What You Don’t Know Can Hurt You: The Role of Team Member Uncertainty in Virtual Team Trust and Performance

by

Scott Cassidy

A Thesis presented to The University of Guelph

In partial fulfilment of requirements for the degree of Doctor of Philosophy in Psychology

Guelph, Ontario, Canada

© Scott Cassidy, November, 2018
ABSTRACT

WHAT YOU DON’T KNOW CAN HURT YOU: THE ROLE OF TEAM MEMBER UNCERTAINTY IN VIRTUAL TEAM TRUST AND PERFORMANCE

Scott Cassidy
Advisor: Professor Harjinder Gill
University of Guelph, 2018

Previous research suggests that virtual teams have difficulty developing trust relative to collocated teams; and that low team member trust can adversely affect team performance. Unfortunately, there is little research to date that considers the actual process by which virtual media inhibits team trust and performance. Seminal work on organizational trust posits that team trust is at least partly a function of the uncertainty that team members feel during their interactions. Following this idea, the present study sought to test the role of felt uncertainty in explaining the negative relation between virtualization (i.e., media richness) and both trust and team performance. To test this idea, participant teams completed a military rescue simulation under varying degrees of media richness; after which, their felt uncertainty, trust towards one another, and team performance were assessed using a variety of self-reported and objective metrics. This methodology was designed to test a likely mediator of the relation between media richness and both team trust and performance, while also simulating core task features that may generalize to applied settings. The results suggested that more media rich (i.e., less virtual) teams felt less uncertainty than more media lean (i.e., more virtual) teams. Moreover, team members’ felt uncertainty partially mediated the relation between media richness and trust; as well as the relation between media richness and self-reported performance beliefs (though not objective process performance or task performance).
ACKNOWLEDGEMENTS

“Credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.” – Theodore Roosevelt

As I write these final acknowledgements, it hits me that the completion of this document also marks the closing of a major chapter in my life. Endings are invariably bittersweet. But they also represent a valuable opportunity to reflect on the many lessons that one has learned. In reflecting back on my years at Guelph, one key learning for me is the recognition that my thesis turned out to be as much a story of perseverance as it was one about virtual teams. Despite many happy years here, my doctoral work was marked by struggle as often as it was marked by success. And as greatly as I may have dared in my imagining and undertaking of this project, my completing it wasn’t always some act of smoothly-executed grand strategy. Sometimes, I only skimmed by because I was lucky enough to be surrounded with some truly dedicated, caring, and brilliant individuals – and I would be remiss if I failed to recognize those people here.

First, it is perhaps fitting that I ended up running a military-themed study; because in the end, it took an army to run. Luckily for me, I had the best research “army” a lab director could ask for. A huge thank you to the many talented and aspiring young academics who stood by me,
and who “dared greatly” with me. Throughout my many years in this program, the Guelph Organizational Trust Lab proved time and again to be my “Tenth Legion”; my “Grande Armée”. The “Escape from Drapo Island” study would not have been the success that it was if it were not for the consistent hard work, perseverance, and positivity of the team running it. To all who served in the GOT lab “army”: know that your smiling faces made coming in to the lab something that I looked forward to each and every day; and that I already miss the very special culture that we built in our little corner of Blackwood Hall. More so, I am grateful to have had the opportunity to watch so many of you grow and develop into promising academics in your own right. One of the greatest joys of leadership is witnessing the success of the people you’ve had the privilege to work with. What I saw during our time together made me beam. And as we close this chapter in the GOT lab and disband our current team, know that I envy the world for the young talent that is about to step into it. Never stop daring greatly, any of you! Your grit, determination, and intelligence have already made so much possible. I hope you move forward with pride and with conviction. And as you do, remember that I’ll be here, eagerly waiting to hear about how you’ve taken the world by storm.

This work also would not have been possible if it were not for the contributions of a few key faculty members. First among these, I would like to thank Dr. Peter Hausdorf for his service on both my advisory and examination committees. Peter: your thoughtful feedback, your insight, and your genuine belief in the value of this work were invaluable (both for moving the project forward, and for keeping me motivated to do so). Moreover, I would like to thank Dr. Ian Newby-Clark and Dr. Natalie Allen for taking time out of their busy schedules to serve on my examination committee; and for helping to turn the thesis defense into a thoughtful conversation that I thoroughly enjoyed. I hope neither of you begrudges me for that PowerPoint “magic trick”
I pulled. Please take it as evidence that your questions were important and poignant enough that I had found myself pondering them too. And you know what they say about great minds?

To Dr. David Stanley: Thank you serving on my advisory committee; and for your many rounds of fair, thorough, and well-considered feedback. But more than this, thank you for your many years of support and mentorship in the Guelph I/O program! I appreciate you taking on this “kludgy but clever” student (as you once put it); and helping me find my voice as a researcher and a statistician. Know that I credit much of the critical thinking, methodological and statistical rigor, and narrative exactingness that I came to approach my work with to the example that you set during our time together. I feel very lucky to count you as a mentor, a colleague, and a friend.

To Dr. Harjinder Gill – my long-time colleague, first contact, and dearest friend in the Psychology department: We did it! From the day I walked into your office looking for an Honours advisor, I sensed we’d be a good fit. And as soon as you offered me a place as your student, I knew that I was going to truly enjoy working with you. Thank you so much for giving me my first chance in this department; and for the endless opportunities that you’ve afforded me since then. If it weren’t for the inspiration you stirred; the kindness you showed; and yes, the trust that you placed in me, this document would never have been possible. I hope – looking back on all our years working together – that you feel I was worth taking a risk on!

Outside of the lab and official committees, there are also a few people whose support helped make this project possible. Chief among these, I would like to thank Dr. Norman Warner for providing me with the Non-Combatant Evacuation Operation materials that would form the crux of my experimental design (and prove to be the biggest conversation starter about the project). I would also like to thank Dr. Agnes Zdaniuk and Johannes (Hans) Soer for their support and patronage throughout the many years of my graduate work. Your generosity and
flexibility as employers allowed me to focus on completing this thesis without worrying about how I would keep a roof over my head. Finally, I would like to thank Trish Schmidt for her invaluable support and encouragement throughout my time in the program; and for helping to guide me towards deeper emotional understanding and greater presence. I feel that my time at Guelph would not have been nearly as developmental, reflective, or ultimately successful, if it wasn't for the many lessons that I learned during our sessions together.

Speaking of my time at Guelph: This city now holds a special place in my heart. And this would not have been the case if it were not for the many fantastic and varied folks who helped to make my time here so memorable. This document is already 246 pages long; and I fear it would take another 246 to name all of the wonderful individuals who made these years some of the of the most fulfilling and fun in my life So, let me just say a global thank you to all of my friends and colleagues in the Guelph Psychology program! I’ll miss our late night ‘work parties’ in the office; our life chats; and, the many gallons of coffee that we’ve downed together. Know that your friendship and support made this program a place where I was able to find my community; and turned Guelph into a second home that I’ll always remember fondly.

Finally, to Sulan Kith, my partner and my friend: your (occasional) ability to pull me away from my work, and your (unerring) ability to make me feel valued and loved, have been a tremendous comfort and solace during the more challenging moments of my graduate career. Know that there is no one with whom I would rather be sharing this journey. And to my parents, John and Brenda Cassidy: thank you for your unconditional acceptance and endless support throughout my graduate work. I don’t know that I would have made it to this day if I didn’t know that you were always in my corner, always available during my darker moments, and utterly unflinching in your belief that I would succeed.
## Table of Contents

Abstract .................................................................................................................................................. ii

Acknowledgements ................................................................................................................................. iii

Table of Contents ...................................................................................................................................... vii

List of Tables ............................................................................................................................................ xvi

List of Figures .......................................................................................................................................... xviii

Introduction ............................................................................................................................................. 1

The Rise of Virtual Work Teams ............................................................................................................. 2

The Technology Behind Virtual Work Teams ......................................................................................... 2

What Makes a Work Team “Virtual”? How Media Richness Defines the Virtual Experience ................. 3

Trust: A Central Challenge in Virtual Work Teams .................................................................................. 8

Why Virtual Trust Research is Needed Now ........................................................................................ 9

How Does Virtual Trust Develop? Can “Swift Trust” Explain It? ......................................................... 11

The Development of “Swift Trust”, and its Application to Teams Research .......................................... 11

Can “Swift Trust” be Effectively Applied to Virtual Work Teams? ....................................................... 13

Why Lean Media Hinders the Application of “Swift Trust” to Virtual Work Teams ........................ 14

Back to Basics: How Trust May Work within a Virtual Work Team .................................................... 15
A Brief Introduction to Trust ................................................................. 15

Risk Assessment and the Inherent Role of Uncertainty in Trust .................. 16

Uncertainty Reduction Theory and the Role of Uncertainty in Determining Trust .... 17

Hypothesis Development ................................................................................. 19

Overview ............................................................................................................. 19

Media Richness Decreases Team Members’ Uncertainty about One Another
(Hypothesis 1) ........................................................................................................ 20

Media Richness Increases Team Member Trust (Hypothesis 2) ....................... 21

Team Members’ Uncertainty about One Another Decreases Team Member Trust
(Hypothesis 3a) ..................................................................................................... 22

Media Richness Increases Team Members’ Trust by Decreasing Team Members’
Uncertainty about One Another (Hypothesis 3b) .............................................. 23

The Negative Relation between Team Members’ Uncertainty and Team Member Trust
Attenuates when Team Members have a Higher Propensity to Trust Others
(Hypothesis 4) ..................................................................................................... 24

Media Richness Increases Team Performance (Hypothesis 5) ......................... 24

Team Member Uncertainty Decreases Team Performance (Hypothesis 6a) .......... 26

Media Richness Increases Team Performance by Decreasing Team Members’
Uncertainty about One Another (Hypothesis 6b) ............................................ 26

Team Member Trust Increases Team Performance (Hypothesis 7a) .................... 27
Media Richness Increases Team Performance by Increasing Team Member Trust
(Hypothesis 7b) ........................................................................................................ 27

Team Members’ Uncertainty about One Another Decreases Team Performance by
Decreasing Team Members’ Trust (Hypothesis 8) ..................................................... 28

Methods..................................................................................................................... 30

Participants ................................................................................................................ 30

Decision to Recruit Cross-Gender Teams ................................................................. 31

Decision to Retain Two-Person Teams .................................................................... 31

Experimental Task..................................................................................................... 32

Pilot Test of the Non-Combatant Evacuation Operation Simulation ....................... 34

Media Richness (i.e., Virtualization) Manipulation .................................................... 35

Measures.................................................................................................................... 35

Perceived Uncertainty ............................................................................................... 35

Propensity to Trust Others ....................................................................................... 36

Trust in Team Members ............................................................................................ 37

Team Performance ..................................................................................................... 38

Procedure ................................................................................................................... 44

Stage One: Participant Arrival and Consent Process ............................................... 44

Stage Two: Team Briefing and Experimental Simulation ........................................... 45

Stage Three: Post-Simulation Questionnaires and Team Debrief ............................. 46
Did Uncertainty Mediate the Relation Between Media Richness and Trust (Hypothesis 3b)? ................................................................. 72

Did Propensity to Trust Moderate the Relation Between Uncertainty and Trust (Hypothesis 4)? ................................................................. 75

Did the Media Richness Manipulation Predict Team Performance (Hypothesis 5)? ...... 77

Overview ............................................................................................................. 77

Media Richness and Performance Beliefs ............................................................. 78

Media Richness and Process Performance ............................................................ 80

Media Richness and Task Performance ................................................................ 82

Summary ............................................................................................................. 84

Did Uncertainty Predict Team Performance (Hypothesis 6a)? ................................. 85

Overview ............................................................................................................. 85

Uncertainty and Performance Beliefs ................................................................. 85

Uncertainty and Process Performance ................................................................. 87

Uncertainty and Task Performance ..................................................................... 88

Summary ............................................................................................................. 89

Did Uncertainty Mediate the Relation Between Media Richness and Team Performance (Hypothesis 6b)? ........................................................... 90

The Indirect Effect of Media Richness on Performance Beliefs via Uncertainty ....... 90

The Indirect Effect of Media Richness on Process Performance via Uncertainty ...... 92
The Indirect Effect of Media Richness on Task Performance via Uncertainty ........... 93

