge task does not directly impact performance on other events in a scenario, it will however serve as a distraction throughout the rest of the scenario, and uses time and cognitive energy to solve it when the hidden knowledge information is not effectively shared or utilized. Teams will spend more time trying to solve that event, taking away from their ability to solve the other events.

**Team Member Schema Similarity (TMSS) Measure**

Fourteen measures of teamwork were rated by each participant, assessing their perspectives on the importance of various factors in teamwork. This metric was adopted from...
(Rentsch & Hall, 1994; Rentsch & Klimoski, 2001), and delivered via an online questionnaire (Connors, 2006). Each participant responded using a seven-point Likert scale rating the level of importance (ranging from (1) “not at all important” to (7) “extremely important”) of a factor of teamwork. Participants first completed ratings for their own perspectives of teamwork (a self measure; see Appendix C), and then for how they believed both of their other teammates viewed teamwork (two partner measures; see Appendix C). Participants completed questions in the same order for themselves and their two teammates. Who was designated “Partner 1” and “Partner 2” was chosen by the participants themselves, as participants were asked to designate which team member partner they were referring to by selecting the team mates role (fire, police, hazmat) prior to filling out the questionnaire. Missing values were generated via a construction of a linear model that allowed estimation of the missing values based on the other responses of the 2 participants for that section.

TMSS Congruence, measured as the overlap of responses for the “self” perspectives of teamwork for each dyad (A:B; B:C; C:A) within a team was calculated using the sums of the Euclidean Distances between each of the dyad pairs. Higher numbers indicate greater distances between team members’ responses and a lower overall team accuracy for the TMSS metric. A score of zero represents the best possible score. The Euclidian Distance formula (Barrett, 2005) is represented as:

$$d = \sqrt{\sum_{i=1}^{v}(p_{1i} - p_{2i})^2}$$

TMSS Accuracy was measured as the overlap of responses between each person’s perceptions with their partners’ ratings of teamwork as compared to that partner’s actual ratings. Perspectives for the overall responses for each team member were aligned (i.e. Partner 1 = Police
role; Partner 2=Fire role; Partner 3= Hazmat role) and compared against the “self” responses for
each team member role for each of the 14 measures of teamwork. The Euclidian distances
between each dyad pairing (A:B; B:C; C:A) were calculated, and the average of those Euclidean
distances was taken to create a single “accuracy score” for each team. Higher numbers indicate
greater distances between team members’ responses and a lower overall team accuracy for the
TMSS metric.

TMSS Analyses

TMSS Congruence

Following the calculation of average Euclidian Distances, a linear model was run for the
TMSS congruence measure. To assess whether there were discernable differences between male
and female teams on TMSS congruence, a variable measuring the percentages of females on a
team (0%, 33%, 66%, 100%) was included as a predictor of the occurrence of congruent TMSS.
There were no differences in congruence of TMSS in all male teams and all female teams \( t (39)=
-1.68, p=.09. However, non-linearities may be present as a fraction of mix of males and females
on a team in comparison to all male and all female teams. In assessing the levels of diversity in a
team and its impact on the occurrence of shared schema similarity, the level of gender diversity
(‘gender composition’) was coded as mixed and uniform to assess the impact of gender diversity
within teams (i.e. 2 males, 1 female or 2 females, 1 male) in addition to the impact of national
diversity. All female and all male groups are treated equally as homogenous, where both
combinations of gender heterogeneity are considered mixed.

A two-sample t-test revealed no significant team difference between multinational and
national teams for TMSS congruency \( t (41)=0.08, p=0.94). The level of national diversity on a
team was assessed at a level beyond the team type diversity, including no diversity (completely homogenous), moderately diverse (two team members of the same nationality), and completely diverse (completely heterogeneous) in assessment of hypothesis 4 (described as ‘team diversity’).

A linear regression model was calculated to predict TMSS congruence based on the level of team diversity and gender composition. No main effects of team diversity ($F (2,37)= 0.78, p=0.38$) or gender composition ($F (1,37)= .24, p= 0.22$) were found to be significant predictors of TMSS congruence. A significant interaction effect between the level of team diversity and gender composition ($F (2,37)= 4.20, p= 0.006$) was found to be a significant predictor of TMSS congruence. The congruence of TMSS across teams was significantly influenced by the moderate levels of team diversity in combination with singled gendered teams, which created greater distance in overall congruence of “self” measures of teamwork in the TMSS measure. This supports hypothesis 4d, and the null is rejected.

**TMSS Accuracy**

Following the calculation of Euclidian Distances, a linear model was run for the TMSS Accuracy measure. To assess whether discernable differences between male and female teams on TMSS accuracy, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) was included as a predictor of the occurrence of TMSS accuracy. There were no differences in accuracy of TMSS in all male teams and all female teams ($t (39)= .97, p=.33$). The levels of diversity in a team and its impact on the occurrence of TMSS accuracy were assessed at the level of gender diversity (‘gender composition’) was coded as mixed and uniform to assess the impact of gender diversity within teams (i.e. 2 males, 1 female or 2 females, 1 male) in addition to the impact of national diversity. All female and all male groups are treated equally as homogenous, where both combinations of gender heterogeneity are considered mixed.
A two-sample t-test revealed no significant team difference between multinational and national teams for TMSS accuracy, \((t(41)=1.4, p=0.17)\). The level of national diversity on a team was assessed at a level beyond the team type, including the levels of no diversity (completely homogenous), moderately diverse (two team members of the same nationality), and completely diverse (completely heterogeneous) in assessment of hypothesis 4 (described as ‘team diversity’).

A linear regression model was calculated to predict TMSS accuracy based on the level of team diversity and gender composition. A main effect of gender composition \((F(1,37)= 7.83, p=0.005)\) was found to be a significant predictor of TMSS accuracy. Uniformly gendered teams had higher levels of TMSS accuracy than mixed gendered teams. A main effect of team diversity \((F(2,37)= 2.93, p=0.10)\) was not significant. There was no significant interaction effect between the level of team diversity and gender composition.

Table 4-11: Description of Main Effects on TMSS Accuracy.

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>Mean Sq.</th>
<th>F</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Composition</td>
<td>1</td>
<td>84.25</td>
<td>7.83</td>
<td>.005</td>
</tr>
<tr>
<td>Team Diversity</td>
<td>2</td>
<td>63.53</td>
<td>2.93</td>
<td>.10</td>
</tr>
<tr>
<td>Gender Composition X Team Diversity</td>
<td>2</td>
<td>13.92</td>
<td>1.29</td>
<td>.26</td>
</tr>
</tbody>
</table>

Pairwise Grid Comparisons

Similarity

Team mental model (TMM) similarity was measured as the overlap of responses of all three respondents’ perspectives in each pairwise grid (Appendix D). As above in the TMSS, the Euclidian distances between each dyad pairing (A:B; B:C; C:A) were calculated for each of the comparisons. The average of those Euclidean distances were then summed to create a single “similarity score” for each team. In this model, higher scores indicate a greater distance between
responses and lower ones indicate more convergence, indicating higher levels of similarity. A Linear model was created for each concept being evaluated: teamwork TMM similarity and temporal TMM similarity, as well as relatedness of events TMM similarity.

Accuracy

In assessing whether a team had a “good” mental model, common practice (Mohammed, et al., 2010) is to compare teams comparison ratings to a set of expert paired comparison ratings (typically 3) to assess the accuracy of the team’s mental model. Averages of three expert responses were generated (experts here are defined as 3 persons, one being the programmer of the system and as well as the primary researcher, and the third an experienced NeoCITIES researcher, who are highly familiar with the NeoCITIES simulation and the interrelatedness of concepts within the simulation). The Euclidean distances of every participant’s response on each pairwise grid concept were calculated in relation to those averages of expert responses. A team score was generated as the sum of each of the three participant’s Euclidean Distance to those expert averages. In this model, higher scores indicate a greater distance between responses and lower ones indicate more convergence, indicating higher levels of accuracy. A Linear model was created for each concept being evaluated: teamwork TMM accuracy, and temporal TMM accuracy, as well as relatedness of events TMM Accuracy.
Teamwork TMM

Similarity

A linear regression model was run on the pairwise grids for teamwork TMM similarity. A two-sample t-test revealed no significant team difference between multinational and national teams for teamwork TMM similarity, \( t (41)=1.04, p=0.3 \).

To assess discernable differences between male and female teams on TMM similarities, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) was included as a predictor of the occurrence of TMM similarity for teamwork. There were no differences in the level of TMM similarities of teamwork in all male teams and all female teams \( t (39)=-0.66, p=0.51 \). The linear model revealed that team diversity approached significance as a predictor of the occurrence of TMM similarity for teamwork \( F (2,39)= 2.08, p=0.06 \) where moderately diverse teams (those with two members from a single national group and one from another) had lower levels of similarity than either completely homogeneous teams or completely heterogeneous teams. There was no main effect of gender \( F (2,37)=0.25, p=0.84 \) as a function of mixed (some male and some female) versus uniform (all male or all female) or an interaction effect between gender composition and team diversity \( F (2,37)=2.07, p=0.34 \).

Accuracy

A linear regression model was run on the pairwise grids for teamwork TMM accuracy for the simulation task. As previously described, the Euclidean distances of every participant’s response on each pairwise grid concept were calculated in relation to those averages of expert responses. A team score was generated as the sum of each of the three participant’s Euclidean Distance to those expert averages. Three observations were omitted from this analysis due to missing values. A two-sample t-test revealed no significant team difference between multinational and national teams for teamwork TMM accuracy \( t (41)=0.64, p=0.53 \).
To determine discernable differences between male and female teams on teamwork TMM accuracy, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) was included as a predictor of the occurrence of TMM accuracy for teamwork. There were no significant differences in the level of TMM accuracies of teamwork between all male teams and all female teams ($t_{(35)}= 1.26$, $p=0.2$).

No main effects of team diversity ($F_{(2,37)}= 0.5$, $p=0.66$), or Gender composition ($F_{(1,37)}= 0.96$, $p=0.12$) were found to be significant on the level of teamwork TMM accuracy. No interaction effect between level of team diversity and gender composition was found to be significant ($F_{(2,37)}= 0.75$, $p=0.22$).

**Temporality TMM**

**Similarity**

A linear regression model test was run on the pairwise grids for temporal TMM similarity aspects of the simulation task. Three observations were omitted from this analysis due to missing values. A two-sample t-test revealed no significant team difference between multinational and national teams for temporal TMM similarity ($t_{(38)}=1.71$, $p=.10$).

To determine discernable differences between male and female teams on TMM similarities, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) was included as a predictor of the occurrence of TMM similarity. There were no differences in the level of TMM similarities of teamwork in all male teams and all female teams ($t_{(39)}= 0.92$, $p=.36$). The linear model revealed no significant main effects for team diversity ($F_{(2,34)}= 1.48$, $p=0.23$), gender composition of the teams ($F_{(1,34)}= 1.30$, $p=.26$) or interaction effects between team diversity and gender composition ($F_{(2,34)}= .37$, $p=.55$).
Accuracy

A linear regression model was run on the pairwise grids for temporal TMM accuracy. As previously described, the Euclidean distances of every participant’s response on each pairwise grid concept were calculated in relation to those averages of expert responses. A team score was generated as the sum of each of the three participant’s Euclidean Distance to those expert averages. Three observations were omitted from this analysis due to missing values. A two-sample t-test revealed no significant team difference between multinational and national teams for temporal TMM accuracy ($t(38)=1.07$, $p=0.3$).

To determine discernable differences between male and female teams on mental model accuracy, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) is included as a predictor of the occurrence of TMM temporal accuracy. There were no significant differences in the level of TMM accuracies of temporality between all male teams and all female teams ($t(35)=1.26$, $p=0.2$).

No main effects of team diversity ($F(2,37)=0.57$, $p=0.32$) or gender composition ($F(1,37)=0.10$, $p=0.59$) were found to be significant on the level of temporal team mental model accuracy. No interaction effect between level of team diversity and gender composition was found to be significant ($F(2,37)=0.43$, $p=0.41$).

For Temporality TMM accuracy and similarity, Hypothesis 6e is rejected in favor of the null hypothesis.

Events TMM

Similarity

A linear regression model test was run on the pairwise grids for events TMM similarity regarding the teams’ ratings of the relatedness of events from the simulation task just completed.
A two-sample t-test revealed no significant team difference between multinational and national teams for events TMM similarity ($t (41)=1.58, p=0.12$).

To assess discernable differences between male and female teams on mental model similarities, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) is included as a predictor of the occurrence of TMM similarity for events TMM similarity. There were no differences in the level of event TMM similarity in all male teams and all female teams ($t (39)= 1.37, p=0.36$).

A main effect of team diversity (F (2,39)= 2.8, p= 0.03) was found to be significant, where moderately diverse teams (those with two members from a single national group and one from another) had lower levels of event TMM similarity than either completely homogeneous teams or completely heterogeneous teams in their similarity scores, indicating a slight trend for worse team mental models. No significant main effects were found for Gender composition (F (1,39)= .60, p= 0.67) or interaction effects between level of team diversity and gender composition (F (2,39)= 1.44, p= 0.24).

**Accuracy**

A linear regression model was run on the pairwise grids for event TMM accuracy scores. As previously described, the Euclidean distances of every participant’s response on each pairwise grid concept were calculated in relation to those averages of expert responses. A team score was generated as the sum of each of the three participant’s Euclidean Distance to those expert averages. A two-sample t-test revealed significant team differences between multinational and national teams for events TMM accuracy ($t (41)=2.41, p=0.02$).

To determine whether there were discernable differences as a factor of gender diversity, a variable measuring the percentages of females on a team (0%, 33%, 66%, 100%) is included as a predictor of the occurrence of event TMM accuracy. There were no significant differences in the
level of team mental model accuracies of teamwork between all male teams and all female teams  
(t (35)= 1.70, p<0.1).

A main effect of team diversity (F (2,37)= 4.06, p= 0.03) was found to be significant, where moderately diverse teams (those with two members from a single national group and one from another) had lower levels of accuracy than either completely homogeneous teams or completely heterogeneous teams in their event TMM accuracy scores, indicating an influence of team diversity on having less accurate event TMM accuracy. A slight trend for Gender composition (F (1,37)= 0.12, p= 0.07) was found. An interaction effect between level of team diversity and gender composition was not found to be significant  (F (2,37)= 3.15, p= 0.10).

Table 4-12: Description of Effects of Accuracy for Events Pairwise Grids.

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>Mean Sq</th>
<th>F</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Composition</td>
<td>1</td>
<td>0.66</td>
<td>0.12</td>
<td>.07</td>
</tr>
<tr>
<td><strong>Team Diversity (Moderate)</strong></td>
<td>2</td>
<td><strong>22.24</strong></td>
<td><strong>4.06</strong></td>
<td><strong>.01</strong></td>
</tr>
<tr>
<td>Gender Composition X Team Diversity</td>
<td>2</td>
<td>17.25</td>
<td>3.15</td>
<td>.10</td>
</tr>
</tbody>
</table>

**Team Mental Model Concepts and Team Performance**

Table 4-8 above presents an overall model of team performance. The similarity and accuracy ratings for each team mental model concept were included as predictors of team performance. No concept presented as a significant predictor of team performance, however teamwork accuracy approached significance as an influencing factor in team performance.
Within the current chapter, the results from the quantitative study were reported. In summary these results were:

1) The main effect of team type (national or multinational) on performance was found to be highly significant where national performed significantly better than multinational teams.

2) Emergency Crisis Management experience did positively impact performance on teams.

3) On Interdependent events, a significant interaction effect revealed that while both teams were impacted by the presence of a hidden knowledge, Multinational teams were more affected than National teams.

4) On interdependent events, the interaction between Team Type and scenario number yielded a significant interaction effect as a function of team performance on the interdependent events in each scenario. Indicating that national teams performed much better on interdependent events in scenario 2.

5) On interdependent events, a three-way interaction between Hidden Knowledge Condition, Team Type, and Scenario Number was significant. National teams performance greatly differed between scenarios that had hidden knowledge compared to when they did not. Performance by both teams in both scenarios was impacted by the presence of hidden knowledge, although not necessarily in the hidden knowledge event itself.

### Table 4-13: Summary of TMSS and TMM Effects.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Team Diversity</th>
<th>Gender Diversity</th>
<th>Team Diversity X Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMSS Congruence</td>
<td>No</td>
<td>No</td>
<td>Yes (p=.006)</td>
</tr>
<tr>
<td>TMSS Accuracy</td>
<td>No</td>
<td>Yes (p=.005)</td>
<td>No</td>
</tr>
<tr>
<td>Teamwork TMM Similarity</td>
<td>Trend (p=.06)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Teamwork TMM Accuracy</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Temporal TMM Similarity</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Temporal TMM Accuracy</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Events TMM Similarity</td>
<td>Yes (p=.03)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Events TMM Accuracy</td>
<td>Yes, (p=.03)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
6) No significant difference in the occurrence of team mental models (TMSS or Pairwise grid comparisons) for teamwork, timing, and relatedness of events for multinational teams or national teams, nor for all male teams or all female teams. Diversity within teams, however, did play a role in the similarity and accuracy of TMSS, and to some extent for mental models in the pairwise comparisons.

In the following chapter, a rich description of team communication, information sharing and assessment of Hidden Knowledge profiles is presented in the context of comparison between the National and Multinational Team conditions.
Chapter 5

Evaluations of Communication and Information Sharing Processes

In this chapter, I provide a rich, thick description of communication and information sharing behaviors in the context of comparison between National and Multinational teams.

Communication

Transcriptions of each team’s communication were coded using a pre-existing and developed in process coding scheme (Appendix E). From these, themes were iteratively developed using the Thematic Analysis process described by Braun & Clark (2006), to more aptly construct a fuller picture of team behaviors. In particular, several elements of note were evaluated at a deeper level. A more in-depth focus on the information sharing behaviors of teams in each condition (namely those pertaining to the sharing of hidden knowledge from the briefings) occurred. A discussion of this process is conducted below.

Total Communications

Across teams in the two conditions, an analysis of the level of communication across all 4 scenarios (training 1, training 2, scenario 1, and scenario 2) was evaluated based on total number of words spoken during the experimental session. This is presented in table 5-1 below. An independent-samples t-test was conducted to compare the total number of communications (words spoken) scores for multinational and national teams. While there was a general trend for
National teams to converse on average more than Multinational teams, there was no significant difference in amount of words spoken for multinational teams (M = 1866.9, SD = 1600.7) and national teams (M = 2438.5, SD = 1332); (t (41) = -1.3, p = .21). Further analysis through a linear regression model of the level of diversity within a team found that whether a team was of homogeneous, heterogeneous or mixed nationalities do not significantly influence overall communication levels (F (2,40)= 1.02, p=0.35).

Additionally, an independent-samples t-test was conducted to compare the total number of communications (words spoken) scores for the gender composition (i.e. Mixed or Uniform–either all male or all female) of teams. While there was a general trend for Uniformly gendered teams to converse on average more than Mixed gender teams, there was no significant difference in amount of words spoken for Mixed gendered teams (M = 1845.33, SD = 1472.96) and Uniformly gendered teams (M = 2617.75, SD = 1441.56); (t (41) = -1.68, p = 0.10).

Table 5-1: Description of Amount of Total Communication by Team.

<table>
<thead>
<tr>
<th>Team Type</th>
<th>Team ID</th>
<th>Amount of Communication (# of words)</th>
<th>Type of Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>6</td>
<td>228</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>7</td>
<td>3382</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>8</td>
<td>3827</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>10</td>
<td>4387</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>11</td>
<td>2058</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>12</td>
<td>5220</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>14</td>
<td>124</td>
<td>Mixed</td>
</tr>
<tr>
<td>International</td>
<td>15</td>
<td>738</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>16</td>
<td>612</td>
<td>Verbal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>National</td>
<td>17</td>
<td>2740</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>18</td>
<td>2430</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>19</td>
<td>295</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>20</td>
<td>2489</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>21</td>
<td>4137</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>22</td>
<td>1923</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>23</td>
<td>3066</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>24</td>
<td>1340</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>25</td>
<td>2585</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>26</td>
<td>1518</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>27</td>
<td>136</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>28</td>
<td>1963</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>29</td>
<td>244</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>30</td>
<td>2380</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>31</td>
<td>2823</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>33</td>
<td>1262</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>34</td>
<td>3472</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>35</td>
<td>281</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>36</td>
<td>3396</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>37</td>
<td>34</td>
<td>Chat</td>
</tr>
<tr>
<td>National</td>
<td>38</td>
<td>655</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>39</td>
<td>2290</td>
<td>Verbal</td>
</tr>
</tbody>
</table>
### Communications Content

The transcribed verbal communications for each team were analyzed by a single coder\(^7\) using the coding scheme described in Appendix E. (Due to limitations in resources only the primary researcher coded the transcribed communications. Codes were reviewed for consistency and were addressed iteratively across teams). Codes emerged from a baseline coding scheme developed by Entin and Entin (2001) and used on several similar research projects using the NeoCITIES simulation platform (Brewer & McNeese, 2004; Connors, 2006; McNeese, et al.,

<table>
<thead>
<tr>
<th>International</th>
<th>40</th>
<th>1949</th>
<th>Verbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>41</td>
<td>645</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>42</td>
<td>45</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>43</td>
<td>4337</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>44</td>
<td>2111</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>45</td>
<td>4174</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>46</td>
<td>5174</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>47</td>
<td>1964</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>48</td>
<td>1184</td>
<td>Verbal</td>
</tr>
<tr>
<td>National</td>
<td>49</td>
<td>2451</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>50</td>
<td>4111</td>
<td>Verbal</td>
</tr>
<tr>
<td>International</td>
<td>51</td>
<td>1528</td>
<td>Verbal</td>
</tr>
</tbody>
</table>

\(^7\) While conventions of quantitative methodology rely on multiple coders and the utilization of inter-coder reliability, conventions of qualitative methodology allow for single coders.
Additional codes for the communication data were then developed iteratively from the transcribed data. For teams with limited verbal communication, chat communication was incorporated into the analysis and coded as part of the overall communications data set.

A Welch’s Two Sample T-test was run on each of the 50 codes to assess intergroup differences in types of communications between multinational and national teams. Several factors were found to be significant. A break down in the total number of codes is provided below. See Appendix E for the full description of the coding scheme.

Table 5-2: Description of Communication Codes by Team Type

<table>
<thead>
<tr>
<th>Codes</th>
<th>Measure</th>
<th>Multinational</th>
<th>National</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Information Sharing</td>
<td>2985</td>
<td>3091</td>
<td>6076</td>
</tr>
<tr>
<td>1.1</td>
<td>Information Request</td>
<td>609</td>
<td>630</td>
<td>1239</td>
</tr>
<tr>
<td>1.2</td>
<td>Information Transfer</td>
<td>1101</td>
<td>1108</td>
<td>2209</td>
</tr>
<tr>
<td>1.3</td>
<td>Unique Information Exchange</td>
<td>620</td>
<td>599</td>
<td>1219</td>
</tr>
<tr>
<td>1.4</td>
<td>Clarifying Information</td>
<td>15</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>1.5</td>
<td>Identifying Resources</td>
<td>265</td>
<td>232</td>
<td>497</td>
</tr>
<tr>
<td>1.6</td>
<td>Status update</td>
<td>366</td>
<td>480</td>
<td>846</td>
</tr>
<tr>
<td>1.7</td>
<td>Timing Information</td>
<td>4</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>1.8</td>
<td>Acknowledgement of error</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Action</td>
<td>2267</td>
<td>2554</td>
<td>4821</td>
</tr>
<tr>
<td>2.1</td>
<td>Action Request</td>
<td>580</td>
<td>514</td>
<td>1094</td>
</tr>
<tr>
<td>2.2</td>
<td>Action Intention</td>
<td>476</td>
<td>816</td>
<td>1292</td>
</tr>
<tr>
<td>2.3</td>
<td>Action Execution</td>
<td>432</td>
<td>506</td>
<td>938</td>
</tr>
<tr>
<td>2.4</td>
<td>Action Uncertainty</td>
<td>91</td>
<td>89</td>
<td>180</td>
</tr>
<tr>
<td>2.5</td>
<td>Action Instruction</td>
<td>217</td>
<td>151</td>
<td>368</td>
</tr>
<tr>
<td>2.6</td>
<td>Action Instruction request</td>
<td>71</td>
<td>96</td>
<td>167</td>
</tr>
<tr>
<td>2.7</td>
<td>Action Suggestion</td>
<td>194</td>
<td>194</td>
<td>388</td>
</tr>
<tr>
<td>2.8</td>
<td>Action Justification</td>
<td>36</td>
<td>29</td>
<td>65</td>
</tr>
<tr>
<td>2.9</td>
<td>Action Agreement</td>
<td>118</td>
<td>123</td>
<td>241</td>
</tr>
<tr>
<td>2.11</td>
<td>Action disagreement</td>
<td>23</td>
<td>29</td>
<td>52</td>
</tr>
<tr>
<td>2.12</td>
<td>Action Status</td>
<td>29</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Coordination Behavior</td>
<td>141</td>
<td>233</td>
<td>374</td>
</tr>
<tr>
<td>3.1</td>
<td>Request for</td>
<td>59</td>
<td>107</td>
<td>166</td>
</tr>
</tbody>
</table>
Overall, information sharing (codes 1.1-1.8) was not found to be collectively significant. However, concern with timing information on their responses to events was found to be significant between the two groups with multinational teams discussing it on average (M= 0.17,
SD= 0.65) less than National teams (M=1.2, SD= 1.88), \( t \) (41)= -2.4568, \( p=.018 \). Important to note, no significant differences were found for the sharing of the hidden knowledge information (\( p= 0.64 \)) between Multinational teams (M=26.96) and National teams (M=29.95). No other coded information sharing factors were found to be significant.

Overall, the total communications about actions (the sum number of codes 2.1-2.12) were not found to be significant. However individually, the average discussion of action intentions was found to be significantly higher for National teams (M= 40.8, SD= 25.18) than for Multinational teams (M=20.7, SD= 21.56), \( t \) (41)= -2.82, \( p=.007 \). No other coded action factors were found to be significant.

Overall, the total communications dealing with coordination (the sum number of codes 3.1-3.5) were not found to be significant, however several aspects of coordination were found to be significant. Requests for coordination was found to be significantly different between Multinational (M=2.57, SD= 3.27) and National teams (M=5.35, SD=3.59), meaning that a higher number of communications by national teams focused on the coordination requirements of the simulation and sought to actively respond as a team \( t \) (41)= -2.66, \( p\text{-value} = .011 \).

This, however, did not actively translate to verbal agreements to coordinate responses. Additionally, this does not suggest that all National teams focused on coordination, but merely that a higher number of communications overall focused on this aspect. Negative responses to coordination requests, where individuals felt that they were not needed or disagreed with a particular action were found to be significant \( t \) (41)= -2.19, \( p=.034 \) with National teams (M=.3, SD= .66) disagreeing more often than Multinational teams (M=0, SD=0), but a very small margin of codes pertained to this overall.
National teams (M=0.3, SD=0.57) were found to have a significantly higher number ($t$ (41)= -2.52 p=0.016) of dyad (two team members) coordination efforts than Multinational teams (M=0), however only 6 communication codes pertained to this at all. Triad (all three team members) coordination efforts represented a higher number of communications coded (at 50 total), but were not found to be significantly different between the team types.

Overall communications centered on assessment of team progress and performance (the sum number of codes 4.1- 4.4) was not significantly different between the two team types. Independently, there was however a moderate trend, ($t$ (41) =1.85, p=0.07), between Multinational teams (M=4.13, SD= 5.47) and National teams (M=8.3, SD= 9.04) in the number of communications focused specifically on assessment of performance aspects of the simulation, with National teams discussing performance on the simulation events more than Multinational teams. No other coded assessment factors were found to be significant.

Figure 5-1: Boxplot Comparison of Coordination Requests by Team Type.
In terms of generalized utterances, there were no significant differences in team types on expressions of positive or negative sentiment (i.e. encouragement, criticism or dismay), acknowledgements (i.e. “yeah”), development of rapport between team members, insignificant utterances or clarification on instructions).

In looking at the communications regarding the simulation and questions about how to do things in the simulation, there was a moderate trend, \( t(41)= 1.92, \ p=0.06 \), between team types, in which Multinational teams asked slightly more questions or asked for help significantly more often on how to do things \( (M=7.044, SD= 7.81) \) than National teams \( (M=3.5, SD= 2.72) \). There was no difference in the number of instances that members of both types of teams helped their teammates when they had questions about how to do things in the simulation. This was an organic process that emerged during the simulation. The researcher assisted in break times, but not during the simulation itself.

Between the two groups, there were no significant differences in discussion of strategy or utilization of the brute force technique in responses (i.e. send every resource to an event). In evaluating planning type communications there was a significant difference, \( t(41)= -2.01, \ p=.05 \), between team types, where national teams \( (M=0.40, SD= 0.82) \) engaged in planning type communications more often than multinational teams \( (M=0.044, SD= 0.21) \).

**Information Sharing**

**Unique information Sharing**

After analyzing communication data from every team, a classification system for the varying levels of communication and information sharing was developed. This pertained particularly to how much teams shared the information that they received in the briefings. As
described above, some events in the two performance scenarios required extra information that was not provided in the description of the event that was needed to effectively respond in a timely manner (i.e. Briefings events). This required team members to share and discuss the information they received in the briefings (e.g. simulating the receipt of Intel by one agency, and requiring communication for collaborative problem solving). In half of the events the information received via those briefings is described here as “hidden knowledge,” meaning that not all team members received the same information in the briefing. In the other half of the events that the briefings pertained to every member of the team received all of the briefing information, described here as “without hidden knowledge.” In this case, an effective response still required teams to recognize the information being given as useful, and to determine correctly which event the briefing pertained to.

Four levels of information sharing formed this classification: 1) None, meaning that none of the unique information was shared; 2) Some, indicating that 1 piece of unique information was shared within the team; 3) Most, indicating that 2 pieces of unique information were shared within the team; and 4) Full, indicating that teams shared all three pieces of unique information.

Table 5-3: Description of Levels of Information Sharing for Briefing Events.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Level of Information Shared</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>No Information</td>
</tr>
<tr>
<td>Some</td>
<td>1 piece</td>
</tr>
<tr>
<td>Most</td>
<td>2 pieces</td>
</tr>
<tr>
<td>Full</td>
<td>3 pieces</td>
</tr>
</tbody>
</table>

These classifications were determined for every briefing related event by evaluating the communications of each team that dealt specifically with each of the events (table 5-2, coded as 1.3). A total of 2 events (n=2) (1 from each scenario) relied on a briefing to effectively solve the
event. Every team received both of these events (N=46 events). The following analyses will evaluate information sharing at the level of the individual level of events, and will assess information sharing behaviors of Multinational and National teams through the 4 classification levels discussed above.

**Multinational Teams**

52% of multinational teams failed the events that dealt specifically with the briefings and which required team members to exchange unique information (Hidden Knowledge) condition, or at the very least pay attention to the briefings panel (non-Hidden Knowledge condition). In the following section, the information sharing behaviors of the multinational team group will be evaluated for these briefing events.

Table **5-4**: Description of Multinational Teams Overall Level of Information Sharing for Briefing Events.

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>Number of Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>28</td>
<td>61%</td>
<td>10 (36%)</td>
</tr>
<tr>
<td>Some</td>
<td>11</td>
<td>24%</td>
<td>8 (72%)</td>
</tr>
<tr>
<td>Most</td>
<td>5</td>
<td>11%</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Full</td>
<td>2</td>
<td>4%</td>
<td>1 (50%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>46</strong></td>
<td><strong>100%</strong></td>
<td><strong>22 (48%)</strong></td>
</tr>
</tbody>
</table>

**Overall Trends in Information sharing**

Overall, multinational teams did not share much of the unique information they received in the briefings. Of the multinational teams, the full information was shared on only two events (out of 46), one in the hidden knowledge condition (which was still not successfully completed) and one in the without hidden knowledge condition (which was successfully completed). On a
large percentage (61%) of events (n=28 events) across both the hidden knowledge and without hidden knowledge conditions, multinational teams shared none of the unique information. These events where teams shared no unique information, had a low success rate for those events (36%). Only 10 events in both conditions were successfully completed, and only 4 of the teams successfully solved the event in the hidden knowledge conditions. This may be because they utilized a brute force tactic (a limitation of the experiment) by sending all of the resources to the event. The remaining 18 events were not successfully completed, and 12 teams failed the event in the Hidden Knowledge condition.

Figure 5-2: Overall Sharing of Briefing Information by Multinational Teams.

Eleven events across conditions were classified as “Some information shared,” meaning that teams only discussed one piece of the unique information they received from the briefings. This represents the second largest percentage (24%) of events across both the hidden knowledge and without hidden knowledge conditions. Of these events (across conditions) where only some information was shared, only 8 were successfully completed. However, it is noteworthy that only 3 of the teams that shared some information successfully solved the event in the hidden knowledge conditions, with 2 teams failing the event in the Hidden Knowledge condition.
Five events across conditions were classified as “Most information shared,” meaning teams discussed 2 of the 3 pieces of unique information from the briefings (11%). Of these five events, 3 were successfully completed, with 1 being successfully solved in the Hidden knowledge condition.

*Information Sharing in the Hidden Knowledge Condition*

Half of the above events required the sharing of hidden knowledge (unique information received in a briefing) in order to effectively solve the event. The total sample of events in the hidden knowledge condition was 23 (N=23), one for each team.

Table 5-5: Description of Multinational Teams Level of Information Sharing for Hidden Knowledge Events.

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>HK Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>16</td>
<td>70%</td>
<td>4 (25%)</td>
</tr>
<tr>
<td>Some</td>
<td>5</td>
<td>22%</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Most</td>
<td>1</td>
<td>4.3%</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Full</td>
<td>1</td>
<td>4.3%</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>23</strong></td>
<td><strong>100%</strong></td>
<td><strong>8 (35%)</strong></td>
</tr>
</tbody>
</table>

Overall, Multinational teams didn’t end up sharing any of the unique information on 70% of the hidden knowledge events (16 teams). This lack of information sharing is coupled with a failure of 15 of the total 23 (65%) overall hidden knowledge events across the sample.

The remaining 30% of the information sharing sample is as follows: Some information sharing occurred in 22% of events (5 teams), Most information was shared in 4.3% of the events (1 team), and Full information was shared 4.3% of the events (1 team).
Three of the five multinational teams that shared one piece of information ("Some" classification) successfully completed their events. The one team (Team 43) that shared ‘most’ information also successfully completed their hidden knowledge event by sharing the required order and amount of time for a response; this was accompanied by a very coordinated response (in which they directed first a then b then c).

Fire

Police

Fire

Hazmat

Fire

Hazmat

Police

Fire

Hazmat

Fire

I’m sending an ambulance now …
Only one team shared all of the information, and despite this still failed the event. Further analysis revealed that while this team (Team 50) shared all of the information from the briefing, and even coordinated a response, they still didn’t send the SWAT resource in time to effectively solve the event.

<table>
<thead>
<tr>
<th>Police</th>
<th>Oh they need a SWAT to go there, just sent a SWAT team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>Oh, did you not send one earlier</td>
</tr>
<tr>
<td>Police</td>
<td>No I tried investigator and squad, it’s just a briefcase</td>
</tr>
<tr>
<td>Fire</td>
<td>Yeah well it said you had to send SWAT first to clear the crowd I guess … it’s almost midnight, that was two hours ago</td>
</tr>
<tr>
<td>Police</td>
<td>It doesn’t say over here … oh you told me that</td>
</tr>
<tr>
<td>Fire</td>
<td>Yeah I think I did, I don’t know, maybe we didn’t communicate effectively.</td>
</tr>
<tr>
<td>Hazmat</td>
<td>So there are three bomb squads out working on this suspicious luggage</td>
</tr>
<tr>
<td>Police</td>
<td>because I hadn’t sent the SWAT team … it says over there</td>
</tr>
<tr>
<td>Fire</td>
<td>and we failed</td>
</tr>
</tbody>
</table>

Despite the team sharing information, this did not translate to effectively acting on that information, suggesting that how teams integrate information across the team presented challenges for teams.