Summary................................................................................................................................................. 94

Did Trust Predict Team Performance (Hypothesis 7a)? ................................................................. 95

Overview .................................................................................................................................................. 95

Trust and Performance Beliefs .................................................................................................................. 96

Trust and Process Performance .................................................................................................................. 97

Trust and Task Performance ...................................................................................................................... 99

Summary................................................................................................................................................. 100

Did Trust Mediate the Relation Between Media Richness and Team Performance (Hypothesis 7b)? ........................................................................................................................................... 101

The Indirect Effect of Media Richness on Performance Beliefs via Trust .................. 101

The Indirect Effect of Media Richness on Process Performance via Trust .................. 103

The Indirect Effect of Media Richness on Task Performance via Trust ...................... 104

Summary................................................................................................................................................. 104

Did Trust Mediate the Relation Between Uncertainty and Team Performance (Hypothesis 8)? ................................................................................................................................................. 105

The Indirect Effect of Uncertainty on Performance Beliefs via Trust ......................... 105

The Indirect Effect of Uncertainty on Process Performance via Trust ....................... 106

The Indirect Effect of Uncertainty on Task Performance via Trust ............................. 107

Summary................................................................................................................................................. 107
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion</td>
<td>108</td>
</tr>
<tr>
<td>Overview</td>
<td>108</td>
</tr>
<tr>
<td>Felt Uncertainty: A Matter of Media Richness</td>
<td>109</td>
</tr>
<tr>
<td>Trust in Team Members: Media Richness, Uncertainty, and Propensity to Trust</td>
<td>111</td>
</tr>
<tr>
<td>Media Richness and Trust</td>
<td>111</td>
</tr>
<tr>
<td>Uncertainty and Trust</td>
<td>112</td>
</tr>
<tr>
<td>Propensity to Trust and Trust</td>
<td>113</td>
</tr>
<tr>
<td>Team Performance (Performance Beliefs): Media Richness, Uncertainty, and Trust</td>
<td>115</td>
</tr>
<tr>
<td>Media Richness and Performance Beliefs</td>
<td>115</td>
</tr>
<tr>
<td>Uncertainty and Performance Beliefs</td>
<td>116</td>
</tr>
<tr>
<td>Trust and Performance Beliefs</td>
<td>117</td>
</tr>
<tr>
<td>Team Performance (Process Performance): Media Richness, Uncertainty, and Trust</td>
<td>119</td>
</tr>
<tr>
<td>Media Richness and Process Performance</td>
<td>119</td>
</tr>
<tr>
<td>Uncertainty and Process Performance</td>
<td>120</td>
</tr>
<tr>
<td>Trust and Process Performance</td>
<td>122</td>
</tr>
<tr>
<td>Team Performance (Task Performance): Media Richness, Uncertainty, and Trust</td>
<td>123</td>
</tr>
<tr>
<td>Media Richness and Task Performance</td>
<td>123</td>
</tr>
<tr>
<td>Uncertainty and Task Performance</td>
<td>124</td>
</tr>
<tr>
<td>Trust and Task Performance</td>
<td>125</td>
</tr>
</tbody>
</table>
Limitations and Future Directions ................................................................. 127

The Use of a Laboratory-Based Research Design .......................................... 127

The Use of Undergraduate Student Participants .......................................... 128

The Use of Temporary, Swift Starting Action Teams ...................................... 129

The Use of a Single Experimental Session .................................................. 130

The Use of Limited Combinations of Media Richness Cues ......................... 131

Implications for Research ............................................................................ 132

Towards an Understanding of How Trust Operates in Virtual Teams ............ 132

Towards an Understanding of the Nuances of Virtual Communication .......... 134

Implications for Management ...................................................................... 135

The Current State of Virtual Team Practice ............................................... 135

Improving Virtual Team Knowledge, Trust, and Performance in Practice ......... 136

Conclusion ..................................................................................................... 139

References Cited ............................................................................................. 141

Appendix A. Non-Combatant Evacuation Operation (Non-Combatant Evacuation Operation):
Red Cross Scenario ....................................................................................... 172

.......................................................................................................................... 191

Appendix C. International Personality Item Pool propensity to trust items. ............. 192

Appendix D. Trust scale derived from Schoorman, Mayer, and Davis’s (1996) measure. .... 193
Appendix E. Marks, Mathieu, and Zaccaro’s (2001) process performance items. 194

Appendix F. Ideal solution to the Non-Combatant Evacuation Operation simulation based on subject matter expert feedback. 196

Appendix G. Non-Combatant Evacuation Operation simulation scoring matrix. 197

Appendix H. Initial (pre-study) consent form. 199

Appendix I. Participant demographics questionnaire. 204

Appendix J. Lab layout depending on team’s media richness condition assignment. 206

Appendix K. Second (post-study) consent form. 208

Appendix L. Script for study sessions. 211

Appendix M. AsPredicted.Org analysis plan form. 215

Appendix N. Control analyses and results. 217
LIST OF TABLES

Table 1: Clark and Brennan's (1991) review of the characteristics of collocated versus virtualized environments ........................................................................................................................................ 7

Table 2: Intraclass correlation coefficients (ICC(1)) estimates, and design effect estimates for individual-level outcomes in the model ........................................................................................................................................ 51

Table 3: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ uncertainty ratings .... 66

Table 4: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ trust ratings ........... 69

Table 5: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and uncertainty ratings; and participants’ trust ratings ........................................................................................................................................ 72

Table 6: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation, uncertainty ratings, propensity to trust ratings; and participants’ trust ratings ........................................................................................................................................ 76

Dependent Variable: Trust Ratings ........................................................................................................................................................................................................................................................................ 76

Table 7: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ performance belief ratings ........................................................................................................................................................................................................................................ 79

Table 8: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and teams’ process performance ratings .......... 81
Table 9: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and teams’ task performance ratings ......................... 83

Table 10: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and uncertainty ratings; and participants’ performance beliefs......................................................................................................................................................... 86

Table 11: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, and teams’ process performance ratings........................................................................................................................................................................................................ 87

Table 12: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, and teams’ task performance ratings........................................................................................................................................................................................................................................................................ 89

Table 13: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation, uncertainty ratings, trust ratings; and participants’ performance belief ratings ........................................................................................................................................................................................................................................................................ 97

Table 14: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, trust ratings; and teams’ process performance ratings ........................................................................................................................................................................................................................................................................ 98

Table 15: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, trust ratings; and teams’ task performance ratings ........................................................................................................................................................................................................................................................................ 100
LIST OF FIGURES

Figure 1: Proposed moderated mediation model - The effect of media richness on trust and team task performance ................................................................. 29

Figure 2: Standardized path coefficients (i.e., $\beta$) and their associated 95% confidence intervals for proposed moderated mediation model. ................................................................. 109
INTRODUCTION

Many organizations are eschewing traditional reporting hierarchies in favour of highly-coordinated lateral teams (see Salas & Fiore, 2004; Boies, Lvina, & Martens, 2010; Driskell, Radtke, & Salas, 2003). Although lateral team-based structures present many opportunities for organizations to increase their flexibility, innovation, and productivity, the success of any work team is contingent on its effective design; and part of effective team design involves encouraging positive interpersonal dynamics between team members. To that end, previous research suggests that one of the key interpersonal determinants of team effectiveness is the level of trust that exists between team members (e.g., Brahm & Kunze, 2012; Salamon & Robinson, 2008; Costa, 2003). Consequently, as the modern workplace incorporates more team-based structures, organizations should also strive to foster greater interpersonal trust between team members.

How might this be accomplished? At its core, interpersonal trust is founded on effective communication (Tyler & Kramer, 1996; McAllister, 1995; Moorman, Deshpande, & Zaltman, 1993). Therefore, in order to build trust, organizational leaders must first consider how team members communicate. Although this seems intuitive enough, the nature of organizational communication is also currently in flux. As organizational structures become more dispersed, many organizations have come to rely on technologically-based modes of communication such as email and videoconferencing systems (virtualization); and in doing so, have moved away from traditional collocated forms of communication. Due to a lack of communication cues (e.g., body language, co-presence), virtualization often creates more perceived distance between team members, and discourages trust development (McComb, Kennedy, Perryman, Warner, & Letsky, 2010). Because traditional trust-building often revolves around increasing communication in the
hopes of lessening the perceived psychological distance between individuals, it may be difficult to build trust specifically within teams that rely on virtual communication, due to the lack of available communication cues (Whitford & Moss, 2009).

The present study works to develop a theoretical framework based on Uncertainty Reduction Theory that will help researchers and practitioners better understand virtual team trust and performance. In doing so, the study aims to contribute to the extant virtual trust literature in at least three key ways. First, by applying Uncertainty Reduction Theory to virtual trust, the study offers a theoretical mechanism specifically for virtual trust development. In doing so, the study builds on previous research that has extensively relied on extending broader collocated team-based theories such as “swift trust” to virtual teams. Second, the study works to better establish the specific aspects of virtual work that affect trust. It does so by operationalizing virtualization as “media richness” (rather than relying on a dichotomous “virtual-not virtual” operationalization). Third, the study adopts a unique work simulation-based experimental design that allows the effects of virtualization to be examined under controlled, experimental conditions, while also retaining a high degree of generalizability to applied settings (thus increasing the “real world” applicability of any observed relations; Locke, 1986).

**The Rise of Virtual Work Teams**

**The Technology Behind Virtual Work Teams**

Traditionally, organizations have been constrained by geographic and cultural boundaries due to their reliance on collocated, face-to-face forms of communication. Because organizations have historically operated in a single delineated space, employees and other collaborators could only be hired if they could enter into and share the same physical space as the people that they
were working with. These constraints have become increasingly obsolete as the modern workplace shifts towards the creation and management of data, rather than traditional industrial enterprises (Gurstein, 1998; Nilles, 1998). This shift towards an information-based economy has greatly diminished the need for centralized working structures; and many jobs that once required employees to commute to a central location can now be accomplished from anywhere using information and communication technologies (Nilles, 1998). These technologies include any number of tools, techniques, and knowledge bases that enable groups of individuals to participate in discussions and collaborative projects with one another through sophisticated methods of collecting, processing, managing, retrieving, and displaying data (DeSanctis & Poole, 1994). Such techniques encompass everything from simple e-mail programs to advanced teleconferencing and videoconferencing systems; and even include elaborate virtual reality environments such as Second Life. The defining feature behind all information and communication technologies, however, is that they are all designed to enable multi-party collaboration across time and space in a manner that would not be possible without their use.

**What Makes a Work Team “Virtual”? How Media Richness Defines the Virtual Experience**

The term “virtual work team” encompasses any work team in which team members primarily communicate with one another through the mediating use of information and communication technologies; and who can subsequently communicate across time and space, instead of communicating within the constraints of a single collocated space (Boudreau, Loch, Robey, & Straub, 1998). Virtual teams are often touted as a way to promote greater organizational flexibility (Boudreau, Loch, Robey, & Straub, 1998), and encourage information sharing among team members (Van den Bosch, Volberda, & De Boer, 1999). For these reasons,
virtual teams have been gaining popularity since the 1990s (Cascio, 2000), and are increasingly common across many industries. In 2011, Aon Consulting’s “Benefits and Talent” survey reported that no less than 44 percent of organizations anticipated a significant increase in their use of virtual work teams in upcoming years (Leonard, 2011); a prediction that would soon be corroborated by a number of sources. More recently, Gallup’s (2016) “State of the American Workplace” survey found that 43 percent of employees work virtually at least part of the time; and FlexJob’s “State of Telecommuting Report” (2017) noted that nine million people (2.90 percent of the total U.S. workforce) do so more than 50 percent of the time. This trend towards virtual work may be most pronounced, however, among the burgeoning millennial workforce; 64 percent of whom report working virtually at least part of the time, according to Deloitte’s (2017) “Millennial Survey”.

Despite their increasing popularity, there is still some debate over what makes a work team “virtual” – and subsequently, at what point a work team should be considered a “virtual work team”. Most researchers agree that distance is the key variable to consider (Chudoba, Wynn, Lu, & Watson-Manheim, 2005); and in doing so, note that virtuality may be most effectively operationalized by considering the verbal and non-verbal communication cues that virtual modes of communication lack when compared to collocated communication (e.g., Watson-Manheim, Chudoba, & Crowston, 2002; Clark & Brennan, 1991). According to Media Richness Theory, collocated communication has six specific communication cues that are often unavailable when communicating over information and communication technologies; specifically: copresence, visibility, audibility, cotemporality, simultaneity, and sequentiality (Clark & Brennan, 1991). The former three cues subsumed under this theory are relatively self-explanatory. Of these, copresence refers to the simple sharing of physical space. Visibility refers
to the ability of group members to see one another. And audibility refers to the ability of group
members to hear one another.

The latter three cues are more nuanced, and require slightly more elaboration. Cotemporality refers specifically to the speed at which messages are transmitted, such that higher
cotemporality indicates faster transmission. For example, yelling to your teammate across a room
would achieve high cotemporality; whereas sending the same teammate a letter through the
Canada Postal Service would achieve relatively low cotemporality.

Simultaneity refers to the ability to both send and receive communications at the same
time – often because the communicator has access to several different verbal and non-verbal cues
that facilitate information transmission. Simultaneity is distinct from cotemporality in that
speedy forms of one-way communication may achieve cotemporal communication by
transmitting messages quickly; but fail to achieve simultaneous communication by not providing
additional communication cues that allow information to be transmitted and received at the same
time. For example, your teammate could smile at you while you give them happy news in-
person. In this case, the teammate is both receiving information (i.e., hearing the news) and
giving information (i.e., displaying that they are happy to receive the news); thus achieving
simultaneity. Conversely, that same letter sent through the Canada Postal Service would facilitate
the transmission of this happy news; but would fail to facilitate the simultaneous transmission of
how your teammate is receiving it (thus failing to achieve simultaneity).

Sequentiality refers to whether or not it is possible for group members' speaking turns to
stay in order based on non-verbal social cues. For example, if you and your teammate were
speaking about work in-person and a friend you had spoken to earlier that day were to interrupt
your conversation, this would likely cause a major disruption to your work-related conversation
(due to high sequentiality). Conversely, if you and the same teammate were emailing about work, and your friend from earlier that day sent you an unrelated email, this would cause less of a disruption to your work-related conversation (due to low sequentiality).

Only a collocated team meeting exhibits all six of these characteristics, in that team members occupy the same space, see and hear one another, receive messages as soon as they're spoken, can send and receive information at the same time, and can speak in an intuitive, logical order (Driskell, Radtke & Salas, 2003). Meetings facilitated by information and communication technologies exhibit fewer of these characteristics. That said, the extent to which these characteristics are present or lacking can vary across different information and communications technologies. For example, in real-time videoconferencing scenarios team members can see and hear one another, can receive messages as soon as they're spoken, can speak and listen at the same time, and can speak in turn. Therefore, videoconferencing would afford five of the six characteristics present in collocated communication: visibility, audibility, cotemporality, simultaneity, and sequentiality – only copresence is missing (Driskell, Radtke & Salas, 2003). Conversely, in online “live chat” environments, team members do not see or hear one another, and do not occupy the same physical space; however, they can receive messages as soon as they're sent, can send and receive messages at the same time, and can send messages in turn. Because of this, in online chat environments the cotemporality, simultaneity, and sequentiality characteristics of collocated meetings are still present (Driskell, Radtke & Salas, 2003). In this sense, online chat scenarios could be considered “more virtual” than videoconferencing scenarios, because they afford fewer of the characteristics that distinguish a collocated conversation from a virtual one (see Table 1).
Table 1: Clark and Brennan's (1991) review of the characteristics of collocated versus virtualized environments

<table>
<thead>
<tr>
<th>Media Characteristics</th>
<th>Copresence</th>
<th>Visibility</th>
<th>Audibility</th>
<th>Cotemporality</th>
<th>Sequentiality</th>
<th>Sequentiality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collocated</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Videoconferencing</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Conference Calls</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Computer Chat</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Email</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>


Under Media Richness Theory, an information and communications technology that provides individuals with many of the same cues available in collocated settings is referred to as a “rich” form of media; whereas a technology that offers few if any of these cues is referred to as a “lean” form of media. As media becomes leaner, team members begin to incur various costs that make effective communication more difficult. In these situations, team members must find other – often less efficient – means for achieving the same level of understanding (Clark & Brennan, 1991). For example, uttering a statement verbally is generally less time-consuming and cognitively-taxing than writing the same utterance. Thus, written communication forms such as
email incur a larger production cost. Similarly, listening to an utterance is generally less
cognitively-taxing than reading a written representation of the same utterance. Thus, written
communication also incurs a larger reception cost. The various costs that lean media incur make
communication more taxing in terms of time and expended energy, and often interact with one
another (Clark and Brennan, 1991). Consequently, although it is difficult and somewhat
unhelpful to disentangle the specific effects of each communication cue in a vacuum (and thus
quantify or rank-order the importance of these cues), increasing the number of communication
cues available in any given media should holistically improve a team’s communication (Clark &

Following this idea, a team environment cannot be adequately conceptualized as simply
“virtual” or “not virtual” due to the presence or absence of a mediating communications
technology. Instead, the level of virtualization that any given form of technology engenders can
be more accurately understood as its degree of removal from collocated communication
environments. By making this distinction, one can more usefully characterize virtual work
environments along a continuum that encompasses and differentiates many different virtual
structures.

**Trust: A Central Challenge in Virtual Work Teams**

Although virtual teams have enabled more flexible communication across time and space
(Burgelman, 2000), most researchers agree that virtualization cannot seamlessly approximate
collocated communication. This is because information and communication technologies
generally fail to facilitate many of the essential non-verbal cues that are present in collocated
communication (e.g., Olson & Olson, 2000; Driskell, Radtke & Salas, 2003). Because additional
verbal and non-verbal cues like visibility and audibility are available in collocated communication, behaviour in a collocated environment can be understood at a more complex level. Conversely, the lack of these cues in virtual environments forces communicators to interpret behaviour at a more basic level (Lea & Spears, 1992; Forster, Friedman, & Liberman, 2004; Whitford & Moss, 2009). This distinction can subsequently affect the ways in which a team member infers the actions of their co-workers in a virtual versus in a collocated setting.

This idea is particularly troubling when one considers the negative effects that a lack of communication cues can have on team trust. Trust is a critical variable in developing effective teams (e.g., Brahm & Kunze, 2012, Salamon & Robinson, 2008), and there is sizable demand for trust development within both collocated- and virtual work teams. However, because trust is founded on interpersonal connection and requires information sharing between team members (McAllister, 1995; Moorman, Deshpande, & Zaltman, 1993), it may be more difficult to develop in a virtual team than it is in a collocated team, due to an overarching lack of communication cues. A lack of these cues may hamper effective information transmission, preventing the requisite information gathering that is necessary for grounded trust decisions.

**Why Virtual Trust Research is Needed Now**

At least two meta-analytic studies suggest that trust relates positively to employee task performance and organisational citizenship behaviours; and negatively to counterproductive work behaviours (Colquitt, Scott, & LePine, 2007; Dirks & Ferrin, 2002). Trust accomplishes this by allowing trustors to focus their full attention on their work (instead of using that energy to monitor co-workers; Dirks & Ferrin, 2002; Mayer & Gavin, 2005); as well as by encouraging more effective and cooperative exchange relationships between co-workers (Blau, 1964). A
growing body of work further supports the integral role that trust may play specifically within team settings. Empirical work has identified trust as a key predictor of team performance (e.g., Brahm & Kunze, 2012; Langfred, 2004; Costa, 2003; Dirks, 2000; Porter & Lilly, 1996).

Although less research has considered the means through which trust affects team performance (Dirks & Ferrin, 2001), the extant body of work in this area highlights the mediating role that team processes, such as knowledge sharing (e.g., Staples & Webster, 2008), reflexivity (e.g., Schippers, 2003), checking in (e.g., De Jong & Elfring, 2010; Langferd, 2004), and effort (e.g., De Jong & Elfring, 2010; Spreitzer, Noble, Mishra, & Cooke, 1999) play in translating the trust that exists between team members, into the team’s subsequent performance. These findings highlight the need to build trust early in a team’s development in order to maximize its positive effects on team functioning and effectiveness.

In virtual settings, trust may be even more important for team effectiveness than it is in collocated settings; as virtual team members may be also unable to engage in trust alternatives like close supervision or monitoring (O’Hara-Devereaux & Johansen, 1994; Wigand, Picot, & Reichwald, 1997; Swagerman, Dogger, & Maatman, 2000). Because virtual team members do not share the same physical space, they cannot easily observe one another’s progress, and are less able to effectively monitor one another (Wigand, Picot, & Reichwald, 1997; Swagerman, Dogger, & Maatman, 2000). Moreover, many of the factors that facilitate social control in a collocated setting (such as perceived proximity or ease of monitoring one another), may also be absent in virtual settings (Jarvenpaa, Knoll, & Leidner, 1998). As a result, virtual team members often have fewer options than collocated team members for influencing their team members via monitoring or other direct social control mechanisms.
Moreover, previous research suggests that even attempting to exert behavioral control in a virtual setting may negatively impact the team’s trust and performance (Piccoli & Ives, 2003). This is due in part to the design of virtual teams, which are often structured laterally rather than vertically; and frequently formed on an ad-hoc, temporary basis (Snow, Miles, & Coleman, 1992; Kasper-Fuehrera & Ashkanasy, 2001). Because monitoring and social control are often less effective (if even possible) in virtual teams, virtual team members must instead rely heavily on the level of trust that exists between one another (Brahm & Kunze, 2012; Jarvenpaa & Leidner, 1999). This has led several researchers to conclude that trust is an essential component for the functioning and success of virtual teams (e.g., Nelson & Cooprider, 1996; Sheppard & Tuchinsky, 1996; Swagerman, Dogger, & Maatman, 2000).

Given the rapid proliferation of virtual work teams, there is a growing need to examine the ways in which virtual team trust may be developed. Doing so will promote the effective inception of virtual teams into the modern workforce, and will allow industrial and organizational psychologists to make a meaningful contribution to the effective management of virtual teams.

**How Does Virtual Trust Develop? Can “Swift Trust” Explain It?**

**The Development of “Swift Trust”, and its Application to Teams Research**

An important first step in understanding how to foster trust within virtual teams is to consider the existing literature on virtual team trust; and attempt to reconcile it with broader trust theories. Current scholarship on virtual team trust borrows heavily from the larger teamwork literature. Much of this scholarship draws specifically on Meyerson and colleagues’ (1996) concept of “swift trust”, which refers to apparent instances of improbably-high initial trust
specific to swift-starting, collocated action teams (Meyerson, Weick, & Kramer, 1996). Swift-starting action teams are short-lived teams of employees that are formed to address a common task with finite life spans (such as film crews, theater groups, presidential commissions, senate selection committees, and cockpit crews). Swift-starting action teams often consist of members with diverse skills, a limited history of working together, and little prospect of collaborating again in the future (Meyerson et al., 1996). The tight deadlines under which these teams work leave little time for relationship-building; and this lack of time presents an inherent difficulty for developing trust in a traditional sense. Researchers argue that it is this limitation of swift-starting action teams that make the literature on them an effective proxy for that of virtual work teams (which, due to their reliance on information and communication technologies and leaner forms of media, face similar barriers to trust development; Meyerson et al., 1996).

Because the members of swift-starting action teams do not have enough time to make informed assessments about one another’s trustworthiness, they are thought to make trust decisions based on other, more basic criteria. These criteria may include: their propensity to trust others generally; heuristics they hold based on the role they or the trustee is in; and, habitual trust that’s carried over from other teams or working arrangements (Meyerson, Weick, & Kramer, 1996). For example, if a new team forms and its members don’t have time to get to know one another, a team member may think back to their experiences in other teams; or alternatively, may make inferences about his or her new team members based on the perceived responsibilities and power implied in each team member’s job title. That information is then used to decide whether or not the new team members can be trusted. The decision to trust in these cases is made out of necessity and habit, rather than being made through having any personal connection or information about the trustee (Meyerson et al., 1996).
As swift trust is not based on personal knowledge, it is fragile and often requires reinforcement in order to maintain. Consequently, as a team works together, swift trust is maintained through a “highly active, proactive, enthusiastic, generative style of action” (Meyerson et al., 1996, p. 180). This concept, at its core, strongly resembles the monitoring and other social control behaviours that usually represent trust alternatives. Such actions may include task-related communication, checking-in with team members, or reporting that one has reached a performance goal or milestone (Meyerson et al., 1996). Fulfilling these actions promotes team performance and, subsequently, the maintenance of the swift trust (Iacono & Weisband, 1997). In this sense, swift trust may best be described as a case of trusting others but then taking the time to verify that trust (Rousseau, Sitkin, Burt, & Camerer, 1998).