Information Sharing in the Without Hidden Knowledge Condition

While all team members received the same information in the briefings panel in the without hidden knowledge condition, often discussion and coordination of the information occurred.
The total sample of events in the without hidden knowledge condition was 23 (N=23).

Overall, teams in the without hidden knowledge condition had a higher completion rate for the briefing related event, with 14 teams successfully completing the event (only 9 teams of 23 failing (39%)).

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>WHK Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>12</td>
<td>52.1%</td>
<td>6 (50%)</td>
</tr>
<tr>
<td>Some</td>
<td>6</td>
<td>26.1%</td>
<td>5 (83%)</td>
</tr>
<tr>
<td>Most</td>
<td>4</td>
<td>17.4%</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Full</td>
<td>1</td>
<td>4.3%</td>
<td>1 (100%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>23</strong></td>
<td><strong>100%</strong></td>
<td><strong>14 (61%)</strong></td>
</tr>
</tbody>
</table>

The total sample of events in the without hidden knowledge condition was 23 (N=23).

Overall, teams in the without hidden knowledge condition had a higher completion rate for the briefing related event, with 14 teams successfully completing the event (only 9 teams of 23 failing (39%)).

Multinational teams did not discuss the briefings for 52% of the events (n=12 teams). A larger number of teams discussed the briefings (‘some’ to ‘full’ information) in the without hidden knowledge condition (n=11). 26% of teams (n=6) engaged in ‘some’ level of information sharing about the briefings, 5 of these teams successfully completed the event. 4 teams discussed
‘most’ of the information from the briefings. Only 1 team discussed all of the information from
the briefings panel. This team successfully responded to the briefing related event.

**Comparison of Hidden Knowledge Conditions**

There was a noticeable uptick in the discussion of the briefing information in the without
hidden knowledge condition. A larger number of multinational teams discussed the briefings
(‘some’ to ‘full’ information) in the without hidden knowledge condition (n=11) than in the
hidden knowledge condition (n= 7 teams). This result aligns with Stasser and Titus (1987)
findings of bias towards discussion of shared information over information that is uniquely held.

**National Teams**

National teams failed 35% of the events that dealt specifically with the briefings and
which required team members to exchange unique information (Hidden Knowledge) condition, or
at the very least pay attention to the briefings panel (non-Hidden Knowledge condition). In the
following section, the information sharing behaviors of the national team condition will be
evaluated for these briefing events.

**Overall Information Sharing**

Overall, national teams shared some to all of the unique information they received in the
briefings about half the time. Of the 20 national teams, the full information was shared on 7
events out of 40 (about 18% of the time). All 7 of these events were successfully completed
across both the hidden knowledge condition (n=4 events) and the without hidden knowledge condition (n=3 events).

Table 5-7: Description of National Teams Overall Level of Information Sharing for Briefing.

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>20</td>
<td>50%</td>
<td>11 (55%)</td>
</tr>
<tr>
<td>Some</td>
<td>6</td>
<td>15%</td>
<td>2 (33%)</td>
</tr>
<tr>
<td>Most</td>
<td>7</td>
<td>17.5 %</td>
<td>6 (86%)</td>
</tr>
<tr>
<td>Full</td>
<td>7</td>
<td>17.5 %</td>
<td>7 (86%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>100%</strong></td>
<td><strong>26 (65%)</strong></td>
</tr>
</tbody>
</table>

On half (50%) of events across both the hidden knowledge and without hidden knowledge conditions, national teams shared none of the unique information. 11 of these events were successfully completed, and only 6 of the teams successfully solved the event in the hidden knowledge conditions. This may be because they utilized a brute force tactic (a limitation of the experiment) by sending all of the resources to the event.

Six events across conditions were classified as “Some information shared,” meaning that teams only discussed one piece of the unique information they received from the briefings. This represents the lowest (15%) information sharing level across both the hidden knowledge and without hidden knowledge conditions. Of these events (across conditions) where only some information was shared, only 2 were successfully completed; one team in the hidden knowledge conditions, with one team failing the event in the Hidden Knowledge condition, and 4 teams failed the event in the without hidden knowledge condition.
Seven events across conditions were classified as “Most information shared,” meaning teams discussed 2 of the 3 pieces of unique information from the briefings (17.5%). All 7 teams that discussed ‘most’ of the briefing information did so in the without hidden knowledge condition, and all but 1 team successfully completed the event.

**Information Sharing in the Hidden Knowledge Condition**

Thirteen of twenty National teams (65%) successfully completed the briefing event in the Hidden Knowledge condition. Four teams shared all of their uniquely held information in the hidden knowledge condition, and all were able to successfully complete the event.

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>HK Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>14</td>
<td>70%</td>
<td>8 (57%)</td>
</tr>
<tr>
<td>Some</td>
<td>2</td>
<td>10%</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Most</td>
<td>0</td>
<td>0%</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Full</td>
<td>4</td>
<td>20%</td>
<td>4 (100%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20</strong></td>
<td><strong>100%</strong></td>
<td><strong>13 (65%)</strong></td>
</tr>
</tbody>
</table>
Fourteen teams shared ‘no’ information, making up 70% of the sample. A little over half of these teams (57%) were successful on this event, despite sharing no information.

Two teams shared ‘some’ information, however only one was successful in solving the hidden knowledge event. For the team that failed (Team 22) the hidden knowledge event in the ‘some’ information sharing classification, communications revealed that team members recognized that they didn’t all receive the same information in the briefing, however they still didn’t actively share the information that was in their briefing. This may be due to several factors, which will be discussed in greater detail below.

Fire
So at 2:30 we’re going to need

Police
Where do you see the time

Fire
Up at the top in the briefings

Police
Well yeah but there’s no time for this one … I don’t know when it’s coming in.

Fire
Oh I have that, around 2:30 today a riot will take place if local team loses

Hazmat
We are a briefing servant

Police
Yeah, mine is saying that the defacing a bank

Fire
That’s on mine too

Hazmat
Oh, but there’s no time

Figure 5-6: Overall Sharing of Hidden Knowledge Information by National Teams.
No teams in the hidden knowledge condition shared ‘Most’ of the briefings information.

**Information Sharing in the Without Hidden Knowledge Condition**

Thirteen of twenty teams (65%) successfully completed the briefing event in the Without Hidden Knowledge condition. Three teams shared all of their uniquely held information in the hidden knowledge condition, and all were able to successfully complete the event.

Table 5-9: Description of National Teams Level of Information Sharing for Without Hidden Knowledge Events.

<table>
<thead>
<tr>
<th>Level of Unique Information Sharing</th>
<th>WHK Events</th>
<th>Percentage of Events</th>
<th>Number of Teams Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>6</td>
<td>30%</td>
<td>3 (50%)</td>
</tr>
<tr>
<td>Some</td>
<td>4</td>
<td>20%</td>
<td>1 (16%)</td>
</tr>
<tr>
<td>Most</td>
<td>7</td>
<td>35%</td>
<td>6 (86%)</td>
</tr>
<tr>
<td>Full</td>
<td>3</td>
<td>15%</td>
<td>3 (100%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20</strong></td>
<td><strong>100%</strong></td>
<td><strong>13 (65%)</strong></td>
</tr>
</tbody>
</table>

Six teams shared ‘no’ information, making up 26% of the teams. Half of these teams were successful on this event, despite sharing no information. Four teams shared ‘some’ information, however only one was successful in solving the hidden knowledge event.

Figure 5-7: Overall Sharing of Without Hidden Knowledge Information by National Teams.
For the team that succeeded (Team 22) the hidden knowledge event in the ‘some’ information sharing classification, communications revealed that team members anticipated the event, and then shared their individual response activities.

<table>
<thead>
<tr>
<th>Team</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>I still don’t know how to take care of the airport</td>
</tr>
<tr>
<td>Police</td>
<td>Well it’s not happening until 6:45 so we probably won’t have to</td>
</tr>
<tr>
<td>Hazmat</td>
<td>oh okay</td>
</tr>
<tr>
<td>Police</td>
<td>so we just need to know immediately to send those people …</td>
</tr>
<tr>
<td></td>
<td>we have to send it a minute before</td>
</tr>
</tbody>
</table>

Since the information was common across team members, they were able to use the information and actively coordinate a response to the event.

<table>
<thead>
<tr>
<th>Team</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazmat</td>
<td>I think it’s going to pull up and we have to do it in that order</td>
</tr>
<tr>
<td>Fire</td>
<td>Yeah so we need to do that, police haven’t gotten to the fire</td>
</tr>
<tr>
<td>Police</td>
<td>Alright SWAT team sent</td>
</tr>
<tr>
<td>Fire</td>
<td>did the police go first, bomb squad go</td>
</tr>
<tr>
<td>Hazmat</td>
<td>yes bomb squad went</td>
</tr>
</tbody>
</table>

Lastly, seven teams discussed ‘most’ of the information from the briefings, representing 30% of the teams. Six of these teams successfully completed this event. The team that failed (Team 18), despite discussing two-thirds of the briefing information (time of the event and order of resource response), failed because they did not effectively coordinate a response.

Table 5-10: Summary of Information Sharing Behaviors.

<table>
<thead>
<tr>
<th></th>
<th>Multinational</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>48% of Briefing related events completed (N=46)</td>
<td>65% of Briefing related events completed (N=40)</td>
</tr>
<tr>
<td>Hidden Knowledge</td>
<td>35% of HK events successfully completed (n=23)</td>
<td>65% of HK events successfully completed (n=20)</td>
</tr>
<tr>
<td>Without Hidden</td>
<td>60% of WHK events successfully completed (n=23)</td>
<td>65% of WHK events successfully completed (n=20)</td>
</tr>
</tbody>
</table>
Information Awareness

Conceptually ‘information awareness’ in this setting boils down to the level of understanding for both individuals and teams that there is information that is needed for teamwork to be effective. This requires teams to recognize that not all information is of equal value, and to be aware of the information that is relevant and important for team success.

Recognizing that the information from the briefing was different across each team member presented a challenge for many teams.

“When one partner had the entire briefing with order of units to dispatch but this was not communicated and failed that event. We were all talking about why it was not working. Perhaps he told it only in terms of what to dispatch - so did not know that was credible and maybe had not paid attention, nor recheck the units sent, with the instructions.” (Team 50, Multinational Team, Police Role, India).

Teams needed to establish a shared and accurate level of information awareness in order to actively apply that information to their actions. Failing to share that information may be due to inattentional blindness (Mack & Rock, 1998). The cognitive workload of the simulation tasks themselves may have contributed to failures in adequate and appropriate information sharing.

“Information was relatively easy to deal with as it came in. At some points, such as in the first simulation when there was a briefing with a specific time on it, the new tasks would distract me from watching the clock, leading me to miss the time that was warned about.” (Team 40, Multinational team, Fire Role, United States).

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8 Concept of Information Awareness adapted from McNeese, N. (2014)
Summary

While the overall communication was not quantitatively different across team types, many differences in information sharing and the types of information shared were observed qualitatively within this chapter. These distinct differences across team types in approaches to information sharing reflect some of the underlying intricacies of team behaviors.
Chapter 6

Qualitative Results

In this chapter, qualitative findings triangulated from several pieces of data are presented. These findings take an explanatory approach and focus on understanding variances in multinational and national teams in regards to information sharing behaviors and the development of team cognition and during a crisis management simulation. Specifically, several findings will be discussed detailing:

1) Approaches to teamwork within multinational and national teams
2) Culturally adapted team mental models
3) Interpretations and impacts of the crisis event
4) Factors of awareness in teams
5) Processes of information sharing

Analysis Process

As described in the Methods chapter above, the six-stage thematic analysis approach proposed by Braun and Clark (2006) was utilized across the data set (through the triangulation of the iterative development of codes for the transcribed communication data, participants’ qualitative questionnaires, and observational data). As discussed in Chapter 3 above, Braun and Clark (2006) emphasize an analytic approach that requires the researcher to familiarize themselves with the data and to systematically develop codes and themes across the whole data set—thus allowing themes to emerge through a continuous engagement with the data. Through the development of rich, thick description, I aim to convey underlying causes and perspectives of
team behaviors relating to the completion of crisis response tasks, and in particular to evaluate the influence of culture in team activities through explanatory methods.

Themes were generated through both vertical (all individual responses to a single question) and horizontal (across an individual’s responses to all questions) immersion in the data that spanned across both team types. Following coding (Appendix E) of the communications data, some initial perspectives emerged. These initial codes were iteratively refined and ultimately expanded through immersion in both observational data and through the questionnaires participants were asked to complete following their experience with NeoCITIES. These themes were further refined and are described in this chapter with supporting quotations. These themes are not exhaustive, but rather are representative of some of the overarching leitmotifs that emerged across teams in both National and Multinational conditions. Special emphasis has been placed on assessing specifics of Multinational teams in the context of teamwork in the NeoCITIES simulation. Some integration with the quantitative data emerges in this chapter, however primary processes of data integration (Creswell, 2015) will emerge in the following chapter.

From the quantitative analyses of performance, communication, and information sharing behaviors it can be concluded that there are differences in multinational teams and national teams. While it seems that national teams on average (92%) out performed multinational teams on average (85%), the underlying reasons for these differences are complex and require a more in-depth analysis. A cross-modal interpretation of the data is presented below with the aim to generate a broader perspective of teams and develop a model of team cognitive behaviors in both multinational and national teams.
Team Cognition

“TMMs fulfill multiple functions, such as allowing team members to interpret information in a similar manner (description), share expectations concerning future events (prediction), and develop similar causal accounts for a situation (explanation) (Rouse, Cannon-Bowers, & Salas, 1992). That is, teams with a well-developed TMM should have a common view of what is happening, what is likely to happen next, and why it is happening,” (Mohammed, et al., 2010, p. 879).

In this study, the development of Team Cognition across teams was examined through an exposure to a shared task environment. In assessing the sharedness of team mental models as they emerge over time through the interactions of team members, it is necessary to articulate the nature of the current team task environment as oriented towards “a team performance situation demanding spontaneous or implicit coordination,” (Mohammed, et al., 2000, p. 127). The action-oriented nature of the current task is evident in the team processes that emerged through the communication, information, and behavior strategies of all teams.

Most of the information shared in the tasks was formulated towards developing and carrying out actions. Activities, understandably so, in the crisis environment of the simulation are more oriented to actions. In the case of teams in the NeoCITIES simulation, shared awareness was formulated as participants ascertained generalized and specific knowledge from their team members on their roles, resources and capabilities, while also understanding actions team members had taken, actions that still needed to be taken and what their own actions and roles are in the simulation.

Team Mental Models

From the quantitative analyses, the occurrence of team mental models did not vary much across multinational teams and national teams. Rather there were only slightly significant impacts
of cultural diversity when teams were moderately diverse (two team members form the same nationality and the third from another) as compared to completely homogeneous or completely heterogeneous in composition. This suggests that the task design may have created limitations on how team cognition emerges. The very role oriented nature of the NeoCITIES simulation may have set expected parameters on how teamwork should be carried out across all team types.

“Sometimes certain tasks were specific to one of the departments. Almost automatically, that unit would realize it and prioritize that above other tasks which might require more detailed communication or a set order of events,” (Team 24, Multinational Team, Police role, Indian).

This process of role prioritization as response was shared across almost all teams in both conditions. It is important to note that this emerged organically through team activities in the simulation and, most often, was not a result of a planned approach:

“Each person in the simulation was responsible for their area of dispatch, so they prioritized their responsibility. I too did the same,” (Team 7, Multinational Team, Fire Role, Sri Lanka).

This approach directed many of the team activities that occurred within the simulation, from decision-making, to problem solving and response behaviors.

Making Decisions on an Individual Basis, Forming TMMs of Task Work

The role prioritization as response emerged through specific and repeated patterns of response within teams. It directed the focus of attention on responses that related to a team
member’s role. Teams would read the events and look for key words; from there they would generate responses.

“I would first read the scenarios and then look for key words. If the scenario said something about 'chemicals' or 'riot control' for example, I wouldn't send any of my units since I knew those situations didn't deal with my task force. If at any point in the scenario said the word 'fire' or anything related to a injury or illness, I would immediately dispatch the proper units needed to help the situation,” (Team 38, National Team, Fire role).

This role prioritization as response perspective creates limitations on checking up with other team members on task progress, and status of response, however this is mitigatable through communication.

In the following section five approaches to teamwork in the current experiment will be described.

**Approaches to Teamwork**

Five main approaches to team work across teams were identified through thematic analyses of participant questionnaires (table 6-1). Responses to these questionnaires were triangulated with team communications transcriptions from the simulation, and researcher observations. These approaches were also evaluated in the context of findings from the quantitative side of the study. While five main approaches have been identified, there may be many variations on these processes.
Given the nature of the task participants were asked to complete, these five approaches were constrained by the parameters created by the NeoCITIES simulation and are very much situated in the task environment. These five approaches will be discussed in greater detail below.

**Parallel processing**

![Figure 6-1: Parallel Processing Model of Teamwork.](image-url)
A parallel processing model of teamwork approach describes an approach to teamwork that starts at a parallel, but individual response level and moves to a team approach as required by the situation (McNeese, N., 2014), then back to an individual, but parallel response. As described in figure 6-1, after receiving an event, each team member would individually read the event description and assign their own appropriate units to respond, as they felt necessary. This may be accompanied by some communication of actions taken (i.e. updating team members). Most often, these actions would occur in parallel with periodic team problem solving when issues emerged.

Once an event that required team collaboration was solved or dealt with, team members resumed a parallel processing approach. As one national team member described:

“We pretty much acted independently but at the same time communicated with each other what we were doing and kept each other in the loop. We also asked each other about if they sent resources to certain scenarios to confirm that they were sent,” (Team 26, National Team, Hazmat role).

This teamwork approach is very oriented towards a role specific taskwork team model in which team members focused their responses primarily on the capabilities of their individual roles, and did so in parallel with their team members, only coming together for events that required coordination of multiple resources from each role, or if individual problem solving was not sufficient.