Can “Swift Trust” be Effectively Applied to Virtual Work Teams?

A number of researchers have suggested that Meyerson et al.’s (1996) swift trust concept could also be applied to virtual work teams (e.g., Crisp & Jarvenpaa, 2013; Jarvenpaa & Leidner, 1999; Henttonen & Blomqvist, 2005; Iacono & Weisband, 1997; Wilson, Straus, & McEvily, 2006). As with swift-starting action teams, virtual teams face sizable challenges to traditional trust development. Specifically, Johnson et al. (2002) argue that virtual team members often need more time at the early stages of team development to coordinate their activities and establish relationships and norms (Johnson, Suriya, Yoon, Berrett, & La Fleur, 2002). This is due to a lack of communication cues in virtual teams, which make it more difficult for virtual team members to gather information about the trustworthiness of their co-workers (Wildman, Schuffler, Lazzara, Fiore, Burke, Salas, & Garvin, 2012). Because these communication cues are missing, team members may not know how to effectively interact and operate in a virtual setting (Johnson
et al., 2002). Their confusion may also be exacerbated by the ad-hoc and unstructured way in which virtual teams are often formed (Kanawattanachai & Yoo, 2002), introducing further ambiguity into the virtual team setting.

Given the importance of developing trust in teams to ensure performance (e.g., Brahm & Kunze, 2012; Langfred, 2004; Costa, 2003; Dirks, 2000; Porter & Lilly, 1996), swift trust followed by subsequent reinforcement may represent one avenue for developing and maintaining trust in a virtual setting in a way that overcomes the inherent ambiguity of virtual settings (which may preclude traditional trust development).

**Why Lean Media Hinders the Application of “Swift Trust” to Virtual Work Teams**

Because swift trust is inherently fragile and requires regular reinforcement (Meyerson, Weick, & Kramer, 1996), researchers believe it often reaches its apex at the beginning of a team’s lifespan (Meyerson et al., 1996). After this point, swift trust can only be maintained by regular reinforcement that gives evidence of the trustee’s trustworthiness (ideally building towards a more traditional, stable form of trust over time; Iacono & Weisband, 1997). However, unlike in collocated, swift-starting action teams (for whom swift trust was originally theorized), virtual teams often systematically lack access to the necessary socio-emotional cues that allow trust to develop over time (Handy, 1995). Because of this, team members in virtual teams are unlikely to access many of the cues needed to work towards the maintenance of swift trust (even when they’re given sufficient time to do so; Henttonen & Blomqvist, 2005; Jarvenpaa & Leidner, 1999). As a result, swift trust may fail to evolve into a more stable, traditional form of trust when enacted in virtual settings. Consequently, an alternative theory of trust may be necessary for virtual work teams.
Back to Basics: How Trust May Work within a Virtual Work Team

A Brief Introduction to Trust

Before positing a theory of virtual trust development, one must revisit the definition of trust itself. Trust refers to a dyadic phenomenon in which one party (the trustor) willingly accepts vulnerability to another party (the trustee) based on positive expectations of the trustee’s intentions and behaviours (Mayer, Davis, & Schoorman, 1995; Johnson-George & Swap, 1982; Rousseau, Sitkin, Burt, & Camerer, 1998). According to Mayer and colleagues (1995), individuals make the decision to trust others based on evidence of three characteristics in the trustee: their ability, their benevolence, and their integrity (Mayer, Davis, & Schoorman, 1995). Ability refers to all of the domain-specific skills, competencies, and characteristics of a trustee that allows him or her to be competent at a given task. Benevolence refers to the extent to which a trustee is motivated to help the trustor beyond considerations of self-interest. Integrity refers to the extent to which a trustee adheres to a set of principles that the trustor finds acceptable; and which make the trustee dependable and reliable in the trustor’s opinion. When a trustee has high levels of perceived ability, benevolence, and integrity, the trustor is more likely to accept vulnerability to the trustee – and as a result, offer trust.

When a trustor makes the decision to trust another individual, they often engage in two distinct (but not mutually exclusive) forms of behaviour that evidence their trust: reliance behaviours and disclosure behaviours (Gillespie, 2003; Lau, Lam, & Wen, 2014). Reliance behaviours refer to actions a trustor takes to effectively delegate power or authority on tasks to a trustee. For example, an employee who asks their co-worker to handle a sensitive assignment on their behalf is engaging in reliance. Conversely, disclosure behaviours refer to actions a trustor takes to share personal information, evidence liking, or establish social bonds with a trustee.
Collins & Miller, 1994). For example, an employee who confides potentially damaging information about problems he or she is having at home to a co-worker is engaging in disclosure.

**Risk Assessment and the Inherent Role of Uncertainty in Trust**

Trust decisions are inherently decisions about risk taking. Consequently, trust can only meaningfully develop in situations where the trustor and the trustee have partial certainty about one another. A situation in which two people know nothing about one another precludes trust development; as there is no rational basis for making trust decisions (McAllister, 1995; Moorman, Deshpande, & Zaltman, 1993). Similarly, a situation in which two people can predict one another’s actions with complete certainty also precludes trust development; as there is no vulnerability (and therefore risk) inherent in the decisions these individuals make (McAllister, 1995; Moorman, Deshpande, & Zaltman, 1993). By definition, trust decisions can only be made in situations where trustors can make some (albeit imperfect) assessment of the trustee, particularly with regards to the trustee’s ability, benevolence, and integrity (McAllister, 1995; Moorman, Deshpande, & Zaltman, 1993). By virtue of having less uncertainty about the situation and the trustee (with the understanding that their knowledge is never perfect), trustors can take more calculated risks. Using knowledge to minimize perceived risk is, at its core, what trustors do when they use ability, benevolence, and integrity cues to decide whether or not to trust another individual.

Some empirical work supports the idea that trust indirectly functions as an indicator of the level of uncertainty that exists in a relationship (Luhmann, 1979; Lind, 2001; van den Bos, 2001; van den Bos, Lind, & Wilke, 2001; Colquitt, LePine, Piccolo, Zapata, & Rich, 2012). Specifically, Fairness Heuristic Theory suggests that teams exist in situations of inherent
uncertainty; and that one way to reduce the uncertainty in a team situation is to make trust decisions about one’s team members (Lind, 2001; van den Bos, 2001; van den Bos, Lind, & Wilke, 2001). That is, deciding where to place trust reduces the complexity and uncertainty inherent in team settings by minimizing certain dangers through informed risk assessment. Doing so allows for coordinated actions that would not have been possible or practical without trusting another party (Luhmann, 1979). This kind of uncertainty reduction is shown to be particularly relevant for trust in situations that emphasise cognitive trust decisions rather than affective trust decisions (Colquitt, LePine, Piccolo, Zapata, & Rich, 2012), which are the kind of situations most often encountered in virtual work teams (Chidambaram & Bostrom, 1993; Walther, 1995; Walther & Burgoon, 1992).

**Uncertainty Reduction Theory and the Role of Uncertainty in Determining Trust**

Critically, this idea is supplemented by Uncertainty Reduction Theory. Uncertainty Reduction Theory refers to a theory for understanding the role that relative certainty plays in the initial communication between individuals; and the subsequent effects of this certainty on interpersonal affective outcomes such as trust and liking. According to Uncertainty Reduction Theory, when team members start to interact, their primary concern is to reduce uncertainty about their team members, in order to increase the predictability of one another’s behaviour (Berger & Calabrese, 1975; Kellerman & Reynolds, 1990). The more uncertain team members are about one another, the more motivated they are to seek out information that will reduce their uncertainty (this is known as axiom three of Uncertainty Reduction Theory; Berger & Calabrese, 1975). In doing so, team members aim to make their teammates’ actions more explainable and predictable. Doing so allows them to anticipate how they should act towards the people they
work with (Berger & Calabrese, 1975; Kellerman & Reynolds, 1990; Sunnafrank, 1990). In this
sense, changes in uncertainty ultimately dictate the nature of the interactions and relationships
that develop between individuals (Berger & Calabrese, 1975; Sunnafrank, 1990).

Axiom seven of Uncertainty Reduction Theory is most relevant for this study. According
to this axiom, uncertainty is negatively related to liking and other related affects (Berger &
Calabrese, 1975). Previous research has found strong links between interpersonal liking and
interpersonal trust (e.g., Nicholson, Compeau, & Sethi, 2001; Popa, 2005; Nacci & Tedeschi,
1976; Feng, Lazar, & Preece, 2004). Therefore, it is likely that uncertainty will affect trust as
well as liking (an idea that is already evidenced in seminal work that links predictability to trust;
see Mayer, Davis, & Schoorman, 1995; Dasgupta, 1988; Gambetta, 1988; Good, 1988; Rotter,
1967).

Moreover, trusting decisions are inherently decisions concerning vulnerability. The more
certainty that a decision can be made with, the more likely a trustor is to feel safe in accepting
vulnerability; thus increasing their propensity to accept that vulnerability and offer trust
(Jarvenpaa & Leidner, 1999; Ben-Ner, & Putterman, 2006; Loomis, 1959; Peters, Covello, &
McCallum, 1997). Because trust centres on vulnerability, it should therefore develop through the
enactment of communication behaviours between team members that reduce uncertainty to a
degree that allows informed trust decisions to be made (e.g., Jarvenpaa & Leidner, 1999; Ben-
Ner, & Putterman, 2006; Loomis, 1959; Peters, Covello, & McCallum, 1997) – with the
understanding that some element of uncertainty will always be present when dealing with
another individual (i.e., perfect certainty is not possible).
Hypothesis Development

Overview

If trust decisions are, at their core, decisions concerning whether or not to accept vulnerability in situations of imperfect knowledge (Luhmann, 1979; Lind, 2001; van den Bos, 2001; van den Bos, Lind, & Wilke, 2001; Colquitt, LePine, Piccolo, Zapata, & Rich, 2012), then a few conclusions can be drawn regarding the role that uncertainty may play in predicting virtual team trust and performance. First, the level of trust that an individual affords someone is likely to be inversely proportional to the risk that they perceive. By reducing the number of “unknowns” that a trustor has, greater certainty should encourage greater levels of trust between team members; as feeling more certain about a given outcome reduces feelings of risk (Das & Teng, 2004; Fischhoff, 1985; Luhmann, 1993). Due to their reliance on lean forms of media, virtual teams often lack the necessary socio-emotional cues to sufficiently reduce uncertainty (Clark & Brennan, 1991; Jarvenpaa & Leidner, 1999; Fiol & O’Connor, 2005). Subsequently, these teams should be less likely to develop sufficient trust.

Much of the current interest in virtual teams stems from the fact that – although these teams are emerging across several sectors of industry – they often underperform collocated teams (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Hollingshead & McGrath, 1995). Previous research suggests that this lack of performance is related to trust in virtual teams (Nelson & Cooprider, 1996; Sheppard & Tuchinsky, 1996; Swagerman, Dogger, & Maatman, 2000). If team member trust predicts team performance (Brahm & Kunze, 2012; Langfred, 2004; Costa, 2003; Dirks, 2000; Porter & Lilly, 1996), then virtual teams may fail to approximate the performance of their collocated counterparts due to the same lack of socio-emotional and non-
verbal cues that hinder team members’ certainty and, subsequently, trust. If this is the case, then a number of specific hypotheses can be drawn:

**Media Richness Decreases Team Members’ Uncertainty about One Another (Hypothesis 1)**

Previous research already supports a link between virtual communication and feelings of uncertainty (e.g., Jarvenpaa & Leidner, 1999; Fiol & O’Connor, 2005). When team members interact virtually, the quality of their interactions is often reduced due to limitations in the verbal and non-verbal communication cues that virtual media provides (such as audibility, simultaneity, or sequentiality). This is especially true in cases where the team specifically relies on lean forms of media, such as email (Clark & Brennan, 1991). Consequently, the depth with which virtual team members – especially those operating under lean media – can understand and interpret one another’s behaviour is likely to limited (Lea & Spears, 1992; Forster, Friedman, & Liberman, 2004; Whitford & Moss, 2009). Compounding this problem is the fact that virtual media may also preclude team members from actively monitoring one another’s processes or work as they complete their task (Wigand, Picot, & Reichwald, 1997; Swagerman, Dogger, & Maatman, 2000). If team members do not see each other while working together (i.e., lack visibility), they may be relegated to only seeing their team members’ objective outputs or any announcements their team members choose to make – and these might only come at infrequent intervals.