“Decisions were made on an individual basis, and then evaluated by the team. Being in an emergency response situation did not allow for discussion of each individual action,” (Team 24, Multinational Team, role, Indian).
This approach, seems to represent a *divide and conquer approach* and may unintentionally cause the development of entrenchment in team processes, leading to a limited development of dynamic team responses, potentially causing team members to get tunnel vision and overlook broader problems (such as those that require team problem solving, and evaluate new information, as in hidden knowledge from briefings). One participant outlined the impact of this approach on team activities, indicating a negative impression of this approach,

“*Some of the teammates were only concentrated in informing what resources they have sent and what they think is necessary rather than discussing what resources we needed together,*” (Team 20, Multinational Team, Hazmat Role, South Korea).

**Team Consensus Approach**

![Team Consensus Model of Teamwork](image_url)

Figure 6-2: Team Consensus Model of Teamwork.

The team consensus approach (Figure 6-2) was centered on a process of teamwork that engaged individual members at the team level. In this teamwork approach, teams had little independently planned action. Instead, the course of response activity was reached through a
team-centered approach to task orientation (i.e. reading aloud the event description), identifying the problem (i.e. what is the issue), and discussing the appropriate course of action (i.e. who sends what resources).

“Basically whenever a new event came up we would alert everyone in the team then we would all read it. We would all then discuss what we thought was needed for that event and based on consensus we would send the right units.” (Team 45, Hazmat role, National Team).

This seemed to be one of the less common approaches for most teams as it involved a higher level of persistent interactivity than many teams seemed comfortable with. However, it added dimensions to a team response, as it allowed for a follow through and follow up process at the team level that worked to ensure the right resources went to the right places, and that coordination was timely.

“We spoke out loud as a team stating which resources we would need in which order and what tasks still needed more resources. We also used each others varied information to assess the status of each task.” (Team 22, National team, Fire role).

The follow through process engaged team members in identifying resources, attending to detail, and interacting with team members. The follow up process assessed that resources had actually been sent to the event, and engaged teams to rectify inappropriate responses. This approach relied heavily on continuous communications to maintain and coordinate team consensus.
**Blended Approach**

The blended approach to teamwork is a ‘blend’ of the parallel processing approach and the team consensus approach (Figure 6-3). It involves a greater level of interactivity amongst team members than the parallel approach, and more independence than the team consensus approach.

“It [decision making] was all team based. At first we would send out our units that we think is absolutely needed in the task. Then communicate with the teammates about the units sent and if they think it makes sense. So some decisions were individual while some were team based,” (Team 21, Multinational Team, Police Role, India).

Teams using the blended approach may still read the event descriptions aloud, but may act on their own at first, rather than reaching consensus first. Indeed, The blended teamwork
approach often followed a pattern of self-identification of individual role oriented responses, then team consultation, falling in line with role prioritization team mental models discussed earlier in this chapter.

“We seemed to read the situation, and then discuss while responding to it. However, if a situation dealt with a certain department, we trusted that person to see it and take care of it,” (Team 17, National Team, Fire role).

Role prioritization involved many of the individual elements from the parallel processing model of teamwork, such as how teams determined what problem needed to be addressed,

“We read the scenario independently and came to a consensus as to what resource should be allocated to efficiently handle the situation after an analysis. The resources were then dispatched as discussed,” (Team 25, Multinational team, Hazmat role, India).

However, a team’s engagement of a consensus process through communications and through team-directed response activities (i.e. sending resources based on a group decision making process) makes this approach a blend of both parallel processing and team consensus approaches.
**Leader Driven Approach**

In the leader driven approach, teams adopted a single team member as a leader to direct the team response activities. In this approach, an individual from within the team took the initiative and directed the activities of team members.

“We handled the tasks generally by reading them. The fire person usually read the important stuff kind of out loud so that we didn’t have to spend as much time individually reading it. Then we would either say ‘I’m sending . . . ’ or someone (usually fireman) would ask to get somebody like an officer or bomb squad,” (Team 26, National Team, Police Role).

The emergence of a single leader was often not done by team consensus (the team did not nominate a leader), and generally one emerged organically in the process of the simulation.

“I was role playing a leader and I did most of the communications to them rather than them telling me what to do,” (Team 46, Multinational Team, India).

Figure 6-4: Leader Driven Model of Teamwork.
The leader driven approach may have emerged due to differences in personality, or due to a lack of coordination across the team that one person may have been trying to rectify, may also have emerged due to cultural necessities for strong, central group leadership.

**Shifting Leadership Approach**

![Shifting Leadership Model of Teamwork](image)

Figure 6-5: Shifting Leadership Model of Teamwork.

This teamwork approach involved a more dynamic approach to leadership (Figure 6-5). It was primarily an emerging phenomenon, rather than one acknowledged by participants, and overlaps somewhat with the other approaches listed above. Often in the simulation, multiple events would arrive at the same time in the Event Monitor. When teams received an event, one team member whose role was required to respond would take charge and read the event, and then direct responses, as needed, from their teammates (designated by the colored arrows in the figure above). Simultaneously, when another event appeared, another team member would step in, and after either reading the event aloud to the team or to themselves, would direct team members
responses and so on. In each event, team members would exchange leadership roles as they felt
the simulation required, based most often on the primary responder to that event. This involved a
shifting tradeoff of leaders throughout the simulation and seemed to emerge fluidly as an
approach to teamwork and task allocation. It should be noted that this may not have been as
uniform as the figure above presents (this is just an illustration of the process), as some individual
members may have directed responses more than others.

Cultural Awareness

From a research standpoint, the process of conceptualizing the influence of
multiculturism on teams can be challenging. Overall, only a small portion (22 participants in the
Multinational conditions and 11 participants in the National condition) of the overall participants
articulated that they felt that there were cultural differences amongst themselves and their team
members. Many participants felt that cultural differences played no role in their team interactions
or team performances:

“No, our cultures did not play a large role in the task at hand. I don't think that culture
had an influence on our actions,” (Team 19, Multinational team, Hazmat role, Philippines).

Several participants were even offended by the implications of a question asking whether cultural
differences had any kind of impact on their teamwork.
Multiculturalism in teams

The articulation of “cultural differences” took many forms across the overall sample. In some cases an overt identification of cultural differences amongst teammates was highlighted simply through simple visual or linguistic cues:

“Yes, with partner 2, he had an accent and it was a little difficult to understand him at times.” (Team 25, Multinational Team, Fire role, United States), or simply:

“Yes, because we are from different countries...because different culture have different way to communicate.” (Team 28, Multinational Team, Fire role, Hong Kong).

In other cases overt identification of cultural difference amongst teammates was described in reflections of specific behavioral and cognitive processes, which often differed from their own. One participant described his experience in a comparison between his two team members:

“Yes, I felt my hazmat/bomb teammate who seemed culturally similar to me worked in a similar way to the way I did, I felt the ems/fire teammate thought differently in the way they acted, asking many questions before deciding to allocate resources instead of aiming to send resources quickly.” (Team 47, Multinational Team, Police role, United States).

In this case, this participant was describing the behaviors of one teammate (Hazmat role) who was also from the United States, but of a different ethnicity (Hispanic) as distinctly similar to his own, and the other (Ems/Fire role) who was from Panama as being distinctly different.
Likewise both teammates also articulated that they felt their team had cultural differences. In their questionnaires, this team felt that they all communicated effectively and shared information, (their performance on both scenarios was 72% and 73% completion of the events), but they failed to share any of the briefing information in either scenario, failing both briefing events.

The same US participant from team 47 however felt that they had adequate information sharing:

"I shared event brief pop-ups when the time of their event was happening. This information needed to be shared to complete tasks that I could not," (Team 47, Multinational Team, Police role, United States).

Evaluations of team communications indicated that for the hidden knowledge event, the team “referenced the brief, but didn’t share the information from it, spending a lot of time trying to figure out a correct response, whereas there was no discussion or mention of the event or briefing at all for the non hidden knowledge event.” (observer note). Additional evaluations from observational data suggest that this team “shared only some information about events, and made decisions on that (almost all of their events in progress require additional resources). It seems like there is a desire for quick consensus in this group, no one really discusses responses or disagrees with suggestions even if they are incorrect,” (observer note). And while their communication (updating one another, asking for assistance) seemed to increase during the second scenario (hidden knowledge), the team still ran into issues, “coordinating actions and behaviors, but still sending the wrong resources and not going back and looking at the event progress” (observer note).

Additionally, the impact of multiculturalism may emerge in more subtle ways on how teams interact with one another, communicate and share information. These aspects can, in turn,
be influential in the shared development of team mental models across the team. Subtle cultural influences on team interactions and behaviors can have larger ramifications to teamwork. As suggested by one participant:

“I felt like our unfamiliarity made us more shy of each other, and not really suggesting opinions to each other. With more time spent working with each other will improve this aspect of this simulation” (Team 6, Fire role, Multinational team, ‘Asian’).

This lack of familiarity made it more difficult for this team to establish some common ground and to develop a shared understanding of how their team would accomplish the goals of the simulation. In particular, the cultural diversity amongst participants can lead to inconsistencies in perspectives of how teamwork was performed. For example in team 6, two members felt that communication could have been improved (in addition to the quote above):

“We should have communicated better to handle events. Although we had a low failure rate towards the end, but the damage could have been reduced further had we communicated better,” (Team 6, Police role, Multinational team, India); however the third member felt that his “Team communicated effectively by communicating only whenever we needed to,” (Team 6, Hazmat role, Multinational team, South Korea).

These subtleties can seem insignificant, however, they may reflect varied cultural perspectives on teamwork and aspects of team performance that affect teams at the outset. While the Hazmat participant may have felt communication was effective, it may have been aligned

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9 Quotes are from the questionnaires filled out by participants. They have been edited for misspellings.
with a perspective of teamwork that suggests they communicate only when individual level responses were insufficient on their own:

“Each of us evaluated the incidents on our own and made our own decisions to send out resources. However, when more resources were needed, we communicated to let each other know to send which resources to which incidents,” (Team 6, Hazmat role, Multinational team, South Korea).

For national teams, the articulation of “cultural differences” most often took the form of participants identifying and pinpointing ethnic or racial differences in their team as an overt and impactful cultural difference:

“Even though we were all females, I could tell based on how we were each dressed and the ethnicity differences between us that there were cultural differences” (Team 22, National Team, US/French dual citizen).

**Approaches to multinational teamwork**

Although, it seems that while several teams articulated perceived cultural differences within their team, there appeared to be many approaches to multinational teamwork, allowing for team members to overcome potential barriers to performance. In particular, several teams engaged in active interaction and coordination behaviors.

For example, while one such team (team 11) articulated that they felt their team had cultural differences, it was observed “this team conferred the whole way through the scenarios, they discussed a lot of what needed to be sent, what they are going to send. There seemed to be a lot of active sense making and problem solving together, and while it seemed that the events that
required coordination of their resources gave them a lot of trouble, they kept revisiting the issues and try to figure it out” (observer note).

For another team (Team 28), the approach to teamwork in this multinational context took the form of a more single person leadership style, where one team leader emerged. In this case it was to the detriment of the team’s cohesion, communication and information sharing. The leader that emerged in this team took a very directive role in his team’s activities and actions, “even actively moving between his teammates computers and directing their responses. This person dominated the overall communications (speaking a little over half of the time) to the detriment of his own performance, neglecting some of his role specific events” (observer note, team 28). This was accompanied by an observation from the researcher that “I would not say that the other team members are giving active or accurate updates to him [team leader], in fact despite his directives, only about half of the resources from each member actually got sent to the events in question” (observer note).

**Perspectives on Prioritization**

Prioritization of tasks took many different forms across the teams. In some cases, how teams prioritized tasks reflected how they approached teamwork. Reflecting the parallel processing teamwork approach discussed above, one multinational team member outlined their perspective on how their team prioritized tasks:

“We all seemed to prioritize tasks in a parallel level as the tasks became available. So I don’t think that they [the team members] prioritized their tasks any differently than I did,” (Team 46, Multinational team, Police role, India).
This approach to prioritization emphasizes an individual role-directed process of problem solving and decision-making and ascribes a certain shared modus operandi across the team. As one participant discussed:

“*Yes, all of us had a different unit we were responsible for and I think each of us prioritized our units more than the other units.*” (Team 15, Multinational team, Fire role, Dominican Republic).

It also reflects a very action oriented, reactive prioritization to problem solving, where teams address events as they become available and do not engage in planning of coordinated actions, or a team wide response.

In focusing on the multinational team perspectives of prioritization, possible areas of cultural conflict become apparent. Varied cultural perspectives and their role in how members of multinational teams work together during cognitively intensive tasks, such as those in the NeoCITIES simulation, reflect one of the primary issues that emerge for multinational teams. In a shared task environment, the prioritization process includes identifying what kinds of tasks will be responded to first, and which will be secondary. It also articulates methods of approach for dealing with issues that may be present in the task environment, and directs how team members will engage with the problem space. When multiple prioritization perspectives are present within the same team a loss of common ground may occur leading to annoyance or conflict, a loss of sharedness of mental models of the task environment, and potentially a loss in inter-team engagement or interactions. Several examples emerged:

“*I think my teammates prioritized task accuracy, whereas I prioritized getting the most number of tasks right. So they were more concerned about sending the "right" resources to the event,.*
whereas I preferred to just try a bunch of different things and see if they worked.” (Team 43, Multinational team, Hazmat role, Malaysian).

“I prioritized tasks by which took the longest to resolve over newer tasks. My teammates seemed to focus on the new tasks even though we hadn't resolved the original task first. However, we all prioritized the collaborative solutions out of everything when they first came in. Afterwards, we shifted back to our original prioritization methods.” (Team 34, National Team, Police role).

“I feel the fire/ems teammate was more concerned with being correct that being timely, unlike my other teammate and I,” (Team 47, Multinational Team, Police role, United States).

“I believe that my teammates were more worried about getting their units deployed than they were about what order they were being deployed in if that was situationally relevant. Instead of prioritizing the team tasks they prioritized their own tasks,” (Team 47, Multinational team, Police role, United States).

“Partner one had a tendency to throw everything at a situation, rather than stopping and analyzing the situation and evaluating the appropriate needs. Partner two had a tendency to just sit back and wait to be told what to do for the various events as they occurred,” (Team 36, Multinational Team, Fire role, Canada).

While at the surface level, it may seem that differences in prioritization may be insignificant (and they may prove to be) to overall team response behaviors, they can still represent radically different approaches and perspectives that will require negotiation by all team members.
The Role of Conflict

While several diverse perspectives on prioritizations were highlighted in the section above, it is notable that across most teams, multinational and national, there is a lack of reference for overt conflict experienced by teams. Observationally, there was not much open conflict amongst team members that created an awareness of culturally based differences in approaches required teams to negotiate across cultural spaces to accomplish team goals. One participant sums this up nicely:

“I don't think that I had much cultural differences with my team because we were all heavily influenced by U.S. culture, around the same age, and were not working on anything particularly controversial. Yes, there were slight nuances like gender and race—and maybe others like religion and sexuality that cannot be seen—but it did not affect our overall performance. Also, we only worked together for 2 scenarios for less than an hours worth of time so nothing presented itself as a cultural clash. There can be something said about how our identities can clash because of how we were conditioned socially, but in this short amount of time nothing was apparent”

(Team 34, National Team, Police role).

While for many teams it seemed to be the case that the nature of the task, and the time constraints on the task may have limited overt conflict amongst team members, some participants did identify occasions where they observed specific cultural or linguistic ‘triggers’ that impacted their perspectives and approaches to the task and their teams.

As described by Earley and Mosakowski (2000), the development of a hybrid culture within multinational teams is the process of negotiation of a new cultural space for a multicultural teamwork to occur. This hybrid culture emerges through the negotiation of conflict amongst team
members. The benefits of multinational teamwork can be realized in this “space of conflict.” One participant describes this:

“Minor cultural differences, the person in charge of Police asked me what vandalism meant; him not knowing that one phrase may have had affect of his judging of situations. My teammates were all very goal-oriented, but I think our slightly different lines of thought due to cultural differences may have helped cover some spots we would miss if we were all well the same.” (Team 50, Multinational Team, Fire role, American/ Malaysian dual citizen).

Diverse cognitive perspectives on prioritization, problem solving, decision-making and teamwork approaches can be meaningful to team cognition and to overall team performance.

**National Teamwork**

National teams showed a shared trend for a particular type of teamwork team mental model in which teamwork approach and task allocation was tightly coupled across the team. The large majority of all teams in this condition employed an independent decision making process for role specific responses to the events, and only involved the team for more collaborative decision making on more complex tasks.

“For simple tasks, there was not much collaboration. For more complex tasks, we communicated the order that units should be dispatched and notified each other when we had sent them. First, we read the task and determined which unit should be sent. Then we talked to each other to make sure the proper unit was sent and notified each other if there was an error in our decisions (incorrect unit, need more units, etc.).” (Team 34, National Team, Fire role).
While this may seem to indicate a very divided approach to teamwork, this was accompanied in many cases by a strong, consistent communication pattern in which team members read event descriptions out loud, acted on their own, but still updated team members on actions taken, and any particular needs that had not yet been met by their response:

“We would read over the case and depending on which team [role] it impacted one of us would vocally say something to the other so we knew it was being taken care of. For tasks that were not related to me specifically, I would just make sure whoever was responsible was taking care of the issue,” (Team 49, National Team, Police Role).

The levels of communication during this process varied from very continuous to more periodical, and as suggested by this participant, omissions in initial resource allocation communications seemed common:

“The team handled each task by reading the task description and initially reacting by sending resources, reporting on what they sent, and prompting others to send resources if more were needed. I often omitted the report on initial sending of resources unless prompted by a teammate. If resources were missing for a task, the team would prompt one another to send the resources that were likely still needed, and sometimes we briefly discussed which would be needed,” (Team 26, National Team, Fire Role).

Indeed, many teams relied on communications only when an individual response alone was not effective. This may be due primarily to a perspective of trust that team members will address the role specific tasks identified within the events, relying on the roles assigned to them as taskwork allocations.
“We seemed to read the situation, and then discuss while responding to it. However, if a situation dealt with a certain department, we trusted that person to see it and take care of it,” (Team 17, National Team, Fire Role).

Teams in the National condition that employed a more collaborative approach to teamwork over the individual to team approach (McNeese, 2014) also seemed to share a common mental model for their teamwork. In more collaborative teamwork processes, team members were engaged across all stages of problem identification (i.e. reading the events), identifying responses (i.e. identifying appropriate resources), coordination of a team response (i.e. sending multiple resources), updating team members (i.e. actions taken, status of events), and reassessing incomplete tasks (i.e. coordinating additional resources for an unsolved event).

“One of us would read the situation out loud and clearly stated the order in which we needed to proceed. Then each of us would say aloud which of our units we would dispatch. After, we would each say when we had dispatched our units so we could follow the order stated in the alert. Afterwards, if there were any issues one of us would say aloud what the issue was and we would come to a consensus on how to resolve it by just saying ideas we thought would work or just committing to an action then verbalizing it later,“ (Team 34, National team, Police role).

**Temporal Awareness/ Sensitivity**

In general, US teams seemed very focused on time issues. Having a quick response to events is emphasized across the sample as an aspect of which they are particularly “proud.” Uses of words (repeatedly) we [I] got to it “quickly and efficiently” and “responded in a timely
“I dealt very well with it [information]. Even as a lot of it would come in at once, I kept my composure and read all of the information as thoroughly as I could without spending too much time doing it,” (Team 38, National Team, Fire Role). Another US participant asserted: “I think I dealt with it well. I didn't feel overwhelmed. An example would be when we had almost over 6 different scenarios to deal with at once, I was able to help out and figure out what we needed to do, even though there were so many there,” (Team 18, National Team, Hazmat Role).

This sentiment is repeated across many of the National team participants.

Additionally, very few American teams felt like they ran into problems dealing with the information they received and applying it to solving events. These teams exhibited high confidence of their individual performance. In contrast, the language in multinational teams seems a bit softer than in the national teams. Many participants in the multinational team condition felt they handled information well, while in a positive direction, there were many more qualifiers attached, accompanied by an overall tone that suggests they felt there could have been improvement as compared to a starkly similar perspective from the US team members, such as: “More communication could be done in terms of the timing” (Team 28, Multinational Team, Police role, India), and “I think I did pretty good. The information was coming in at a good pace and gave me time to manage each event,” (Team 14, Multinational Team, Police role, Thailand).
Impact of the “crisis”: Feeling the time crunch and the impact on approaches

The nature of the task in which teams were employed was thoroughly situated in a crisis environment. This environment and its impact on cognition was emulated through the simulation via an added construct of time, in which participants were only given a set amount of time to respond to each of the events throughout the course of the simulation. Additionally, the crisis environment was emulated through a manipulation in task load, in which teams had multiple events to respond to at one time, as well as multiple kinds of events (i.e. to respond individually, as a dyad, or as a full team) to at one time. The impacts of each of these aspects of the crisis simulation created a kind of cognitive stress for teams trying to solve the events. This seemed to be felt particularly by multinational teams who referenced the nature of the crisis environment as influential in their decision-making processes. In such a case one participant described their decision-making process as:

“Mostly on my own. That was a lot already. I believe it happened to my teammates as well—we were too busy managing our own resources to communicate!” (Team 15, Multinational team, Hazmat role, China).

Time Stress in Multinational Teams

From an evaluation of participants’ perspectives, it becomes clear that the influence of time stress influenced many aspects of individual and team cognition. This impact ranged from teamwork, team collaboration, and information processing, to the evaluation and sharing of the hidden knowledge briefings. In fact, it seems many participants acutely felt the impact of task
load increases when they would have to respond to several events at once. One participant discussed:

“It was hard to process all the information that was bombarded at the same time” (Team 37, Multinational Team, Hazmat role, South Korea).

This time oriented stress on cognitive processing carried over to how teams communicated with one another, having ramifications for both coordination abilities and performance. As articulated by one participant who was very dissatisfied with their team’s communication:

“We did not communicate enough, especially for those events that needed timing and coordination. But we just had no spare efforts to communicate,” (Team 15, Multinational Team, Hazmat role, China).

The impact of the time stress felt during the simulation also carried over to how teamwork was carried out. One participant described:

“Once I got used to figuring out how to find the information about the event that I could use to assess appropriate response to the event, I think I deal with the information appropriately. However, team collaboration sometimes confounded this, because we'd get 'stuck' or held up figuring out how to respond to a particular event, while two new ones have already popped up,” (Team 36, Multinational Team, Fire Role, Canada).
The manifestation of temporal team mental models across teams was influenced by the perceived time stress required by responses to multiple events within the simulation. This impacted a lot of how teamwork was carried out, as discussed by this participant from team 24:

“Due to the timeliness component of the simulation, I chose to make decisions on my own and not to involve the team in my personal decision making process. Rather, I used them as consultants who could update me on their actions so far, and I could assess if any more action was needed on my part,” (Team 24, Multinational Team, Police Role, Indian).

While an approach of starting with an individual, then moving to team response was also described by (McNeese, N. 2012), it seemed that to this participant, the influence of the time management requirement in the simulation necessitated an individual decision-making process that later integrated the team.

**Interventions**

Many international teams discussed the need to adjust their communication processes in future team activities in order to deal with perceived shortcomings in performances. It may be the case that multinational teams need an “early and often” communication structure to effectively overcome cultural distances and develop shared team cognition. This is also accompanied by an emphasis on the need to develop interpersonal relationships. Across the swath of multinational participants it was clear that many people felt that many aspects of teamwork could have been improved across several areas—namely planning, leadership, and communication, among others. Most teams that marked the quality of their team as “fair” or
“poor” also indicated that improvements needed were either, making a plan with teammates prior to the scenarios, more/ better communication and leadership.

**Pre- Scenario Planning**

Multinational team participants emphasized the need to discuss and plan with their team members before the scenario emerged when asked to reflect on what they would want to do differently next time. A need for pre- scenario planning activities in future team activities was highly emphasized by participants on the multinational teams.

“Next time I would talk with teammates before starting the tasks. I would tell them to listen to each other. I would tell them to plan first then open the tasks,” (Team 11, Multinational Team, Hazmat Role, Kazakhstan).

Planning activities were articulated in discussions of how the team should approach communication, problem solving and coordination activities, as well as better discussion of leadership roles, and terminologies. As one participant discussed, they would like to:

“Make an agreement with the team in advance to discuss the event happenings, decide what resources were needed to address it, and then decide how to coordinate the sending of resources appropriately to address the event need,” (Team 36, Multinational team, Fire role, Canada).

Another participant described a change in problem solving strategies that could have been addressed through discussion with the team prior to the simulation scenarios.
“Before the game starts, I would make agreement on terms and stuff so that there is less confusion in chaotic situation” (Team 37, Multinational Team, Hazmat role, South Korea).

Another participant expressed dissatisfaction with her team and outlined several issues that could have been resolved through planning activities prior to the simulation:

“We could have planned the responses since the beginning. The way to response each task could be explored in a briefing. For example, one could deal with all new situations and another could monitors the ongoing tasks. The final decision could be for a team leader,” (Team 40, Multinational Team, Hazmat Role, Brazil).

Leadership

In line with the need for planning activities prior to the scenario, a presence of leadership was often included as an aspect of teamwork many multinational teams felt was lacking.

“Leadership. There is no leader in our group, and no body is really talking. I wish one of my teammates can just talk about the event and make more comments” (team 40).

In fact, some participants attributed a lack of leadership to poor performance and lack of communication within their team.

One participant attributed lack of team leadership as influential in how his team interacted, suggesting that without someone in a leadership role, team cohesion was negatively impacted. Outlining and identifying some of the expectations of a leadership role, one participant described his experience in the simulation (rating his team as “poor”):
“A lot of times the fire role guy even doesn't know that he can send ambulance. It's really important to be informed about others' roles and their capacities. We didn't choose a leader and that leads us to confusion about orders,” (Team 41, Multinational team, Police Role, China).

Often it was felt that a leader was needed to merely initiate communication and discussion for team members, indicating that several felt an extra barrier to team interactions, influencing communication behaviors, and the development of team cognition.

“Communication is a key one not only in this exercise. Also, having a decision structure and a leader would help if conflicting opinions arise. Finally, cohesion and identifying with the team is the third key facet involved in this experiment” (Team 24, Multinational Team, Hazmat Role, India).

The articulation of an absence of this team function may indicate an emphasis of importance for many participants across cultural groups.

**Communication**

Consistently, teams indicated that communication was one of the primary requirements of a good team:

“I believe that some characteristics that differentiate a good team from a bad team are the teams use of communication. In order for a team to work effectively they must communicate well and
get their points across to each other to better understand how they can achieve their goals. Communication is very important in the resolution of problems and differentiates a good team from a bad team," (Team 24, Multinational Team, Fire Role, Mexican American).

Communication, however, featured as a major aspect of teamwork that produced a lot of anxiety for participants. The low level of confidence many participants, both National and Multinational, had in their team communication indicates that there were some significant barriers to inter-team communication. As one participant described:

“My team did not perform well in being confident in their responses. The unsure nature with which we spoke to one another made us uneasy and not confident in our decision making process. Be more communicative and more confident in how I talk to my peers. I thought I was helping them by sugar coating my communication, but it only opened us up to being unsure about our decisions. However, these differences are mostly applicable to only scenarios like this one,” (Team 34, National Team, Police role).

In the multinational team condition, some linguistic aspects emerged as somewhat troublesome for some participants who did not have English as a first language. While it is important to note that this seemed to effect only a handful of participants, there were some impacts related to how those participants processed communications from their team members, particularly given the impact of cognitive load and time stress presented by the simulation (by introducing several events at once).
“As teammates sometimes spoke at the same time. At first I had a difficulty and ask again, but this was a minor issue. I tried to recognized the voices since had no time to have a face-to-face conversation,” (Team 24, Multinational Team, Hazmat Role, Turkey).

These barriers to communication were emphasized by the nature of the simulation task where teams acutely felt the stress of having to respond to several events at once, creating breakdowns in communication and teamwork:

“We did not communicate enough, especially for those events that needed timing and coordination. But we just had no spare efforts to communicate,” (Team 15, Multinational team, Hazmat Role, China).

In addition to this, a significant number of teams expressed a need for a higher level of communication during the scenarios. These teams emphasized several key aspects for improving communication. This included openness, which focused on teammates expressed or unexpressed willingness to be a communication partner:

“I think next time we would encourage each other more and be more open when communicating,” (Team 25, Multinational team, Police Role, Bengal).

Improving the efficiency of communication was also viewed as a needed improvement for many teams, who viewed better, more focused communication as a mechanism for a better operational understanding of what each team member could do. One participant expressed a desire to:

“Communicate more efficiently and get a full awareness of my teammates’ capabilities,” (Team 37, Multinational team, Police Role, China).
This sentiment was echoed somewhat regretfully across the sample, which felt that pre-exercise communication would have benefited them greatly:

“...*We should have communicated our dispatch's capabilities before the exercises, rather than figuring out each other's capabilities during,*” (Team 17, National Team, Hazmat role).

Teams articulated the benefits of communication within their experience of the simulation. One participant discussed this:

“I think we did pretty well when it came to dealing with incoming information, though at times it seemed to get a little hectic. It became better the more we communicated though, since others feedback really helped the decision making process,” (Team 26, National Team, Hazmat Role).

**Interpersonal**

Many participants in the multinational team condition expressed the desire for greater interpersonal connectivity. This desire was not shared by the national participants, suggesting multinational teams perhaps felt the impact of the ad hoc nature of team formation more acutely than national teams did. One participant elucidated this feeling:

“I need friends to be my teammates. Not strangers,” (Team 27, Multinational Team, Hazmat Role, China).
Another participant had a lot of anxiety about the interpersonal relationships of their team, and in particular was concerned about being wrong, being disliked for it and hurting team member feelings:

“It was not so good. Sometimes I don’t know if I sent right resources so I would just send all I have and see which one’s not right. And since I don’t understand my teammates’ role quite well, I can’t just tell them what to do or that would hurt their feelings if I was wrong.” (Team 41, Multinational Team, Police Role, China).

It seems that affording multinational teams extra time to develop common ground could alleviate some of the emotional discomfort many participants professed having. Increased time with teammates and with the simulation allows a great level of interpersonal comfort to be reached:

“Better communication and getting to know the teammates better. And with regular usage of the system, it gets easier,” (Team 19, Multinational team, Fire role, Indian).

The nature of crisis response and management limits this allowance greatly, but it does present interesting implications for future research and intervention possibilities.

Summary

Within this chapter, the findings from the Qualitative analysis are described. These findings were discussed within the context of several important team related concepts. These results were triangulated from several different sources of data to include team communications,
participant questionnaires and researcher observations. In summary this chapter describes several key findings:

1) It presents role prioritization as process as a Team Mental Model framework
2) It presents 5 approaches to teamwork
3) It explores both Multinational and National approaches to teamwork
4) It discusses several key Factors of Awareness, *Cultural and Temporal Awareness*
5) It presents several future Interventions

In the following chapter, a discussion of the results of the two sets of analyses outlined in the previous three chapters is presented.
Chapter 7

Discussion

In the current chapter, I discuss the integration of the results from the quantitative and qualitative portion of the current study, examining both theoretical and practical implications. A mixed methods design approach was emphasized as a way to overcome the limitations of a single method alone. The process of integration involves evaluation and summary of the results from each methodological approach. The goals of integration are to not only represent the findings of the study overall within the greater context of multicultural team cognition, but to also assess the efficacy of this particular mixed methodological and blended (pragmatist) epistemological approach in this context. Ultimately, this study aims to serve as a confirmation of mixed methodological designs for use in the study of team cognition as well as cross-cultural comparisons. Following the integration and summary of results where the manipulations and measures of this study will be evaluated and assessed in terms of hypothesis and research questions, this chapter will discuss the study’s practical and theoretical contributions, limitations and plans for future work.

Study Sample

The study sample was selected purposefully and pragmatically in order to evaluate teamwork in multinational and national teams. Often, multiculturalism in samples is overlooked, and certainly is underreported within cognitive studies (Henrich, et al., 2010). While multinational teamwork is often commonplace, the full implications of national diversity on team cognition are still understudied. The focus of this study was on multinational teamwork as it
compares to single nationality teamwork, rather than the implications of a cognitive behavioral perspective on particular cultural groups within team settings. For this study, the primary focus for sample recruitment was for national diversity in one condition, and national homogeneity in another—the level for both conditions was deemed sufficiently met following review of the demographic information participants provided.

This study took place on a university campus, and relied on the participation of students. However, it is felt that many of the criticisms posited by Henrich et al. (2010) on the nature of psychological research as singularly evaluative of Western, well educated, college sophomores were avoided through the incorporation of participants from a diverse spectrum of nationalities, ethnicities, linguistic backgrounds, level of education, age groups, and genders. The levels of diversity within teams in the multinational team condition have been documented throughout the study, which I view as a distinct positive of the sample, rather than a limitation.

Findings Summary

Hypotheses

Several hypotheses were tested in the quantitative portion of this study. Table 7-1 presents a summary of the results of theses tested hypotheses.

10 For a discussion of limitations on the use of nationality as a measure of culture, look at the limitations section below.
Table 7-1: Summary of Support for Hypotheses.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
<th>Results</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Team Type impacts Team Performance</td>
<td>Supported</td>
<td>Multinational teams performed worse than National teams.</td>
</tr>
<tr>
<td>2)</td>
<td>Team Type impacts Team Mental Models</td>
<td>Partially Supported</td>
<td>Event TMM accuracy lower for Multinational teams.</td>
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<tr>
<td>3)</td>
<td>Gender Diversity impacts Team Mental Models</td>
<td>Partially Supported</td>
<td>TMSS accuracy lower for mixed gendered teams.</td>
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<td>4)</td>
<td>Team Type impacts Communications</td>
<td>Partially Supported</td>
<td>Differences in foci of communication, and information sharing</td>
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<tr>
<td>5)</td>
<td>Team Type impacts Sharing of Hidden Knowledge</td>
<td>Supported</td>
<td>Multinational teams performed worse on scenarios with hidden knowledge events.</td>
</tr>
<tr>
<td>6)</td>
<td>Level of Team Diversity Impact on:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6a)</td>
<td>Team Performance</td>
<td>Not Supported</td>
<td>No differences</td>
</tr>
<tr>
<td>6b)</td>
<td>Level of Communication</td>
<td>Partially Supported</td>
<td>No difference in total communications, differences in foci of communications</td>
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<tr>
<td>6c)</td>
<td>Information Sharing</td>
<td>Supported</td>
<td>Information sharing different between national and multinational teams</td>
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<tr>
<td>6d)</td>
<td>Teamwork TMM</td>
<td>Partially Supported</td>
<td>Moderately diverse teams have lower TMM similarity</td>
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<tr>
<td>6e)</td>
<td>Temporal TMM</td>
<td>Not Supported</td>
<td>No differences</td>
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<tr>
<td>6f)</td>
<td>Events TMM</td>
<td>Supported</td>
<td>Moderately diverse teams have lower event TMM similarity and accuracy</td>
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Performance

In this study, several different aspects of performance were explored. Overall team performance was evaluated at the level of the team composition (national or multinational), and at the level of performance on interdependent team activities. These evaluations found several interesting findings, and recognize the indirect impact of hidden knowledge within a scenario on team performance.

Overall Performance

The main effect of team type (National or Multinational) on performance was found to be highly significant, where National teams overall performed significantly better than Multinational teams, supporting hypothesis 1. Specifically in evaluating performance within the simulation, very few variables other than national composition seemed to impact team performance. While team mental models have been found to be covariates of team performance, the current model did not much find support for this. The only other significant predictor of performance for teams in this study was having team members with previous military or emergency crisis management experience, though this only account for a small amount of the variance (2%), and this effect disappeared with the addition of other predictors within the model.

On Interdependent events, a significant interaction effect revealed that while both teams were impacted by the presence of hidden knowledge, Multinational teams were more affected than National teams. National teams performed much better on interdependent events in scenario 2. National teams performance greatly differed between scenarios that had hidden knowledge compared to when they did not. Performance by both teams in both scenarios was impacted by the presence of hidden knowledge.
In identifying influencers for team performance between national teams and multinational, the following sections will evaluate several aspect of team cognition within the context of the current study.