A lack of rich information can make it more difficult for team members to get a strong sense of who they’re working with while completing a shared task. This is especially true if they also have a limited history of working together (which, although not necessarily true in virtual teams, is often the case; see Snow, Miles, & Coleman, 1992; Kasper-Fuehrera & Ashkanasy, 2001). As a result, virtual team members – especially those working under conditions of leaner
media – are likely to feel more uncertainty towards their team members than those working in a collocated setting or under richer forms of media. Consequently, in the present study, participants in more media rich (i.e., less virtualized) settings should report feeling less uncertainty towards their team members:

Hypothesis 1. Media richness will be negatively related to uncertainty.

Media Richness Increases Team Members’ Trust (Hypothesis 2)

Developing trust in a virtual team is thought to be more difficult than it is in a collocated team because many of the ability, benevolence, and integrity cues that promote trust are more difficult to evidence in virtual environments (Forster, Friedman, & Liberman, 2004; Whitford & Moss, 2009). Previous research suggests that, in order to assess a trustee’s trustworthiness (i.e., their ability, benevolence, and integrity; Mayer, Davis, & Schoorman, 1995), a trustor needs access to both verbal and non-verbal behavioural indicators from the trustee (Weiss & Cropanzano, 1996; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999; Wicks, Berman, & Jones, 1999). Unfortunately, these cues may be markedly less available in virtual settings, due to a lack of media richness (Takeuchi & Nagao, 1993; Walther & Tidwell, 1995; Yates & Orlikowski, 1993). For example, a trustee’s benevolence is often inferred through facial indicators, such as through a Duchene smile or strong eye contact (Krumhuber, Manstead, Cosker, Marshall, Rosin, & Kappas, 2007; Holtz, 2014; Stouten & De Cremer, 2010). Neither of these non-verbal indicators may be present when working together over a more lean form of media such as e-mail. If this is the case, then virtual team members – especially those working under conditions of leaner media – should feel less trust towards their team members than those working in a collocated setting or under richer forms of virtual media. Consequently, in the present study, participants in more
media rich (i.e., less virtualized) settings should report feeling more trust towards their team members:

**Hypothesis 2.** Media richness will be positively related to trust.

**Team Members’ Uncertainty about One Another Decreases Team Members’ Trust (Hypothesis 3a)**

Team member trust is inextricably tied to the uncertainty that team members have about one another. This is the case because, at their core, all trust decisions centre on whether or not to accept vulnerability to another individual. Precluding some form of omniscience, such decisions are necessarily made in situations where the trustor lacks perfect knowledge about the trustee. Therefore, the decision of whether to trust another individual (and in doing so, accept vulnerability to that individual) will always involve an element of uncertainty and – consequently – risk (Mayer, Davis, & Schoorman, 1995; Johnson-George & Swap, 1982; Rousseau, Sitkin, Burt, & Camerer, 1998). Because there is always some inherent risk involved in trust, a major determinant of whether that trust is offered is the relative confidence with which a trustor can accept vulnerability, knowing that the likelihood of failure or betrayal on the trustee’s part is relatively low (this is often operationalized as the trustee’s trustworthiness; for seminal discussion, see Mayer, Davis, & Schoorman, 1995; Good, 1988; Lieberman, 1981).

Gaining this relative surety necessitates having enough information about the trustee to effectively assess their trustworthiness. Feeling more certain about the trustee should allow a trustor to be more confident in the trusting decision that they ultimately make (Jarvenpaa & Leidner, 1999; Ben-Ner, & Putterman, 2006; Loomis, 1959; Peters, Covello, & McCallum, 1997). Therefore (assuming the trustee has sufficient ability, benevolence, and integrity), a trustor should be more likely to accept vulnerability to a trustee if he or she experiences a
minimal amount of uncertainty about that trustee. Consequently, in the present study, participants’ felt uncertainty about their team members should be negatively related to the trust they feel for their team members:

*Hypothesis 3a.* Uncertainty will be negatively related to trust.

**Media Richness Increases Team Members’ Trust by Decreasing Team Members’ Uncertainty about One Another (Hypothesis 3b)**

Non-verbal cues are important for reducing uncertainty between team members; and subsequently, allowing informed trust decisions to be made (Clatterbuck, 1976; Clatterbuck, 1979; Stouten & De Cremer, 2010). Because virtual communication often lacks the means to transmit information from these important non-verbal behaviours, collocated communication is often more effective at reducing uncertainty and allowing trustworthiness displays (Nohria & Eccles, 1992; Grundy, 1998). That said, trust decisions are unlikely occur just because information is lacking. Instead, missing information is likely to discourage trust by increasing the level of felt uncertainty potential trustors feel about their trustees. Trust decisions are implicitly decisions regarding how to handle uncertain outcomes. Richer forms of media are likely to foster greater team member trust, specifically because these forms of media lessen the relative uncertainty that exists between team members. Consequently, in the present study, participants in more media rich (i.e., less virtualized) settings are likely to report greater trust in one another by virtue of perceiving less uncertainty:

*Hypothesis 3b.* Uncertainty will partially mediate the positive relation between media richness and trust.
The Negative Relation between Team Members’ Uncertainty and Team Members’ Trust Attenuates when Team Members have a Higher Propensity to Trust Others (Hypothesis 4)

When a trustor lacks the necessary information to make informed trustworthiness appraisals, they must rely on less situation-specific criteria for making trust decisions. One such criteria is their trait-level propensity to trust others. Propensity to trust refers to an individual’s dispositional inclination to make trusting decisions, independent of trustworthiness cues (Mayer, Davis, & Schoorman 1995). Previous research suggests that propensity to trust may moderate the relation between trustworthiness information and trust decisions (Aubert & Kelsey, 2003; Mayer, Davis, & Schoorman, 1995). And in settings where trustworthiness information is less readily available (such as in virtual teams with lower media richness), propensity to trust may play an even more important role in making trust decisions (Gill, Boies, Finegan, & McNally, 2005; Yakovleva, Reilly, & Werko, 2010; Wildman, Shuffler, Lazzara, Fiore, Burke, Salas, & Garven, 2012). When there is greater uncertainty in a team, a trustor should be less likely to make a trusting decision; however, if the trustor has a higher propensity to generally trust others, he or she may be more likely to show trust, even if he or she experiences a large amount of uncertainty when doing so. Consequently, in the present study, participants’ propensity to trust others should attenuate the negative relation between uncertainty and trust:

Hypothesis 4. The relation between uncertainty and trust will be moderated by propensity to trust; such that this relation will be weaker for participants with a higher propensity to trust others.

Media Richness Increases Team Performance (Hypothesis 5)

Previous research suggests that virtual teams often suffer lower performance than collocated teams (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; DeMeyer, 1991;
Galegher & Kraut, 1994; Hollingshead & McGrath, 1995). Media Richness Theory posits that, when teams communicate over less rich forms of media, their communication becomes less grounded (Clark & Brennan, 1991), and they have less communication information available to interpret and properly react to one another’s behaviour. In situations where teams need to carefully coordinate their actions, this lack of information could reduce the team’s ability to perform. This is particularly true when teams rely on leaner forms of media that lack a greater number of communication cues (Clark & Brennan, 1991). For example, a virtual team that lacks audibility incurs greater production costs when transmitting messages, because team members have to type them. These teams also incur greater reception costs, as team members must read messages instead of listening to them (Clark & Brennan, 1991).

In their meta-analytic review, Baltes and colleagues (2002) built on this idea, and suggested that virtual team members often require additional time to complete their tasks due to the unfamiliar group dynamics that are often present in virtual teams. This problem is exacerbated by the fact that these teams are often formed on an ad-hoc basis (Snow, Miles, & Coleman, 1992; Kasper-Fuehrera & Ashkanasy, 2001), and may lack clear expectations and specific team norms (Sarker, Lau, & Sahay, 2001; Sarker & Sahay, 2001; Suchan & Hayzak, 2001). As a result, virtual teams may lose valuable time that they would otherwise spend completing their shared task due to: 1) having to disentangle ambiguous information to compensate for a lack of communication cues; and, 2) having to disentangle ambiguous information regarding a lack of norms and pre-ordained structure. Consequently, in the present study, participants and teams in more media rich (i.e., less virtualized) settings should engage in greater team performance:

*Hypothesis 5. Media richness will be positively related to team performance.*
Team Member Uncertainty Decreases Team Performance (Hypothesis 6a)

The performance issues that virtual teams face are likely due in part to the relative level uncertainty engendered by virtual communication. Team member information sharing has been linked to team performance in previous meta-analytic research (Mesmer-Magnus & DeChurch, 2009). When team members are able to reduce the uncertainty they have about one another and the task they are completing, they are likely to engage in more effective knowledge sharing (e.g., Lievens & Moenaert, 2000); and to use their experience to integrate task knowledge more effectively (e.g., Gardner, Gino, & Staats, 2012). Subsequently, these teams are likely to see improvements in team performance (e.g., Lievens & Moenaert, 2000; Gardner, Gino, & Staats, 2012). Following this idea, in the present study, participants’ uncertainty towards their team members should be negatively related to their teams’ performance:

Hypothesis 6a. Uncertainty will be negatively related to team performance.

Media Richness Increases Team Performance by Decreasing Team Members’ Uncertainty about One Another (Hypothesis 6b)

Virtual teams members are required to sort through various forms of ambiguity surrounding both the norms of the team (Sarker, Lau, & Sahay, 2001; Sarker & Sahay, 2001; Suchan & Hayzak, 2001), as well a lack of grounding in their communication due to a dearth of subtle communication cues (Clark & Brennan, 1991). If this uncertainty leads to decrements in virtual team performance (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002), it follows that the negative relation between lean forms of media and team performance may be at least partly due to these teams facing relatively higher degrees of uncertainty. Consequently, in the present study, teams in more media rich (i.e., less virtualized) settings are likely to engage in greater team performance by virtue of perceiving less uncertainty:
Hypothesis 6b. Uncertainty will partially mediate the positive relation between media richness and team performance.

Team Member Trust Increases Team Performance (Hypothesis 7a)

Trust has been implicated as one of the major drivers of team performance in previous research (e.g., Brahm & Kunze, 2012, Salamon & Robinson, 2008; Dirks, 2000; Edrem & Ozen, 2003; Schaubroeck, Lam, & Peng, 2011). When team member trust is high, individual team members should feel more comfortable directing their effort toward the team’s shared task (Hackman & Morris, 1975; Yeatts & Hyden, 1998; Dirks, 1999). Conversely, when trust between team members is low, individual team members are likely to direct their efforts toward smaller individual goals where they do not have to rely on the behavior of others (Dirks, 1999). As a result, the level of trust that exists between team members is likely to encourage alternating objectives (e.g., personal versus team-level objectives) by providing team members with information surrounding the likely outcomes of engaging in either individualistic versus cooperative actions. Following this logic, greater trust between team members is likely to encourage team performance by encouraging cooperative behaviours between individual team members. Consequently, in the present study, participants’ trust towards their team members should be positively related to teams’ performance:

Hypothesis 7a. Trust will be positively related to team performance.

Media Richness Increases Team Performance by Increasing Team Members’ Trust (Hypothesis 7b)

Because they lack the necessary socio-emotional and non-verbal cues to allow informed and confident trust decisions to be made (Clark & Brennan, 1991; Weiss & Cropanzano, 1996; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Holtz, 2014), virtual teams may be less
likely to foster trust in the first place. As a result, the members of virtual teams may be more likely to focus on achieving more simple individual goals that do not require coordination with other team members (Dirks, 1999). Following this logic, teams in more media rich settings should be more likely to engage in effective performance behaviours at least partly because there is a greater basis for team member trust in these settings (allowing for the development of more complex, cooperative working behaviours). Consequently, in the present study, teams in more media rich (i.e., less virtualized) settings are likely to engage in greater team performance because their comprising members feel more trust towards one another:

_Hypothesis 7b._ Trust will partially mediate the positive relation between media richness and team performance.

**Team Members’ Uncertainty about One Another Decreases Team Performance by Decreasing Team Members’ Trust (Hypothesis 8)**

Trust essentially centres on whether or not to accept risk in situations of imperfect knowledge. Trust has been meta-analytically linked to task performance (Colquitt, Scott, & LePine, 2007; Dirks & Ferrin, 2002); and some research links team trust to team performance (Brahm & Kunze, 2012; Langfred, 2004; Costa, 2003; Dirks, 2000; Porter & Lilly, 1996). By reducing uncertainty, team members find themselves in a better position to afford this trust, as they will be more focussed on task completion and effective knowledge sharing. Consequently, trusting team members can spend less time trying to reduce their uncertainty by monitoring their co-workers (Dirks & Ferrin, 2002; Mayer & Gavin, 2005). In doing so, trusting teams are likely to subsequently engage in more effective team performance. Consequently, in the present study, teams whose comprising members report less uncertainty are likely to also engage in greater team performance, by virtue of team members feeling more trust towards one another:
Hypothesis 8. Trust will partially mediate the positive relation between uncertainty and team performance.

The proposed moderated mediation model, containing Hypothesis 1 through Hypothesis 8 is presented in Figure 1.

Figure 1: Proposed moderated mediation model - The effect of media richness on trust and team task performance
METHODS

Participants

A sample of 297 participants comprising 106 two- to three-person teams was recruited. Participants had a mean age of 19.42 (SE = 0.63). Of the 297 participants recruited, 195 (65.90 percent) self-identified as female; 100 participants (33.80 percent) self-identified as male; and one participant (0.30 percent) self-identified as non-binary. Participants had an average of 2.75 years of work experience (SE = 0.39). In total, 182 participants (62.10 percent) identified being currently unemployed; 102 participants (32.80 percent) identified having part-time employment; and nine participants (3.10 percent) identified having full-time employment.

All participants self-selected into the study. These participants were primarily drawn from the University of Guelph’s undergraduate subject pool, but were also recruited by visiting lectures on campus and by posting advertisements in public spaces in the larger Guelph-area community. The study was run at the University of Guelph’s Centre for Organizational Studies during the Fall 2015 and Winter 2016 semesters. Participants were compensated with course credit (if they were recruited from the subject pool), as well as entry into a draw to win one of ten gift cards worth $25.00 each. In addition, a $250.00 cash prize was offered to each member of the highest-performing team. This prize was advertised during recruitment to encourage participation in the study, as well as to provide an incentive to motivate participants to perform the experimental task to the best of their abilities. Participant recruitment methods and study procedures were approved by the University of Guelph’s Research Ethics Board (REB#15JL08).
**Decision to Recruit Cross-Gender Teams**

Previous research suggests that men and women may differ in the extent to which they engage in trust and other cooperative behaviours (e.g., Solnick, 2001; Sutter, Bosman, Kocher, & van Winden, 2009). One option that would have helped control for the possible moderating effect of gender was to only recruit participants of one gender (such that all teams in the proposed study would be completely male or completely female in their membership); however, doing this would have made teams in the study inconsistent with the structure of teams in many actual organizations (which often include a diverse range of genders, races, and ethnicities). Because one of the strengths of this study’s methodology is its incorporation of an experimental task that retains the features of many real-world team tasks (despite its laboratory setting; Locke, 1986), using teams that are closer to those found in actual organizations was deemed advisable to maintain this strength. Consequently, participants of all gender identities were recruited and included in the final analysis.

**Decision to Retain Two-Person Teams**

The experimental task was designed for three-person teams; however, it was designed in such a way that it could technically still be completed if only two of the three participants attended their session. Of the 106 teams recruited, 21 teams (19.81 percent) had only two members in attendance. To evaluate the appropriateness of retaining two-person teams, team size was used to predict each of the three dimensions of performance. Inspection of the 95 percent confidence intervals around the point estimate of the effect size (i.e., Cohen’s $d$) did not support a non-zero population-level difference between three-person teams ($M = 6.68$, $SE = 0.11$) and two-person teams ($M = 7.02$, $SE = 0.20$) in terms of their performance beliefs $t(104) = 1.38$, $d =$
0.35, 95% CI = [-0.13, 0.83]. Moreover, inspection of the 95 percent confidence intervals did not support a non-zero population-level difference between three-person teams ($M = 3.28, SE = 0.06$) and two-person teams ($M = 3.32, SE = 0.16$) in terms of their process performance $t(104) = 0.32, d = 0.08, 95\% CI = [-0.40, 0.56]$. Finally, inspection of the 95 percent confidence intervals did not support a non-zero population-level difference three-person teams ($M = 58.28, SE = 1.71$) and two-person teams ($M = 57.43, SE = 3.88$) in terms of their task performance $t(104) = -0.22, d = 0.05, 95\% CI = [-0.43, 0.53]$. These findings suggest that the experimental task could be completed equally well by either two- or three-person teams across all three performance dimensions. Consequently, all 106 teams were retained and included in the final analysis.

**Experimental Task**

Participant teams worked together to complete *The Non-Combatant Evacuation Operation: Red Cross Rescue Scenario*, an unclassified United States military simulation developed by the Office of Naval Research’s *Collaboration and Knowledge Interoperability Program*. In the Non-Combatant Evacuation Operation scenario, participant teams worked together to plan a rescue operation for three Red Cross workers trapped in a church on “Drapo Island”, a fictitious South Pacific island in the midst of a civil war. Participant teams had to provide a full rescue plan to be scored. This plan included: a list of forces to be deployed; transportation and weapons to be used; a timeline of planned events; and, a detailed explanation describing how the operation would be conducted.

To help plan the operation, all team members were provided with common background information about the scenario, including: data about available U.S. military assets; topographical maps; a profile of hostile forces in the area; and, geographic descriptors of the
island. In addition, each team member was randomly assigned to one of three specialist roles: an intelligence expert; a weapons expert; and an environmental expert. Each of these roles afforded the participant additional unique information was necessary for successful completion of the scenario. Specifically, the intelligence expert had unique information about the church layout and the locations and abilities of US military assets in the area. The weapons expert had unique information about the capabilities and limitations of various armaments (e.g., weapons, vehicles) that may be used in the operation. The environmental expert had unique information about the island’s terrain and weather (e.g., tides, time of dawn and dusk, etc.); as well as how these variables could affect the rescue operation. In order to develop a comprehensive and effective strategy, the team had to communicate effectively and utilize both the common and specialist information that they were given, so that it could be incorporated into their final strategy.

The Non-Combatant Evacuation Operation task was developed in conjunction with United States military personnel as part of the Office of Naval Research’s Collaboration and Knowledge Interoperability Program to assess team collaboration and problem solving (Biron, Burkman, & Warner, 2008). The Non-Combatant Evacuation Operation scenario was deemed appropriate as an experimental task because it offered a team task in which members had unique areas of expertise, limited experience working together, and a high need for collaboration; which is consistent with the work that is done in many virtual teams (e.g., Jarvenpaa & Leidner, 1999). In addition, the Non-Combatant Evacuation Operation has been successfully used to study process- and task performance in previous research (e.g., Warner, Letsky, & Cowen, 2005; Warner, Wroblewski, & Shuck, 2003), including research specifically on virtual teams (McComb, Kennedy, Perryman, Warner, & Letsky, 2010). Moreover, the Non-Combatant Evacuation Operation has been successfully used with both military and civilian participant
samples, including university student samples (McComb, Kennedy, Perryman, Warner, & Letsky, 2010). The complete Non-Combatant Evacuation Operation simulation package as it was presented to participants is available in Appendix A.

**Pilot Test of the Non-Combatant Evacuation Operation Simulation**

The Non-Combatant Evacuation Operation simulation was pilot tested during the Winter 2015 semester in order to ascertain whether it could be effectively completed in a variety of collocated and virtual communication environments within the 60-minute timeframe allotted, as well as ascertain whether it could be effectively completed by participants drawn from a university student sample. Data were collected at the Centre for Organizational Studies at the University of Guelph using a sample of 71 participants divided into 26 two- to three-person teams. All participants were drawn from the University of Guelph’s mass participant pool for psychology research. Participant teams were randomly assigned to complete the Non-Combatant Evacuation Operation task either in one room together (i.e., high media richness), in three separate rooms using a synchronous videoconferencing call (i.e., medium media richness), or in three separate rooms using an asynchronous email program (i.e., low media richness). Participant sessions were recorded, and email chat logs were collected. This preliminary work with the Non-Combatant Evacuation Operation suggests that it could be effectively applied to the projected sample; and could also be completed effectively in any of the three proposed virtualization conditions within the allotted 60 minutes.
**Media Richness (i.e., Virtualization) Manipulation**

Media richness was operationalized by altering the communication environment in which the team operated in, with regards to the six communication cues that differentiate collocated from virtual communication according to Media Richness Theory (Clark and Brennan, 1991; see Table 1). Of the various information and communication technologies classified by Clark and Brennan (1991), teams completed the experimental task using one of three communication methods that correspond to either a low degree of media richness (using asynchronous text-based messaging via an email program); a medium degree of media richness (using synchronous video chat via Skype™); or, a high degree of media richness (using collocated communication).

The decision to operationalize media richness using common information and communication technologies that have been classified in terms of their media richness offered two advantages. First, by operationalizing media richness with regards to how many dimensions a given form of media possesses, it was possible to make a quantifiable distinction between different media in terms of how “virtual” they are. Second, using information and communication technologies that are common in office settings improved the applicability of the results to applied settings.

**Measures**

**Perceived Uncertainty**

Perceived uncertainty was assessed at the individual level by having each participant rate the extent to which they experienced uncertainty during the Non-Combatant Evacuation Operation simulation. This was measured using a four-item scale developed by Colquitt and colleagues (2012) based on Uncertainty Reduction Theory (Colquitt, LePine, Piccolo, Zapata, &
Rich, 2012; Lind & van den Bos, 2002; van den Bos & Lind, 2002). A sample item is: “If I think about the Non-Combatant Evacuation Operation simulation, there is a lot of uncertainty”. All responses were assessed using a nine-point Likert-type scale (1 = “Strongly Disagree”, 9 = “Strongly Agree”). Consistent with Schwarz’s (1999) recommendations, the scale was arranged from 1 to 9 instead of -4 to 4 to encourage participants to think of the lower scores as representing the absence of a relation as opposed to a negative relation.

Post-test retrospective ratings such as the ones in this measure have been successfully used to assess communication behaviours in both interpersonal evaluation research (e.g., Hale, Lundy, & Mongeau, 1989); as well as in communication technology research (e.g., Rice & Contractor, 1990), making it an appropriate method for assessing perceived uncertainty in the present study. The data demonstrated acceptable internal consistency ($\alpha = .87$), which is consistent with previous validation work on the measure that supports its psychometric properties (Colquitt, LePine, Piccolo, Zapata, & Rich, 2012). The complete measure is presented in Appendix B.

**Propensity to Trust Others**

Propensity to trust was assessed at the individual level using an eight-item measure from the *International Personality Item Pool*, which was given to each participant after their team completed the Non-Combatant Evacuation Operation simulation. A sample item is: “I believe that others have good intentions”. All items were measured using a nine-point Likert-type scale (1 = “Strongly Disagree, 9 = “Strongly Agree”). Consistent with Schwarz’s (1999) recommendations, the scale was arranged from 1 to 9 instead of -4 to 4 to encourage participants to think of the lower scores as representing the absence of a relation as opposed to a negative
relation. The data demonstrated acceptable internal consistency ($\alpha = .89$), supporting the psychometric properties of the measure. The complete measure is presented in Appendix C.

**Trust in Team Members**

In their work on trust measurement, Cummings and Bromiley (1996) argued against measuring trust by directly asking participants about the extent to which they trust others. To avoid this, team member trust was measured using a survey of behavioural trust intentions, following recommendations from Dietz and Den Hartog’s (2006) review of trust measures. Specifically, participants completed an adapted version of a shorter four-item scale originally developed by Schoorman, Mayer, & Davis (1996); and later established in Mayer and Davis’ (1999) seminal study on trust in management. The measure asks respondents to indicate the extent to which they are willing to allow another party (in this case, their team members) to retain authority over important task-related issues. An example item is: “If I had my way, my team members wouldn’t be in charge of their parts of the information package”.