**Team Mental Models**

Events TMM accuracy was found to be lower for Multinational teams and TMSS accuracy was found to be lower for mixed gendered teams. Otherwise, no significant difference in the occurrence of team mental models (TMSS or TMM) for teamwork, timing, or events for multinational teams or national teams, or in comparing male teams with all female teams.

However the level of diversity within teams (i.e. moderately diverse nationality composition or mixed gender composition) did play a role for mental models similarity and accuracy. In the following section each of these concepts will be evaluated.

**Team Member Schema Similarity**

**TMSS Congruency**

The congruency measure of team member schema similarity reflects the amount of overlap in an individual’s response to those of their partners. Congruency looks at all of the responses of team members and assesses their levels of overlap. In evaluating the effects of diversity of team composition on TMSS congruency, no significant differences were found for the level of team diversity or gender composition. As shown in table 7-1, there was a significant interaction effect between the level of team diversity and gender composition, which was found to be a significant predictor of TMSS congruence. TMSS congruency across teams was
significantly influenced by the moderate levels of team diversity in combination with all gendered teams, which created greater distance in overall congruence of “self” measures of teamwork in the TMSS measure. This supports hypothesis 6d, and the null is rejected.

**TMSS Accuracy**

TMSS accuracy reflects the level of shared knowledge team members ascribe to their team members versus what team members’ actual perspectives may be. In its suitability for use as a measurement tool in the current study, Rentch and Klimoski (2001) found that lower diversity in team composition led to higher levels of shared team member schema similarity. “Theorists have proposed at least three likely antecedents of team member teamwork schema agreement: team composition, team membership acquisition mode, and team size” (Rentsch & Klimoski, 2001, p. 108). The hypothesis that teams with higher levels of diversity (the multinational team condition) would have lower levels of TMSS similarity was not supported.

A main effect of gender composition was found to be significant predictors of TMSS accuracy. Uniformly gendered teams had higher levels of TMSS accuracy than mixed gendered teams. There was no significant interaction effect between the level of team diversity and gender composition.

**Pairwise Grids**

**Teamwork Team Mental Models**

It was found that for teamwork, moderately diverse teams had lower levels of TMM similarity than either completely homogeneous teams or completely heterogeneous teams. There
were no differences in the level of team mental model similarities of teamwork in all male teams and all female teams. While the analyses revealed that team diversity approached significance as a predictor of the occurrence team mental model similarity for teamwork, there were no strong effects of team diversity on the occurrence of shared team mental models for teamwork accuracy. This finding suggests that the team members created a shared operational environment for how teamwork should be carried out given the simulation context. In the qualitative study, it was found that teamwork approaches emerged organically through a team’s interaction with the simulation and with their teammates, but was highly influenced by role prioritization as a process for both teamwork and taskwork approaches. The type of team approach that teams adopted seemed to be shared, though not necessarily liked, by all of the participants within that team, which would diminish cross team conditional differences in the sharedness of team mental models, if they are present.

**Temporal Team Mental Models**

The current study sought to continue the inclusion of temporal team mental models discussed by Mohammed et al. (2015). In addition to perspectives of how things should be done (taskwork) and the structure of doing them (teamwork), when they will be done (temporality) is equally relevant to the development of shared mental models within a team. While it was found by Mohammed et al. (2015) that temporal mental models contribute to team performance, the current study found that differences in the level of team mental model similarity and accuracy of teamwork based on team diversity, gender composition of the teams, and interaction effects between team diversity and gender composition were not supported. Hypothesis 6e was not supported by this measure. This was a surprising result, as it was hypothesized that teams would have varied team mental models on timing aspects of the simulation as a result of cultural
diversity on teams. Cultural perspectives of time are often viewed as impactful on teamwork. The lack of substantial differences in temporal team mental models between multinational and national teams may be a result of the simulation design, which creates a standardized parameter for team activities. In addition to this, events are closely tied to the simulation clock. This level of standardization may have removed any possible impacts of national perspectives on temporality.

*Events Team Mental Model Similarity*

The level of similarity and accuracy of team mental models on events was evaluated based on pairwise grids. Events were included as a metric for how participants viewed and understood relationships between events within the simulation. While it was found that there were no large differences in the level of similarity in participant responses within their teams between national and multinational teams, the level of diversity within a team was significant. Moderately diverse teams had lower levels of similarity and accuracy of team mental models than either completely homogeneous teams or completely heterogeneous teams in their similarity scores. This indicates a slight trend for worse team mental models in moderately diverse teams. This suggests that in some cases, moderately diverse teams did not adequately evaluate the more abstract connections between events and their relatedness, suggesting that there may have been a lower level of shared organization of knowledge of the simulation events, or that other aspects of the simulation impacted teams. Moderate levels of diversity within teams have been found to negatively impact a variety of team interactions and processes. It may be that it creates disconnect in how shared knowledge is developed.
Comparing Measures

Both team mental model measures in the current study focused on a couple of different aspects of the team mental model concept. The Team Member Schema Similarity measure reflects more generalized perspectives of teamwork, whereas the Pairwise grids measure was more situated within the context of participants’ experiences within the simulation.

While effect decay is a possible issue, implementing the pairwise grids metric immediately following participation within the simulation minimized this. The lack of multiple data collection points may have limited the sensitivity of this measure in assessing temporal mental models for the simulation events, and the ordering of team responses. However, it seems that the congruence of TMSS across teams was significantly influenced by the moderate levels of team diversity in combination with all gendered teams, which created greater distance in overall congruence of “self” measures of teamwork in the TMSS measure. This was not as well detected in the pairwise grids, though there were trends towards diversity as being significant in teamwork team mental models across teams.

Looking at the Level of Diversity in Teams

This study found an impact of moderate diversity on team mental models. It is often the case in multinational teams that information about culturally defined team processes emerges, as cultural styles conflict and must be overcome to achieve team or mission goals. In multinational teams, aspects of cultural differences seem to create issues for the development of shared team mental models, particularly when members align on subgroup fronts, where they are unlikely to engage in appropriate coordination activities, or simply do not know that they are missing anything at all. Carton and Cummings (2012) define a subgroup as “a subset of team members
that are each characterized by a form or degree of interdependence” (p.441). Subgroups emerge from the nature of a team’s composition.

Research aimed at understanding the impact of team characteristics on team dynamics, processes and outcomes has identified the development of subgroups as having a strong impact on the overall performance of the superordinate group (the team as a whole). Subgroups form from naturally occurring ‘faultlines’ (Lau & Murnighan, 1998) that are contextually emergent depending on group configuration as well as external forces. Lau and Murnighan (1998, 2005), utilizing an analogy from geographic tectonic movements, propose a holistic approach to understanding diversity and its effects in teams by suggesting that there are hypothetical “break off” points for members of teams based on perceived differences in physical (demographical), imposed (managerial), mental (knowledge), or personality characteristics that could potentially lead to the development of subgroups within a team (Lau & Murnighan, 2005). In multinational teams, the nature of team composition can have an enormous effect on group processes and outcomes, in which heterogeneity can affect trust, group commitment, communication and cohesion. Ayub and Jehn (2006) discuss that in a multinational team setting, “Germans became ‘more’ German and Americans became ‘more’ American” (emphasis added), explaining that context can lead to a greater trait identification by individual team members with their subgroup counterparts as they seek to reaffirm their membership to a specific group (p.182).

In the current study, there is some evidence to support potential alignment on subgroup fronts for moderately diverse teams, but not enough power was present to evaluate this concept fully within the quantitative study (Lau & Murnighan, 2005; Smith & Lindgren, 2010). Many of the manipulations within this study design may have been impacted by the lower sample size common to team research, which may not be sensitive enough to pick up the subtleties of culture as it influences personal and team cognition in these settings.
Integrating Communication Results

In many past studies, NeoCITIES has primarily been implemented as a distributed team simulation (Hamilton, et al., 2010; Hellar & McNeese, 2010; Mancuso, Hamilton, et al., 2011; Mohammed, et al., 2015). This study represents the first time that NeoCITIES has been deployed for collocated teams. For this to occur, the manipulation of communication from a primarily text based chat within the simulation was replaced by the allowance of verbal communication by participants throughout the simulation. This shift allowed for team processes to be observed and recorded with a greater level of detail than afforded by communication chat in a distributed setting. This revealed a lot about the interactions of participants with their team members and with the NeoCITIES simulation itself.

The methodological examination of communication emerged in this study through a mixed approach. Namely this occurred in the iterative development of a coding scheme, which were assessed quantitatively for cross- team type differences. This coding scheme was then utilized to inform the development of themes in the qualitative study by identifying some areas of focus and anxiety for teams within their communications during the simulation.

The quantitative analyses of communications suggest that while there was a general trend for teams with greater levels of homogeneity (gender and nationality) to communicate more, this finding was not found to be significant, which does not support hypothesis 2. For overall levels of communication, the expectation that multinational teams would speak less overall than national teams due to a lack of common ground was unfounded within the current study. While individual cases suggest that communication varied across the two types of teams, the overall trend between groups suggests that multinational teams communicated at a similar, if somewhat lower, rate than national teams. However, some of the foci or emphasis of those communications were found to be significantly different across the two groups, partially supporting hypothesis 2.
National teams focused on coordination issues more frequently than multinational teams, as a higher number of communications by national teams focused on the coordination requirements of the simulation and sought to actively respond as a team. However, along this note there was a greater expression of dissent for coordination being necessary or where individuals felt that they were not needed within national teams. It may be that national teams felt more comfortable disagreeing with team members, or may be due to cultural team processes specific to US teams. McHugh et al. (2008) described this communication style, suggesting that US teams tend to make decisions collaboratively by voicing dissent in the decision meeting, actively challenging leadership and other team mates, and teasing out the specifics as they go.

Multinational teams asked slightly more questions or asked for help significantly more often on how to do things in the simulation than National teams. This may be a potential reason for the differences in team performance, as multinational teams may have struggled with the operational aspects, such as color-coding of event progress in the simulation (i.e. “green” for good, “yellow” for worsening, etc.), of the simulation itself. However more research to assess this is required. Observationally, it seemed that many teams became more comfortable with the simulation as they went through it, though there are some cases where participants struggled with their responses within the simulation.

On teams with a US or North American participant, it was observed that communication generally started earlier and was more involved than other teams. While this is not quantifiable within this study, I felt that there was a noticeable difference in the way communication started when there were North American nationalities on a team, regardless of team condition.
Hidden Knowledge, Information Sharing and Communication Behaviors

The evaluation of the impact of hidden knowledge on overall scenario performances revealed no significant effects. This indicates that the presence of a hidden knowledge event within the scenario itself was not a big influencer of team performance on the overall task itself. Mainly due to a small signal (one event within a scenario and across the simulation requiring hidden knowledge), the level of a measurable performance impact for hidden knowledge profiles was not realized in this study. However within the much smaller sample size of interdependent events, this influence was more readily observable.

In the quantitative study, it was demonstrated that the presence of hidden knowledge profiles in a scenario impacted performance on interdependent events in combination with other factors such as team type and even the specific scenario. The interaction of the presence of hidden knowledge condition, Team Type, and Scenario Number was found to be significant. National teams performance greatly differed between scenarios that had hidden knowledge compared to when they did not. Performance by both teams in both scenarios was impacted by the presence of hidden knowledge. This finding is supported by the results of the information sharing analyses.

From the qualitative analysis of information sharing behaviors with hidden knowledge information it was found that the vast majority of teams shared little to no information from the hidden knowledge briefings and even had a tendency to discuss the briefing info when they all received the same info, in line with findings from both Stasser and Titus (1987) who first report this bias in teams, and Mesmer-Magnus and DeChurch (2009) who support it through a large meta-analyses of information sharing literature.

Limited information sharing meant that team members did not have the team knowledge needed to solve the event. Performance on the hidden knowledge scenarios suffered due to a drain on cognitive resources and focus. From the communication data it becomes clear that teams that
did not directly share hidden knowledge information spent a significant amount of time trying to figure out the appropriate response, which distracted participants from the management (response, monitoring) of other events.

**Hidden Knowledge Information Sharing Comparisons**

In the hidden knowledge scenarios, 70% of multinational teams (16 teams) did not end up sharing any of the unique information on the hidden knowledge events. This lack of information sharing is coupled with a 65% failure rate for teams on this event. Only one team shared all of the information, and despite this still failed the event. As discussed in chapter 5, multinational teams seemed to experience breakdowns in sharing information and, in particular, following up on that information. One team (Team 50), which shared all of their briefing information and even coordinated a response, failed to adequately follow up as they still did not send the SWAT resource in time to effectively solve the event.

Through conscientious coordination amongst team members following the sharing of the briefings information, it seems that teams are actually able to follow through on the information they receive. This differed for National teams greatly, with 65% of teams successfully completing the hidden knowledge event, despite only limited information sharing, suggesting that there are far more complex interactions underlying team responses to these types of events than information sharing alone. These findings suggest that multinational teams experience a deficit in their information sharing behaviors and in the ways in which team members evaluate and act upon the information that is shared.

As discussed in chapter 5, there was a noticeable uptick in the discussion of the briefing information in the without hidden knowledge condition for both national and multinational teams. For example, across the two conditions national teams performance didn't differ (65% completion
rate in both conditions), despite differing levels of information sharing for the briefings events with 26% of teams sharing no information in the non-hidden knowledge condition versus 61% in the hidden knowledge condition. In the multinational condition, a larger number of teams discussed the briefings (‘some’ to ‘full’ information) in the without hidden knowledge condition (n=11) than in the hidden knowledge condition (n=7 teams). This result aligns with Stasser and Titus (1987) findings of bias towards discussion of shared information over information that is uniquely held.

The lack of performance differences for multinational teams may be due to the design of the simulation, which would allow for teams to throw all their resources at an event if they could not figure it out (i.e. a brute force tactic). It may have also been the result of teamwork approaches that emphasized a coordination response, despite very little information being shared. Additionally, it seemed that many participants felt overwhelmed by the number of things they had to attend to within the simulation and reported that they either felt they did not have time to read the briefing, or if they did read it, that they promptly forgot it was there due to new events showing up. This impact of the crisis is discussed in the next section.

*Capturing the impact of the crisis event*

From the analyses of the qualitative study, information overload within the simulation was influential on how participants responded to and handled the crisis aspect of events. Most participants felt the impact of the highly paced, highly uncertain crisis environment presented by the simulation. So much so that it led to detail fatigue for some participants who felt they could not sort through all the information to make timely and impactful responses to every event. Within the questionnaire, one participant discussed this:
“Creating such an in depth scenario with all this extra information was colorful and much appreciated but distracted us from getting to the solutions. We were dissecting each scenario too much for us to act quickly,” (Team 34, National team).

The design of the simulation effectively influenced teams into feeling higher levels of time stress and information fatigue, which may have led to decay in other aspects of team wide information sharing behaviors, including hidden knowledge information.

Figure 7-1: Challenges to Information Awareness.

As was highlighted in the qualitative study, one participant felt that there was so much going on that they did not feel like they could read both the briefings information and manage their responses to events. These informational briefings often represented a trade-off for participants. Due to the nature of their task management perspectives, they often felt that it was one or the other for them; either read the briefing or focus on the events themselves.
Comparison of Teamwork Approaches

Similarities and Differences between Multinational and National Team Approaches to Teamwork

In the Chapter 6, five approaches to teamwork within the simulation were outlined. These five approaches encompassed much of the observed behavior across both the national and multinational conditions, however the impact of these approaches on overall teamwork varied between the two groups.

Within the national team condition, teams most often employed the parallel processing approach, the blended approach and the shifting leadership approach. The shifting leadership approach aligns with the concept of shared or collective leadership in the literature (Barnett & Weidenfeller, 2016; D’Innocenzo, Mathieu, & Kukenberger, 2014). A shared leadership approach to teamwork has been positively associated with team performance and team outcomes (D’Innocenzo, et al., 2014). Shared leadership is described as a “complex adaptive process that occurs between leaders and followers in teams,” (D’Innocenzo, et al., 2014). In the case of teams using the shifting leadership approach in the current study, leadership had a tendency to be dynamically distributed across the team, and was organically emergent from the given context. This shifting leadership approach was not often employed by Multinational teams, which did not seem to achieve the level of dynamicism needed within their interactions. More often, multinational teams employed the parallel processing approach and the blended approach. The leader driven approach was also more commonplace in multinational teams. The team consensus approach was less commonly used in both conditions, but was utilized by some teams.

The team consensus approach represents a higher level of interactivity by all the team members across multiple stages of team problem solving, team decision making, communication and information sharing, and so may have been difficult for teams to maintain as the cognitive
load of the task began to wear on individual members. Most often the dualism of an individual
and sometimes team oriented response (in the parallel processing and blended teamwork
approaches) process allowed for individual role management to occur more easily and for the
team to accomplish its goals overall.

**Team Decision-Making Integration**

McHugh et al. (2008) discuss overall divergence and convergence by team members with
the overall group decisions and group leaders. For example, McHugh et al. (2008) describe an
overall trend towards harmony in Asian (described as collective in their study) teams as opposed
to US, and European teams (p. 146). This trend towards harmony in Asian teams was found in
processes of collaborative decision making as an emphasis on the preservation of face for
leadership, which meant that team members rarely voiced outward dissent during decision
meetings; instead, the process of dissent, or voicing of opinions, occurred in private and typically
prior to a decision being made so that the leader would not lose any face in the process (McHugh,
et al., 2008). The current study findings indicate that this trend may be partially supported, but also
calls attention to the times it was not supported, and to a certain extent demonstrates flaws in
identifying “categories” of culture rather than using strategies which describe culture within its
own context. This was often exemplified with Indian participants, who were typically more vocal
and took charge in their teams, and often employed the leadership driven approach.

This practice differed greatly for US teams, who tend to make decisions collaboratively
by voicing dissent in the decision meeting, actively challenging leadership and other teammates,
and teasing out the specifics as they go. US teams may even shift the decisions or plans that they
make after the initial meeting.
NeoCITIES as an Environment for Co-located Teams

By putting co-located teams in this simulation, voice was given to the processes teams go through in solving events in the simulation, and in the efficacy of the simulation to study team cognition. Designed for distributed teams, this meant that the simulation was lacking in some design specifics for collocated teams, which can be described as mostly a mechanism for shared cues and responses.