The items in this measure were re-worded to reflect trust in team members’ ability. This was done to better reflect the task-focussed nature of the Non-Combatant Evacuation Operation simulation (as well as that of virtual and swift-starting teams more generally; see Powell, Piccoli, & Ives, 2004). Because the wording of items was altered, individual items could not be assumed to represent parallel forms. Therefore, extra items were included to provide a larger initial pool of items, creating a measure of 14 items. All items were assessed using a nine-point Likert-type scale ($-4$ = “Strongly Disagree”, $4$ = “Strongly Agree”). Consistent with Schwarz’s (1999) recommendations, the scale was arranged from $-4$ to $4$ instead of $1$ to $9$ in order to encourage
participants to think of the lower scores as representing a negative relation (i.e., distrust of one’s team members), as opposed to the absence of a relation (i.e., null trust in one’s team members).

Previous research has found that trust can be meaningfully measured using a collective referent (e.g., Salamon & Robinson, 2008); and asking participants about the extent to which they trust their team as a unit is appropriate when looking at trust within teams. Behavioural estimation items such as these have been found to be strongly predictive of actual behavior (Armitage and Connor, 2001); and behavioural intentions to trust are often found to predict trust behaviours (Gillespie, 2003). The data demonstrated high internal consistency ($\alpha = .91$), supporting the psychometric properties of the measure. The complete measure is presented in Appendix D.

**Team Performance**

*What is “Performance”? The Need for a Multimethod Approach*

*Rationale for a multimethod approach.* Using a multi-method approach to assess team performance was advisable for at least three reasons. First, different measures of performance are frequently correlated; however, different performance measures often capture distinct, equally important insights for researchers (Venkatraman, & Ramanujam, 1987). Second, in team settings, objectively-rated team performance may not be directly related to the effort expended by any single team member (Rosen et al., 2008). Consequently, using multiple methods of assessment may capture useful variance in the relation between individual outputs and objective team outcomes (Rosen et al., 2008). Third, using both objective- and self-rated performance assessments helps to address potential shortcomings either measure has when used in isolation. Specifically, an objective measure of team outcome performance addresses the bias concerns
inherent in self-rated performance (e.g., Myers, Holliday, Harvey, & Hutchinson, 1993); whereas a self-rated measure of process performance assesses general communication and strategy-building behaviours that are likely to generalize across team settings (whereas an outcome performance measure may be of limited generalizability outside of the specific experimental task being used; see McCain, 2008).

**Performance as an outcome versus performance as a process.** Although both media richness (e.g., Cramton & Orvis, 2003; Armstrong & Cole, 2002; McLeod, 1992) and trust (e.g., Brahm & Kunze, 2012; Schaubroeck, Lam, & Peng, 2011) have been connected to team performance, what is meant by “performance” across this body of work is unclear. In their seminal work, Campbell and colleagues (1993) distinguished between the behaviours that comprise high performance (process performance), and the objective outcomes of those behaviours (task performance; Campbell, McCloy, Oppler, & Sager, 1993). The idea behind this distinction is that there is a difference between thinking about the ends one wants to achieve (outcomes), versus the means one uses to achieve them (process). Organizations may be effectively differentiated based on the extent to which they emphasize “process or procedural goals” that focus on how tasks are completed (e.g., traditional government or military settings, large organizations), versus “performance goals” that emphasize which tasks are completed (e.g., small- to medium-sized businesses). The extent to which either of these dimensions is given priority creates different behavioural norms within the organization to better meet one or the other (or a combination of both) goals (e.g., Woolley, 2009; Clark, 2004; Burns & Stalker, 1994).

The distinction between process and performance goals may be particularly important for virtual work teams. Early empirical work on text-based computer communication suggests that
the communications processes that virtual teams undertake may qualitatively differ from those of their collocated counterparts. Consequently, media richness may have differential effects on process performance versus task performance (Hiltz, Johnson, & Turoff, 1986). Therefore, to capture the nuances inherent in media richness’ effect on performance, it is advisable to assess performance in terms of both its constituent behaviours, as well as its objective outcomes.

*Self-rated versus objective performance.* It is also worth distinguishing performance measures as assessed by the ratee themselves, versus outside ratings made a third party. Previous meta-analytic work suggests that self-ratings of performance are often subject to inflation (Heidemeier & Moser, 2009); and have only a modest correlation with other ratings of performance (Heidemeier & Moser, 2009; Conway & Huffcutt, 1997; Bommer, Johnson, Rich, Podsakoff, & MacKenzie, 1995; Harris & Schaubroeck, 1988; Mabe & West, 1982). If this is true, then believing one’s self or one’s team to be high-achieving is not the same thing as actually being a high-achieving individual or team. Instead of capturing actual performance, self-rated performance may serve as a proxy for other outcomes such as efficacy or potency.

That said, previous meta-analytic work also supports the idea that performance beliefs predict later team performance (Gully, Incalcandella, Joshi, & Beaubien, 2002). Self-ratings of performance – although empirically distinct – may therefore be an important proximal version of performance to study early in a team’s development. This may be especially important in virtual work teams, where more distal outcomes such as objective performance are often lower (e.g., Cramton & Orvis, 2003; Armstrong & Cole, 2002; McLeod, 1992). Consequently, in order to comprehensively assess performance in virtual teams, it is advisable to also include a measure of self-rated performance among the team members themselves (i.e., performance beliefs).
The operationalizations for performance beliefs, process performance, and task performance are each described below:

**Performance Beliefs**

Performance beliefs were assessed at the individual level by having each team member rate the extent to which they felt their team had engaged in effective team processes during the experimental task. Ratings were made using the 30-item version of the Marks, Mathieu, and Zaccaro (2001) process performance taxonomy. This measure serves as an overall assessment of process performance that includes items for the three major forms of process performance in the teams literature: communications-, strategy-, and interpersonal processes (Marks, Mathieu, & Zaccaro, 2001). A sample item is "To what extent does our team actively work to develop an overall strategy to guide our team activities?" Participants were asked to provide self-assessments of process performance rather than task performance in order to more accurately tap into a proximal version of performance (as the experimental simulation was an unknown to participants, and they would have been unlikely to accurately judge how well their task performance would be rated on a first attempt).

All items were rated on a nine-point Likert-type scale (1 = “Not at All”, 9 = “To a Very Great Extent”). Consistent with Schwarz’s (1999) recommendations, the scale were arranged from 1 to 9 instead of -4 to 4 in order to encourage participants to think of the lower scores as representing the absence of a relation as opposed to a negative relation. The data demonstrated high internal consistency (α = .97), supporting the psychometric properties of the measure. The complete measure is presented in Appendix E.
Process Performance

Process performance was assessed at the team level by a team of five trained raters in the lab. These raters rated each team’s process performance after viewing a video recording and transcript of the team’s session. As with performance beliefs, ratings were made using the 30-item version of the Marks, Mathieu, and Zaccaro (2001) process performance taxonomy (see Appendix E). By using the same measure to assess both performance beliefs and process performance, the study was able to evaluate the same generalizable performance behaviours in terms of both their objective appearance – as well as their subjective felt presence within the team. Using the same items in either measure also eliminated error variance across measures due to measurement artifacts.

To ensure inter-rater reliability, all five raters underwent a standardized training session, after which each independently rated the same set of teams. Inter-rater reliability was measured using the intraclass correlation coefficient (ICC(2)) of each coder's ratings (Bartko, 1976), which examines the stability of ratings across K raters (Bartko, 1976; Bliese, 2000; James, 1982). Intraclass correlation coefficients are an established method for assessing inter-rater reliability (Shrout & Fleiss, 1979; Eye & Mun, 2005), and were deemed an appropriate metric for this analysis. The intraclass correlation coefficients for process performance scores (ICC(2) = .90) exceeded Glick's (1982) recommendation of an ICC(2) value of .60 or higher, indicating strong inter-rater reliability.

Task Performance

Task performance was assessed using the Non-Combatant Evacuation Operation’s scoring system. When the scenario was initially created, an ideal solution and scoring matrix
were designed using input from military operations personnel who had subject matter expertise in similar real-world operations (McComb, Kennedy, Perryman, Warner, & Letsky, 2010). Each team was assigned a composite score from 0 to 100 that considered factors such as timing, choice of personnel, choice of transportation, and choice of weaponry. Points were deducted if teams opted to use personnel, transportation, weapons, or timing that did not represent the most effective resource allotment for the stated goals of the simulation. That said, these points could be recovered if the team made provided adequate rationale justifying their use. This measure was selected because it offers a quantifiable measure of the extent to which team members combined disparate knowledge bases effectively in a way would generalize to real-world situations, and is based on the input of several subject matter experts in the field. The ideal solution to the Non-Combatant Evacuation Operation and the complete Non-Combatant Evacuation Operation scoring matrix are presented in Appendix F and Appendix G, respectively.

Task performance scores were assigned by a team of five trained raters in the lab. To ensure inter-rater reliability, all five raters underwent a standardized training session, after which each independently rated the same set of rescue plans. The raters were given two sets of matching rescue plans to code: Once after the initial training session, and a second time approximately halfway through the scoring process. By rating common rescue plans at two different time points, inter-rater reliability was assessed both initially and throughout the coding process to detect and prevent drift in reliability. As with process performance, inter-rater reliability for task performance scores was measured using the intraclass correlation coefficient (ICC(2)) of each coder's ratings (Bartko, 1976). The intraclass correlation coefficients for task performance scores both immediately after training (ICC(2) = .95), and midway through the
coding process (ICC(2) = .94), both exceeded Glick’s (1982) recommendation of an ICC(2) value of .60 or higher, indicating strong inter-rater reliability.

Procedure

Stage One: Participant Arrival and Consent Process

Participants individually signed up for experimental sessions. Each session comprised three participants. Prior to the study, each of the resulting three-person teams was randomly assigned to either a high- (i.e., collocated), medium- (i.e., Skype™), or low (i.e., email) media richness condition using a random number generator. Each of the three participants was also randomly assigned to either a weapons expert-, intelligence expert-, or environmental expert role that they would play during the experimental task (again, using a random number generator).

Upon arrival at the lab, each participant was greeted by the experimenter (who was either the primary investigator or a trained undergraduate research assistant). The experimenter informed the participants that the study revolved around observing effective team processes. The experimenter then collected each participant’s written consent to participate in the study (see Appendix H), as well as basic demographic information from each participant (e.g., age, gender identity, work experience; see Appendix I).

All participants were then led to their stations, where they completed the experimental task. In the high media richness (i.e., collocated) condition, all participants were situated in a single meeting room with all of the experimental task materials laid out. In the medium media richness (i.e., Skype™) condition, each participant was situated in a different room; each room had a laptop computer running a videoconferencing program (i.e., Skype™), in addition to a copy of the experimental task materials laid out. In the low media richness (i.e., email) condition, each
participant was situated in a different room; each room had a laptop computer running an email program (i.e., Gmail™), in addition to a copy of the experimental task materials laid out. A layout of the lab space for each experimental condition is presented in Appendix J.

If the team had been assigned to either the medium- or low media richness condition (i.e., Skype™ or email), the experimenter instructed each participant to move to their assigned room immediately upon entering the lab; and conducted the briefing and consent process separately for each participant at their station. This was done to avoid having participants in these conditions from interacting with their team members through collocated means before the study began (allowing them to do this could contaminate the effects of the experimental manipulation).

**Stage Two: Team Briefing and Experimental Simulation**

Each participant was then shown a video tutorial of the experimental task. This tutorial detailed the goals of the simulation; the mission statement and objectives for the task; and what the separate intelligence-, weapons-, and environmental expert roles entailed. This training was delivered via a recording to provide a standardized training experience. Delivering the training via video also allowed the experimenter deliver the training simultaneously to all three team members in the medium- and low media richness conditions (who were situated in different rooms throughout the experiment).