The role prioritization as response perspective described in the previous chapter emerges as an affordance of the simulation environment (though emulating real world issues). This perspective may create limitations on those teams that are not full of highly conscientious or outgoing team members. A mechanism that forces teams to check up with one another, or engage the simulation at a team level would be useful for increasing interactions between team members.

The elimination of the viability of the brute force response tactic affordance within the simulation is an example of where future team simulation designs can be improved. The current design of the simulation is such that the sending of all and any resource to a particular event is discouraged and disincentivized through the pacing of events (requiring teams to respond to multiple events at once), and through a time delay in dispatching and recalling resources (thus creating a ‘scarcity of resources’ teams have to be meticulous about).

Importantly, as has been observed in the past with distributed teams, collocated teams reported a high level of enjoyment with the simulation, they were actively engaged and involved with the problem solving of the simulation events. This level of interest in the task indicates a high level of involvement with the events, and most teams were actively engaged in communications and coordination activities.
Theoretical Implications for Team Cognition

This study revealed ways in which cultural influences on team cognition could be examined through the theoretical lens of situated cognition via a shared context (Hutchins, 1995, 2000; Roth & Jornet, 2013). The teams’ interactions within the simulation revealed how tightly coupled team activity is with the context. Team cognitions were situated through their shared experience of the simulation task and teamwork tasks. As stated, one of the primary purposes of this study was to improve on our current understanding of team processes through the examination of the influence of culture on cognitive processes, through the perspective of a situated, contextually dependent, naturalistic view of cognition (Hutchins, 1995). Within the study of cultural influence on cognition, several paradigms have emerged which have a distinct impact on perspectives of cognition. The current view of the role of culture in shaping cognition emerges from an examination of cognition in context, shifting away from a view of the mind as an isolated entity.

The concept of a hybrid team culture, where diverse teams evolve their own shared ‘team culture’ is relevant (Earley & Mosakowski, 2000). In teams, there is a need to develop a shared team mental model of the environment, there is a need to develop shared knowledge of the situation, to ascertain how the team will work and what roles they will play within the team. To do this, there is a process of overcoming individual cultural styles while still involving it within the team’s overall mental model of teamwork and taskwork approaches. Identifying which aspects of culture are overtly realized and which are inert in the process of team development of concepts such as team cognition, and team mental models, and further how these emerge in communication styles, behaviors, on what types of information is shared, is emergent through team engagement within a shared context. There is a tension within teams between what aspects of cultural diversity are realized and which are more subtle and nuanced. How this tension
emerges in team settings, and what can we ascertain from these concepts of culture influencing cognition sets the stage for new areas of focus within the team cognitive literature.

Limitations

Definitions of Culture in this study

The use of nationality as a metric of culture in this study can be considered a limitation, but was a necessary approach. Understanding the role of culture and its effects on team processes starts with a classification problem. More often than not, it is done at the national level, with little attention paid to subgroupings or to bicultural or multicultural individuals, since ‘nationality’ is a measure that can be easily quantified (Minkov & Hofstede, 2012). There is a growing amount of tension surrounding this idea, with some (Hofstede, 1980, 2002, 2003; Minkov & Hofstede, 2012) staunchly defending the idea of ‘national culture’ as the best measure available to researchers. Meyers and Tan (2002) suggest that this view is problematic, “It glosses over the fact that ethnic and cultural groups can exist across many nations, just as it glosses over the existence of cultural and ethnic differences within nations” (p.25).

Culture, as it shapes and structurally impacts cognition through an individual’s experience with cultural behaviors and practices provides a rich avenue by which to examine the aspects of cognitive differentiation amongst populations. “Culture,” however, has been a notoriously difficult concept to pin down. The term “culture” is often used to reflect multiple aspects of experience and is a very dynamically used term. It is used to describe a particular set of beliefs, norms, behaviors of a social group; but may also be applied to the context of organizational or political culture. In many fields, membership to a nation-state is often used to prescribe culture to a group, however, national borders are not always the marker of set cultural
populations, which can transcend national borders and incorporate ethnic, racial, and religious associations.

Over the course of the last century, processes of defining, operationalizing, and ‘discovering’ culture have been divergent and isolated by discipline, with often very little cross-over or conversation amongst researchers (Bender, Hutchins, & Medin, 2010). In some cases, fields of study aimed specifically at understanding human behavior and processes have left culture completely out, arguing instead for a universal, isolated view of the mind (i.e. Cognitive Science) (Donald, 2000; Dreyfus, 2007). Furthermore, divergent perspectives, definitions and theoretical conceptions of culture have emerged between anthropology, psychology and the social sciences when all could benefit from an engaging discussion, transmission of theories, and a deeper interdisciplinary outlook. In surveying academia for the concept “culture,” it becomes immediately clear there are a wide variety of perspectives and treatments across disciplines that are not always commensurate or inclusive of one another. This has led to a widespread rift in the scientific study of culture (Bender, et al., 2010). The complex nature of culture makes it a difficult concept to fully capture, but it is an inherent part of individual outlooks and plays a role in the way teams interact.

While imperfect, the use of nationalities as a marker for culture was considered the best approach for the current study, which did not seek to classify behaviors of a particular cultural group in comparison to another, but rather sought to explore the complexities of cultural interactions in team settings. In this study, only one nationality (United States) was purposefully sought for the sample in the national condition. The multiple nationalities represented in the multinational condition allowed for diversely composed teams to be created.
Team Research

One of the largest limitations of team research is that sample sizes are typically lower than would be desired in a statistically rigorous study (McNeese, et al., 2014). Given the limitations and challenges that recruitment presents within team research, this is one of the limitations inherent to team research studies. All participants must be present to run the study, and often no shows, or late arrivals, means that the study cannot be run. As a result many more participants must be recruited within team research to meet quotas for a study. In the case of this study, 129 participants made up the final experiment sample, however nearly triple this number were recruited, which is a significant drain of researcher time and driver of experimental cost. Typically, small team level sample sizes are the norm in team research (McNeese, et al., 2014).

Other Limitations

The NeoCITIES task may have presented a limitation. While giving teams a shared process of experience, the simulation may have not have required enough abstract problem solving through which the diversity of cognitive experiences could emerge through conflict. The role prioritization as response was deeply imbedded within the design of the system, limiting differences in interpretations and so facilitated participants to focus their team responses through the lens of their role, limiting overt conflict from emerging.

In addition, the simulation allowed for some kinds of brute force response tactics (i.e. send everything to an event) without any overtly realized consequences, though occasionally participants would realize they over extended their resources.
Contributions

This study has several main contributions resulting from the evaluation of multinational versus national teams, understanding team mental models and its research approach. As a result, while it was not possible to substantiate some of the hypotheses presented, it also offered meaningful results.

This study provides an evaluation of multinational team variances in performance and information sharing behaviors in comparison to those of single nationality teams. Furthermore, it contributes a better understanding of team cognitive processes in play within these multinational teams thus allowing the researcher to identify several opportunities for interventions aimed at improving multinational and national team interactions.

Second, this study’s utilization and demonstration of a mixed methodological approach to assess multicultural teamwork is unique. Its findings demonstrate the effectiveness and utility of mixed methods approaches for understanding team phenomena, and furthermore lends a distinct advantage for interpreting underlying concepts relevant for team cognition by allowing more in depth analysis. In addition, the current study demonstrated the utility of this approach for the evaluation of multicultural teamwork—an often-underrepresented feature within studies of team cognition (Salas, et al., 2008).

Beyond the novel mixed methodological approach for the evaluation of team mental models, this study contributed to the research of team mental models in two ways. Typically team mental models have not been evaluated from a mixed methodological perspective. Multiple methods, both qualitative and quantitative have been demonstrated as effective tools to assess team mental models, however it is uncommon for mixed methodological approaches to be used to evaluate team mental model concepts, such as taskwork, teamwork and temporality. For example,
the qualitative analysis identified an overarching task approach detailed as *role prioritization of response* that was ubiquitous for many teams within this study.

![Diagram of Team Mental Models and Approaches]

**Figure 7-2: Description of Contributions.**

Without the mixed design and contributing qualitative methodologies, the impact of this finding would have been unrealized. This study particularly demonstrates how this approach can be useful for the evaluation of the structure of shared knowledge within teams.

The current study presents a novel evaluation of team mental models from the perspective of multicultural teams, utilizing a specifically cross-cultural comparative approach. This study contributes to a newly growing body of team mental model research that evaluates characteristics of teams, such as diversity, that contribute to the development of shared knowledge within multinational teams. This study is unique in that it presents a comparative analysis of multinational teams with single nationality teams, in addition to an assessment of levels of diversity within teams.

Finally, this study contributed to the expansion of knowledge of multinational and national teamwork and team cognition, which can be utilized to inform team simulation designs for complex and dynamic contexts.
Future Work

The relevance of culture in team processes cannot be overlooked. As more cross-cultural interactions are being enabled across a variety of settings, it is becoming clear that a greater understanding of the impacts of culture on performance, interactions and outcomes are needed, particularly in extreme, high stress environments. Developing a mechanism for incorporation of culture towards the goal of improvement of teamwork in complex domains is a much-needed step in the research of team cognition. Further study the role of team mental models in culturally diverse teams is needed to evaluate taskwork aspects of team cognition in addition to teamwork and temporality. The process of generating a model of team mental model formation in diverse teams may benefit from a greater implementation of qualitative methodology such as concept mapping, or even Cultural Network Analysis (Sieck, Rasmussen, & Smart, 2010) specifically geared towards multinational teamwork as opposed to cross-national comparisons. A particular aim will be to identify how the generation of a shared team mental models differ between team types as a function of cultural influence, given their level of diversity, and what those outcomes are on team outputs and performances. Additionally, incorporation of a metric for metacognitive processes and transactional memory (DeChurch & Mesmer-Magnus, 2010) may benefit an understanding of how culture influences team processes.

Future research will evaluate other aspects of cognition in relation to this problem space. Incorporating affect and assessing levels of language fluencies within multicultural teams to assess when and how linguistic differences contribute to team communications and if they contribute to the approaches teams take will be evaluated in future work. The current study did not take into account levels of English competency. Given that NeoCITIES is conducted in English, some multicultural teams may feel the impact of differences in language fluencies within their teams, contributing to some of the differences in why multinational teams underperformed.
national teams. This includes the impact of diction and interpretations of the language within the simulation. Furthermore the impact of affect and emotional state as a construct is an important element that should be considered in its influence on team cognition and interactions. Future studies will take these factors into account.

Additionally, the translation of NeoCITIES to establish structural and contextual cultural parallelism has proven important in the past (T. C. Endsley, Reep, McNeese, & Forster, 2015). Considerations for culturally directed differences in emergency crisis managements processes and infrastructure will be considered in future work.

Lastly, the implications of each team approach on team cognition and team performance for the current task should be evaluated in future studies across team types. This kind of study could indicate what the impacts of team approaches may be on team performance in multinational team settings, and could provide valuable insight on identifying further interventions and tools that allow for benefits of multiculturalism in teamwork to be realized.

Simulation Development

Other future work involves the utilization and application of the rich data set from this study towards the development of new team cognition simulations that facilitate multicultural teamwork and encourage a higher level of dynamicism within a crisis response simulation. As a test bed, NeoCITIES has been active for the past decade in multiple forms and across multiple deployments as a valuable mechanism through which to evaluate team cognition. Furthering the study of team cognition in complex crisis environments with diverse populations, and with modifications towards prominent problems in today’s world (i.e. disaster prevalence, terrorism, humanitarian crises, etc.) could be valuable in gaining insight to multicultural team cognition as well as improvement to our responses in these complex and intense situations.
Conclusions

The primary goal of the current research is to provide an innovative perspective on teams when diversity of team membership is present in teams working within complex emergency crisis events. A broader understanding of cognitive phenomena emerges from seeking to expand current understandings of mechanisms of influence on team cognition, namely how cultural backgrounds and cognitive perspectives influence team interactions, communication and information sharing through a mixed methodological approach.

There has been an emerging trend in research to effectively capture and understand the role that culture plays in the process of cognition, at both the individual and team levels (Helen Altman-Klein & Kuperman, 2008; Helen Altman-Klein, Lippa, & Lin, 2011; H. Altman-Klein & Pongonis-McHugh, 2005; Helen Altman-Klein & Steele-Johnson, 2007; Earley, 2002; Earley & Ang, 2003; Earley & Mosakowski, 2004; Henrich, et al., 2010; Kitayama & Uskul, 2011; McHugh, et al., 2008; Rasmussen & Sieck, 2010, 2012). From infancy, humans are engaged in the process of enculturation in which the history, processes, ideologies and mechanisms of expression are transmitted from past generations, and have been done ad infinitum (Donald, 2000; Goodenough, 2003). The implications of cultural diversity on team cognition within complex environments, as it plays a role in the interactions, coordination, training, planning, decision-making and mental models of teams needs further explorations from a multidisciplinary perspective. There is a growing need to understand the impacts of culture on cognition and to be able to anticipate their potential effects on team interactions and on team performance in a variety of operational contexts. It is important for individual team members who operate in global oriented contexts to be able to effectively coordinate and collaborate with other members-regardless of their cultural backgrounds, in order to achieve mission goals.
Through a deeper level understanding of the emergent aspects of cognition during emergency management, improved decision support tools, training, and simulations can be developed. Focusing on the multidimensional aspects influencing individual and team cognition can improve team performance during crisis events. Incorporation of the cultural aspects of cognition provides new information for a domain that is receiving increased attention worldwide as the number of crises and disasters increases each year. By including a more dynamic perspective on team activities and cognitive processes, a more thorough understanding can emerge.
References


Appendix A

Experimental Procedure

Participants will be asked to take part in an experiment lasting approximately two hours (Each NeoCITIES scenario will last 5-20 min, and participants will participate in a total of 4). Participants will primarily be using the NeoCITIES simulation in which they will take on the role of either Police, Fire, or Hazardous Materials. Following the simulation task, participants will be asked to complete a questionnaire. No personal information will be attached to the data and they will be stored on a secure server that only the researcher has access to.

Upon Arrival:

1. Participants will be seated at random in front of a computer terminal.

2. Participants will be randomly assigned to teams of three. They will be co-located (side-by-side) with their team members, and will be doing the scenarios together at the same time (same location), but will not be able to see each-other's screens.

3. Participants will receive an informed consent form. They will be asked to read through it and sign. They will be given one copy for their records

4. The participants will be verbally briefed about the nature and purpose of the experiment.

5. Training materials in the form of Microsoft PowerPoint slides will be provided to the participant. The slides are specific for each interface type and are included as part of this submission (Within the NeoCITIES simulation, participants are tasked with responding to events by allocating resources and coordinating with team members). The slides provide the information required for the subject to be able to complete the requested task.
   a. 2 Training Sessions will occur:
      i. Role specific training guide
      ii. Training I
      iii. Team Training guide
      ii. Training II

6. Following the two training scenarios, there are two performance scenarios that the participants will be asked to complete, total time of participation will last between 60 and 90 minutes.
   a. Performance Scenario I
   b. Performance Scenario II

7. Questionnaire Battery implemented (Qualtrics Survey)
   a. Demographic Survey
   b. Team Member Schema Similarity battery
   c. Post NeoCITIES Questionnaire

8. Team Mental Models Pairwise Comparisons tool (on Paper)

9. Participants will be debriefed about the fictional nature of the scenarios presented and their roles in said scenario.
Appendix B

Pre- Questionnaire

Study Registration

1. What is your FIRST and LAST name?

2. What is your PSU email? (This will not be shared with any other parties and is for the sole purpose of contacting you about your participation in this study).

3. What is your nationality? (Where are you a citizen?)

4. Thank you for registering your interest in this study! You will be contacted shortly to sign up for a date and time of participation.
Appendix C

Questionnaire Battery

Demographic Questionnaire

1. Please indicate your user name provided by the researcher (this is NOT your PSU ID).
2. What age are you?
3. What is your Gender? (open-ended)
4. What is your nationality? (Of which country are you a citizen?)
5. Do you hold a dual citizenship?
   - Yes
   - No
6. If yes, to what country?
7. What do you consider your ethnicity to be? (Optional)
8. How long have you been a resident of the US? (How long have you lived in the US?)
9. Where did you grow up? (Name cities/states and/or countries if outside of the US)
10. Have you lived in any other countries not listed in the question above? List the country and how long you lived there.
11. What languages do you speak?
12. How many years have you known your language(s)?
13. What language do you speak at home?
14. Year of study?
15. What is your course of study?

16. How many hours/week do you play video games?

17. Do you have any prior experience in the emergency management or medical realm, in the US or elsewhere (i.e. as a fire fighter, EMS, Hazardous Materials response, police officer, nurse, other medical practitioner, military enlisted or officer)

18. If yes, please describe your previous role(s).

19. How much time in years and months did you serve in this role?
Teamwork Schema Questionnaire – Self

Think about what teamwork means to you. Think about teamwork as it may occur on any team. In other words, try not to think about any specific team, but rather think about teams and teamwork in general. Thinking about teamwork in this way, please read each of the following statements. When reading these statements, think about how important these behaviors are to your meaning of teamwork. Ask yourself, “Does this behavior tell me anything about the meaning of teamwork?” When considering the importance of each item, keep in mind your view or meaning of teamwork. For example, consider the statement “Team members do not interrupt each other.” This behavior could have a variety of meanings regarding teamwork (e.g., politeness, lack of assertiveness). Keeping in mind what the statement means to you about teamwork (e.g., politeness, lack of assertiveness). Keeping in mind what the statement means to you about teamwork, rate its importance to your meaning of teamwork. Thus, if the above statement indicates politeness to you, and you think politeness is not very important to your idea of teamwork, then you should rate “Team members do not interrupt each other” as not important.

**PLEASE READ EACH ITEM CAREFULLY** and respond below:

<table>
<thead>
<tr>
<th></th>
<th>Not at all Important</th>
<th>Very Unimportant</th>
<th>Somewhat Unimportant</th>
<th>Neither Important nor Unimportant</th>
<th>Somewhat Important</th>
<th>Very Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>The team continuously re-evaluates its goals.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The team makes decisions by consensus.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The team expects to make mistakes.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Personal preferences are compromised to meet the team goals.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Team members critique each other’s ideas.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Team members are aware of the task at hand.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The team leader</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
makes the final decision.
Team members are of various rank and status.
The team leader changes based on expertise.
The team supports the leader.
Team members are open to ideas.
Team members are active.
Members prompt each other.
Team members focus on the overall team effort.

<table>
<thead>
<tr>
<th>Partner</th>
<th>Police</th>
<th>Fire</th>
<th>Hazmat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner 1</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Partner 2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Teamwork Schema Questionnaire – Team Members

Think about what teamwork means to your partner. Think about teamwork as it may occur on any team. In other words, try not to think about any specific team, but rather think about teams and teamwork in general. Thinking about teamwork in this way, please read each of the following statements. When reading these statements, think about how important these behaviors are to your meaning of teamwork. Ask yourself, “Does this behavior tell my partner anything about the meaning of teamwork?” When considering the importance of each item, keep in mind your partner’s view or meaning of teamwork. For example, consider the statement “Team members do not interrupt each other.” This behavior could have a variety of meanings regarding teamwork (e.g., politeness, lack of assertiveness). Keeping in mind what the statement means to
your partner about teamwork, rate its importance to his or her meaning of teamwork. Thus, if the above statement indicates politeness to your partner, and you think politeness is not very important to your partner’s idea of teamwork, then you should rate “Team members do not interrupt each other” as not important.

**PLEASE READ EACH ITEM CAREFULLY** and respond below for the team member you indicated as **Partner 1**:

<table>
<thead>
<tr>
<th></th>
<th>Not at all Important</th>
<th>Very Unimportant</th>
<th>Somewhat Unimportant</th>
<th>Neither Important nor Unimportant</th>
<th>Somewhat Important</th>
<th>Very Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>The team continuously re-evaluates its goals.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>The team makes decisions by consensus.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>The team expects to make mistakes.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Personal preferences are compromised to meet the team goals.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members critique each other’s ideas.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members are aware of the task at hand.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>The team leader makes the final decision.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members are of various rank and status.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>The team leader changes based on expertise.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>The team supports the leader.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members are open to ideas.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members are active.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Members prompt each other.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Team members focus on the overall team effort.</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
</tbody>
</table>
Teamwork Schema Questionnaire – Team Members

Think about what teamwork means to your partner. Think about teamwork as it may occur on any team. In other words, try not to think about any specific team, but rather think about teams and teamwork in general. Thinking about teamwork in this way, please read each of the following statements. When reading these statements, think about how important these behaviors are to your meaning of teamwork. Ask yourself, “Does this behavior tell my partner anything about the meaning of teamwork?” When considering the importance of each item, keep in mind your partner’s view or meaning of teamwork.

For example, consider the statement “Team members do not interrupt each other.” This behavior could have a variety of meanings regarding teamwork (e.g., politeness, lack of assertiveness). Keeping in mind what the statement means to your partner about teamwork, rate its importance to his or her meaning of teamwork. Thus, if the above statement indicates politeness to your partner, and you think politeness is not very important to your partner’s idea of teamwork, then you should rate “Team members do not interrupt each other” as not important.

**PLEASE READ EACH ITEM CAREFULLY** and respond below for the team member you indicated as **Partner 2**: 

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all Important</th>
<th>Very Unimportant</th>
<th>Somewhat Unimportant</th>
<th>Neither Important nor Unimportant</th>
<th>Somewhat Important</th>
<th>Very Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>The team continuously re-evaluates its goals.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The team makes decisions by consensus.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The team expects to make mistakes.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Personal preferences are compromised to meet the team goals.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Post- NeoCITIES Questionnaire

Please provide as much detail as possible to your responses below.

25. Did you feel that you had cultural differences with your teammates? Please Describe.

26. Do you think that your teammates communicated differently than you? How?

27. Do you think that your teammates prioritized tasks differently than you? How?

28. Do you think that your teammates communicated important information? How so?

29. How did you make decisions during the task? (i.e. When to send out a resource, recall a resource)?

30. Did you involve the team in your decision making process or did you act on your own?
31. As a team, did you plan how you would handle each task?

- Yes
- No
- Somewhat

32. How did your team handle each task? Please describe that process. (i.e. What did you do, what did your teammates do?)

33. How often did you verbally communicate with your team members?

- Continuously (more than once per minute) (5)
- Frequently (every 1-2 minutes) (6)
- Often (every 2-5 minutes) (7)
- Periodically (more than 5 minutes apart on average) (8)

34. Were you satisfied with the level of communication you had with your teammates?

- Very Satisfied (27)
- Satisfied (28)
- Neutral (29)
- Dissatisfied (30)
- Very Dissatisfied (31)

35. Why or why not?

36. What information did you share with your teammates during the task? What led you to share this information?

37. What information was shared with you by your teammates?

38. Was the information you received from your teammates clear? Why or why not?

39. Did you feel that you had enough information to make effective decisions? Why or why not?

40. Describe a time during the task that more information would have been helpful. Why?

41. Describe a time during the task that less information would have been helpful. Why?

42. How well do you think you dealt with information as it was coming in? Provide an explanation.

43. In general, what are some characteristics that differentiate a good team from a bad team?

(Please provide several examples)

44. Did you view yourself and the other members of your group as a team?
45. Did you view your team as:

- Yes
- No

46. Please describe a time during the task that you felt confused. What do you attribute that confusion to?

47. Please describe a time during the task that you felt that your team did not perform well. What do you attribute that poor performance to?

48. What would you do differently next time?

49. Please describe a time during the task that you felt that your team performed well. What do you attribute that good performance to?

50. How satisfied were you with your performance as a team?

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

51. How happy were you with your team?

(Happiness slider scale)
52. Do you have any thoughts in general about the simulation and your experience with it?
Appendix D

Pairwise Grids

INSTRUCTIONS

In this packet you will be completing a series of grids. It is **VERY IMPORTANT** that these grids are completed correctly. Please follow the steps below, carefully.

- Read through all the definitions of the dimensions listed on the left hand side before entering ANY information.

- Insert a number only into the white boxes of the grid that ranges from 1 (Not Related) to 5 (Extremely Related).

- It is easier to complete the boxes at the extreme ends of the scale FIRST (i.e., Extremely Related and Not Related), then complete those in the middle.

**FOOTBALL EXAMPLE**

(NOTE: This is a simplified example. The actual grids will have definitions of each dimension listed):

<table>
<thead>
<tr>
<th></th>
<th>Throw-pass</th>
<th>Catch pass</th>
<th>Huddle</th>
<th>Wide receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter-back</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Throw-pass</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Catch pass</td>
<td></td>
<td></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Huddle</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Wide receiver</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5 (Extremely Related): These events always occur together. In this example, the quarterback always throws passes therefore both are extremely related.

3 (Somewhat Related): These events are likely to occur in the presence of the other but do not need always occur together, e.g., the wide receiver is likely to be in a huddle but doesn’t necessarily have to be there.

1 (Extremely Unrelated): The two events are not dependent on each other, e.g., you would never catch a pass in the huddle or throw a pass in a huddle.
GRID 1

Below are several descriptions of the **TASKWORK** aspects of completing events in NeoCITIES. Please rate how related each aspect is to all of the others.

**NOTE:** Only complete the **white squares**. For example, the uppermost square asks you to rate how “Prioritize Events” is related to “Allocate Resources.” If you have any questions, please ask the experimenter.

<table>
<thead>
<tr>
<th>1 Extremely Unrelated</th>
<th>2 Unrelated</th>
<th>3 Somewhat Related</th>
<th>4 Related</th>
<th>5 Extremely Related</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Allocate Resources:</strong></td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Assign correct number and type of resources to events.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prioritize Events:</strong></td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Respond to events based on their severity and importance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monitor Events:</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Evaluate whether the event was successfully resolved.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Notice Changes in the Situation:</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Watch for changes in events (e.g., pacing, complexity) and anticipate future problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Re-evaluate Decisions:</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Revise a prior decision in regard to whether to respond to an event.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Achieve High Performance:</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Work to receive a high simulation score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Below are several descriptions of the TIMING aspects of completing events in NeoCITIES. Please rate how related each aspect is to all of the others.

**NOTE:** Only complete the white squares.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Unrelated</td>
<td>Unrelated</td>
<td>Somewhat Related</td>
<td>Related</td>
<td>Extremely Related</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decide When to Allocate Own Resources: Decide whether to respond right away or wait for more information</th>
<th>Attend to Deadlines</th>
<th>Coordinate the Timing of Unit Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attend to Deadlines: Notice and communicate when events need to be resolved within a specified time</td>
<td>Coordinate the Order of Unit Responses</td>
<td></td>
</tr>
<tr>
<td>Coordinate the Timing of Unit Responses: Discover whether multiple units (e.g., Fire, Hazmat, Police) need to be at an event within a certain time and work together to meet the deadline</td>
<td>Predict Future Resource Need</td>
<td></td>
</tr>
<tr>
<td>Coordinate the Order of Unit Responses: Discuss the sequence in which units (e.g., Fire, Hazmat, Police) should respond to events and synchronize units to follow the recommended ordering</td>
<td>Perform Effectively as a Team</td>
<td></td>
</tr>
</tbody>
</table>

Predict Future Resource Need: Project into the future what resources will be most heavily used based on patterns of previous events.

Perform Effectively as a Team: Receive a high simulation score
Below are several descriptions of the **TEAMWORK** aspects of completing events in NeoCITIES. Please rate how related each aspect is to all of the others.

**NOTE:** Only complete the white squares.

<table>
<thead>
<tr>
<th>1</th>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Update Teammates: Inform teammates of what resources you sent and feedback status</th>
<th>Assist Teammates</th>
<th>Specify Team Goals</th>
<th>Share Information</th>
<th>Encourage Teammates</th>
<th>Perform Effectively as a Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assist Teammates: Suggest resources that other units should send to events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specify Team Goals: Work with teammates to identify goals and sub-goals for the scenario</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share Information: Pass along relevant information from intelligence briefings that other units may need</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourage Teammates: Motivate and raise each other’s confidence to perform well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform Effectively as a Team: Receive a high simulation score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Below are several descriptions of the **EVENTS** you received in the scenario you just completed. Please rate how related each event is to all of the others.

**NOTE:** **Only complete the white squares.**

<table>
<thead>
<tr>
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<th>2</th>
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<td>Related</td>
<td>Extremely Related</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Rating</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student in the Buff:</strong> A student is seen running around campus in the nude. The student reports that he had been robbed and was only left with a book of matches.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flying Laptops:</strong> An unstable student was throwing stolen laptops off the roof of Paterno Library. The items are injuring passerbys and denting gas pipes below.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Convulsing Student:</strong> A crowd gathered around a student convulsing on the ground floor of the HUB. Caller could not find any identification on the victim, only a set of matchbooks with Greek symbols were found.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stampede at Forum:</strong> A bomb threat was received by an instructor in the Forum Building, who panicked and pulled the fire alarm.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shrine Redesign:</strong> The Nittany lion shrine has been vandalized. Someone has painted a handlebar moustache and Greek symbols on the statue. Units are needed for chemical cleanup.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suspicious Luggage:</strong> A small suitcase with the symbols H2O written on the side was left at the departure gate at the University Park Airport.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Description of Communications Coding Scheme

<table>
<thead>
<tr>
<th>Code</th>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Total Communications</strong></td>
<td>Total number of communications in the session. Described as number of words in the experimental session</td>
</tr>
<tr>
<td>0</td>
<td>No communication</td>
<td>Whole session with no communication</td>
</tr>
<tr>
<td>1</td>
<td><strong>Information Sharing</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Information Request</td>
<td>Request for Information</td>
</tr>
<tr>
<td>1.2</td>
<td>Information Transfer</td>
<td>Sharing of Information</td>
</tr>
<tr>
<td>1.3</td>
<td>Unique Information</td>
<td>Exchange of information pertaining to the Briefings in the Hidden Knowledge condition</td>
</tr>
<tr>
<td>1.4</td>
<td>Clarifying Information</td>
<td>Clarifying questions on shared information</td>
</tr>
<tr>
<td>1.5</td>
<td>Identifying Resources</td>
<td>Identifying the resources that an event needs</td>
</tr>
<tr>
<td>1.6</td>
<td>Status update</td>
<td>Update on the status of a response</td>
</tr>
<tr>
<td>1.7</td>
<td>Timing Information</td>
<td>Dealing with timing aspects of response</td>
</tr>
<tr>
<td>1.8</td>
<td>Acknowledgement of error</td>
<td>Taking blame for the failure of an event, or failure to act for a particular event</td>
</tr>
<tr>
<td>2</td>
<td><strong>Action</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Action Request</td>
<td>Request for an action</td>
</tr>
<tr>
<td>2.2</td>
<td>Action Intention</td>
<td>Statement of intended action</td>
</tr>
<tr>
<td>2.3</td>
<td>Action Execution</td>
<td>Statement of action completion</td>
</tr>
<tr>
<td>2.4</td>
<td>Action Uncertainty</td>
<td>Uncertainty on a course of action, musing aloud</td>
</tr>
<tr>
<td>2.5</td>
<td>Action Instruction</td>
<td>Direct instruction to send a particular resource by another player</td>
</tr>
<tr>
<td>2.6</td>
<td>Action Instruction request</td>
<td>Request for instruction on what to respond to a particular event</td>
</tr>
<tr>
<td>2.7</td>
<td>Action Suggestion</td>
<td>Suggested instruction to send a particular resource by another player</td>
</tr>
<tr>
<td>2.8</td>
<td>Action Justification</td>
<td>Justifying a chosen course of action</td>
</tr>
<tr>
<td>2.9</td>
<td>Action Agreement</td>
<td>Agreement with a particular action</td>
</tr>
<tr>
<td>2.11</td>
<td>Action disagreement</td>
<td>Disagreement with a particular action</td>
</tr>
<tr>
<td>2.12</td>
<td>Action Status</td>
<td>Request for the status of another person's actions/ confirmation of action completion</td>
</tr>
<tr>
<td>3</td>
<td><strong>Coordination Behavior</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Request for coordination</td>
<td>Asking for assistance</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>3.2</td>
<td>Coordinating action</td>
<td>Agreement to coordinate actions</td>
</tr>
<tr>
<td>3.3</td>
<td>Non Coordinating Action</td>
<td>Refusal to coordinate actions</td>
</tr>
<tr>
<td>3.4</td>
<td>Dyad</td>
<td>2 person action coordination</td>
</tr>
<tr>
<td>3.5</td>
<td>Triad</td>
<td>3 person action coordination</td>
</tr>
<tr>
<td>4</td>
<td><strong>Assessment</strong></td>
<td>Activities related to self reflection on performance and behaviors</td>
</tr>
<tr>
<td>4.1</td>
<td>Evaluation of Performance</td>
<td>Assessment of team performance</td>
</tr>
<tr>
<td>4.2</td>
<td>Assessment of Behaviors</td>
<td>Assessment of actions (i.e. not sending the right resource; not sending resources in a timely manner)</td>
</tr>
<tr>
<td>4.3</td>
<td>Projection of future action</td>
<td>Discussion of modified future behavior</td>
</tr>
<tr>
<td>4.4</td>
<td>Assessment of Progress</td>
<td>Assessment of team progress in the simulation</td>
</tr>
<tr>
<td>5</td>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Encouragement</td>
<td>Expression of positive sentiment</td>
</tr>
<tr>
<td>5.2</td>
<td>Acknowledgement</td>
<td>Expression of acknowledgement</td>
</tr>
<tr>
<td>5.3</td>
<td>Rapport Building</td>
<td>Non task related utterance, but which facilitates greater interpersonal sentiment</td>
</tr>
<tr>
<td>5.4</td>
<td>Insignificant Utterances</td>
<td>Non task related utterance, filler words</td>
</tr>
<tr>
<td>5.5</td>
<td>Clarification</td>
<td>Questions or requests for clarification on instructions</td>
</tr>
<tr>
<td>5.6</td>
<td>Criticism</td>
<td>Expression of negative sentiment</td>
</tr>
<tr>
<td>5.7</td>
<td>Dismay</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><strong>Simulation</strong></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Information Request</td>
<td>Request for information on how to do something in the simulation</td>
</tr>
<tr>
<td>6.2</td>
<td>Discussing events</td>
<td>Out loud reading of the events</td>
</tr>
<tr>
<td>6.3</td>
<td>Response to information request</td>
<td>Helping with team mates' questions about the simulation</td>
</tr>
<tr>
<td>7</td>
<td><strong>Strategy</strong></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Strategy Discussion</td>
<td>Discussion of a strategy to responses</td>
</tr>
<tr>
<td>7.1.1</td>
<td>Brute force</td>
<td>Brute force employed</td>
</tr>
<tr>
<td>8</td>
<td><strong>Planning</strong></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Planning an action</td>
<td>Planning a future action</td>
</tr>
<tr>
<td>8.2</td>
<td>Monitoring situation</td>
<td>Monitoring an event for future action</td>
</tr>
<tr>
<td>M</td>
<td>Moderator</td>
<td>Moderator</td>
</tr>
<tr>
<td>T</td>
<td>Times</td>
<td>Times of quiet in the communications</td>
</tr>
</tbody>
</table>
VITA

Tristan Caroline Endsley

FORTHCOMING POSITION
Senior Human Systems Engineer
Charles Stark Draper Laboratories

EDUCATION
Doctor of Philosophy in Information Sciences and Technology (December 2016)
The Pennsylvania State University, University Park, PA, USA

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RESEARCH AND TEACHING EXPERIENCE

Research
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May 2012- December 2015

2014 Summer Intern. MIT Lincoln Laboratory
May 2014- August 2014

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Summer 2008

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College of Information Sciences and Technology,
Threat, Terrorism, and Crime (Security and Risk Analysis (SRA) 211)
Spring 2016

College of Information Sciences and Technology
Crisis, Disaster and Risk Management (IST 564)
Summer 2014, Spring 2015-Fall 2015

2015 Guest Lecturer. Pennsylvania State University.
College of Information Sciences and Technology
Cognition in Life: Foundations for the Expression of Team Cognition in Collaborative
Systems (IST 402_02)
Spring 2015

PUBLICATIONS
Archived Conference Publications (9)
Book Chapters (1)
Research Posters (1)