After a brief comprehension check, participant teams were then given 60 minutes to complete the experimental task. Previous work with the Non-Combatant Evacuation Operation (in addition to the Winter 2015 pilot study) suggested that 60 minutes was an adequate period for both collocated and virtual teams to effectively complete the task (McComb, Kennedy, Perryman, Warner, & Letsky, 2010). During this time, teams were only allowed to communicate
with one another either verbally in-person (if they were assigned to the high media richness condition); verbally over the videoconferencing system (if they were assigned to the medium media richness condition); or in written form over the email program provided (if they were assigned to the low media richness condition). All teams created their final rescue plan using a shared “Google Document” that updated in real time when edited by any team member.

**Stage Three: Post-Simulation Questionnaires and Team Debrief**

Following the 60-minute task, participants were then asked to complete a post-test measure containing the uncertainty measure, team trust measure, propensity to trust measure, and performance beliefs measure. All participants were then brought together for a final debriefing session with the experimenter. During the debriefing session, the participants were told that the study actually revolved around media richness and trust. Participants were also asked to sign a second, post-study consent form (see Appendix K). The full study experimental study script is presented in Appendix L.

**Contingency Procedure when not all Participants Attended Their Session**

If only two participants arrived for the session, the experiment proceeded normally, with one distinction: namely, participants’ roles were re-assigned, such that one of the two participants was randomly assigned to the intelligence expert role, and the other was randomly assigned to the weapons expert role. Both participants received the specialty information corresponding to the third, environmental expert role (i.e., this role became shared knowledge). If only one participant arrived at the session, the experiment was cancelled.
ANALYSIS PLAN

Overview
Data were collected at both the individual level and at the team level. To address this nested data structure, the proposed model was assessed using a multilevel regression framework with bootstrapping, based on recommendations from Bauer, Preacher, and Gil (2006). This technique was chosen to avoid the inherent statistical- and conceptual interpretation issues that arise when analyzing nested data using a single level of analysis; while also conforming to best practices on effective mediation testing with smaller samples, as outlined by Preacher and Hayes (2004).

Justification for using Multilevel Analyses
Multilevel analysis techniques are advisable whenever data are nested at different levels, such that the final dataset includes a combination of lower-order variables (e.g., collected from individuals, or at discreet time points), and higher-order variables (e.g., collected from groups, or across several time points). In the present study, participants signed up for the study individually, and completed many of the measures as individuals; however, their individual-level data were nested within the two- to three-person team that they were participating with. When individuals are nested within groups, teams, or other social categories, individuals who are a part of the same team are often have more similar responses than individuals who are part of different teams (Hox, 2010).

Consequently, it is problematic to interpret results from nested samples at either the individual- or at the team level. By analyzing nested data solely at the individual level, researchers risk erroneously inflating their findings by attributing observed variance to individual
differences, when it is actually due to the nesting structure of the data (Hox, 2010). For example, in the present study, media richness was manipulated at the team level. As a result, all three participants in each team received the same “score” (i.e., condition assignment) for media richness. If this data were analyzed at the individual level, the model would interpret these team assignment scores as multiple independent observations (which effectively triples the sample size for all analyses involving media richness). This issue could be avoided by simply aggregating all data to the team level. However, data aggregation is problematic for different reasons. By analyzing nested data solely at the team level, researchers reduce the variance of the sample and the number of data points they can effectively analyze (this sacrifices statistical power and risks missing important nuances in the data; Hox, 2010).

To avoid either issue, data were tested for the independence violations consistent with nested data structures; and all subsequent analyses were conducted using analytic techniques specifically designed for handling nested data.

**Team-Level Outcomes, and the Question of Multilevel Analysis versus Data Aggregation**

Multilevel data analytic techniques distinguish themselves from either individual-level or team-level analyses by accounting for the fact that individual-level responses are likely to covary as a function of group membership (thus violating the parametric assumption of independence; Peugh, 2010). This issue only arises, however, when the outcome variable under investigation is actually measured at the lower-order (in this case, individual) level. When an outcome is measured solely at the higher-order (in this case, team) level, there is no such violation of independence; and it is not theoretically meaningful or statistically advisable to conduct a multilevel analysis (Peugh, 2010; Hox 2010).
In the present study, several outcome variables were collected at the individual level, including: uncertainty, trust, and performance as operationalized by participants’ performance beliefs. Multilevel analytic techniques were used for all analyses related to these specific outcomes. Conversely, the two other performance outcomes (i.e., process performance and task performance) were only collected at the team level. Because these outcomes were not measured at the individual level, they do not justify the use of multilevel analytic techniques. Consequently, all analyses related to either process performance or task performance were conducted at the team level by aggregating individual responses to the team level.

**Did the Data Conform to a Multilevel Structure?**

Not all nested data structures necessitate multilevel analyses on an empirical level. If there is no variation in the level one outcomes that can be associated with the level two units, then there is not sufficient empirical justification for using analyses that take random coefficient effects into account. Instead, one can use ordinary least squares regression (Peugh, 2010).

In order to assess the extent to which individual-level outcome variation is present at the team level, I examined the intraclass correlation coefficient (ICC(1)) values across teams for each individual-level outcome variable. Intraclass correlation coefficients assess the amount of variance in individual-level responses that can be explained by team-level properties (Bliese, 2000; James, 1982). All ICC(1) estimates in the present study exceeded James' (1982) recommendation of an ICC(1) value of .12 or higher, justifying the use of multilevel data analysis. Moreover, these scores were either within or exceeded the range of ICC(1) values that are considered common in cross-sectional multilevel analyses across social science research (i.e.,
ICC(1) = .05 - .20; Muthén, 1991, 1994; Muthén & Satorra, 1989; Spybrook, Raudenbush, Liu, Congdon, & Martinez, 2008).

In order to further justify the use of multilevel data analyses, I then calculated the design effect, which provides an index of the effect of independence violations on standard errors (Kish, 1965; see Equation 1 below):

\[
(1) \text{Design Effect} = 1 + (n_c - 1)ICC
\]

In this equation, \( ICC \) represents the intraclass correlation coefficient (ICC(1)) for the outcome measure, and \( n_c \) represents the average number of lower-order (i.e., individual) data points within each higher-order (i.e., team) cluster (i.e., the average number of participants in each team in the present study).

A design effect index was calculated for each of the individual-level outcome variables in the model. All design effects and ICC(1) values are presented in Table 2.
Table 2: Intraclass correlation coefficients (ICC(1)) estimates, and design effect estimates for individual-level outcomes in the model

<table>
<thead>
<tr>
<th>Variable</th>
<th>ICC(1)</th>
<th>Design Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty</td>
<td>.15</td>
<td>1.27</td>
</tr>
<tr>
<td>Propensity to Trust</td>
<td>.46</td>
<td>1.83</td>
</tr>
<tr>
<td>Trust in Team</td>
<td>.51</td>
<td>1.92</td>
</tr>
<tr>
<td>Performance Beliefs</td>
<td>.45</td>
<td>1.81</td>
</tr>
</tbody>
</table>

These design effects ranged from 1.27 to 1.92. Although some researchers have proposed a design effect index of 2.00 or larger as a cut-off for determining significant violations of independence (Muthén, 1991, 1994; Muthén & Satorra, 1989, 1995), the observed design effects support the idea that the standard error of participants’ individual-level responses may have been somewhat impacted by their team membership. Consequently, the data were determined to have violations of independence consistent with nested data structures, justifying the use of multilevel data analytic techniques.

1 One possible explanation for the design effect indices falling short of 2.00 is that these indices are susceptible to group size. They may have been underestimated in the present study, given the small number of participants in each team.
Building a Multilevel Mediation Model for Nested Data Structures

How Regression Estimates are (Generally) Created using Nested Data

When employing nested analytic strategies, data are simultaneously analyzed at both the individual level and the team level. Using multilevel regression, both individual- and team-level variables may be included in a single regression equation, such that variance in any individual-level variable is calculated within the team-level variable that it is nested within (Hox, 2010). For example, consider Equation 2 below:

\[
Y_{ij} = Y_{00} + Y_{10}X_{1ij} + Y_{01}Z_j + Y_{02}X_{1ij}Z_j + u_{1j}X_{1ij} + u_{0j} + e_{ij}
\]

In this equation, \(X\) represents an individual-level predictor (for example, the participant’s gender); whereas \(Z\) represents a team-level predictor (for example, the number of hours of training the team received). \(X\) is measured for each participant \((i)\), as well as for each team in which individuals are nested \((j)\). \(Z\) is measured at the team level \((j)\) only. Random error is separately represented at the individual level as in a normal regression \((e)\), as well as at the team level \((u)\).

In the present study, participants’ uncertainty, propensity to trust, and trust in their team were each measured at the individual level. Conversely, media richness was manipulated at the team level. The resulting regression equations for each proposed outcome are presented in Equation 3 through Equation 7 below:

\[
Uncertainty_{ij} = Y_{00} + Y_{01}MediaRichness + u_{0j} + e_{ij}
\]
(4) \( \text{Trust}_{ij} = Y_{00} + Y_{01}\text{MediaRichness}_{j} + Y_{10}\text{Uncertainty}_{ij} + Y_{20}\text{Propensity}_{ij} + \)
\( Y_{30}\text{Uncertainty}_{ij} \times \text{Propensity}_{ij} + u_{1j}\text{Uncertainty}_{ij} + u_{2j}\text{Propensity}_{ij} + u_{0j} + e_{ij} \)

(5) \( \text{PerformanceBeliefs}_{ij} = Y_{00} + Y_{01}\text{MediaRichness}_{j} + Y_{10}\text{Uncertainty}_{ij} + Y_{20}\text{Trust}_{ij} + \)
\( u_{1j}\text{Uncertainty}_{ij} + u_{3j}\text{Trust}_{ij} + u_{0j} + e_{ij} \)

(6) \( \text{TeamProcess}_{ij} = Y_{00} + Y_{01}\text{MediaRichness}_{j} + Y_{02}\text{Uncertainty}_{ij} + Y_{03}\text{Trust}_{ij} + u_{0j} \)

(7) \( \text{TaskPerformance}_{j} = Y_{00} + Y_{01}\text{MediaRchness}_{j} + Y_{02}\text{Uncertainty}_{j} + Y_{03}\text{Trust}_{j} + u_{0j} \)

Note that for Equation 6 (estimating team process) and Equation 7 (estimating task performance), the regression equations specify a simpler aggregated team-level design, rather than a multilevel one. This is consistent with the structure of the data, as both team process and task performance were only collected at the team level.

**The Logic Behind Mediation Testing and the Importance of Bootstrapping**

Both uncertainty and trust were hypothesized to mediate the proposed relation between media richness and performance. Consequently, it is important to also test for indirect effects in the equations presented above. In the social sciences, mediation testing is generally conducted based on logic established in a seminal paper by Baron and Kenny (1986). According to Baron and Kenny (1986), there are four steps to successfully evidence a mediation effect. First, the predictor variable must be significantly related to the outcome variable (\(c\)-path). Second, the predictor variable must be significantly related to the mediator variable (\(a\)-path). Third, the
mediator variable must be significantly related to the outcome variable (\(b\)-path). And fourth, the predictor variable must cease to be significantly related to the outcome variable (or at least drop in its ability to predict the outcome), when the mediator variable is taken into account and included in the regression equation. (\(c'\)-path).

Although instructive in themselves, the steps outlined by Baron and Kenny (1986) have been criticized on the grounds of failing to firmly establish a benchmark for interpreting mediation effects as significant (Hayes, 2009). One method for doing this is to use a Sobel test, which is essentially a difference test between the predictor variable’s relation with the outcome variable before taking the mediator into account, versus after taking the mediator into account (Sobel, 1982). By conducting a Sobel test, researchers are better able to establish whether a drop in predictive power after including a proposed mediator is evidence for actual mediation. However, traditional Sobel tests are limited in their usefulness due to their inherent assumption of normally-distributed populations. Specifically, both the \(a\)-path (predictor to mediator) and the \(b\)-path (mediator to outcome) are assumed to be normally distributed (Preacher & Hayes, 2008). The cross-product of the \(a\)- and \(b\)-paths (i.e., the indirect effect, which specifies the amount of variance in the outcome that is accounted for by the predictor via the mediator) is, however, inherently skewed in smaller samples (Preacher & Hayes, 2008). As a result, Sobel tests are statistically underpowered, barring access to very large samples (Preacher & Hayes, 2008).

A well-established approach for overcoming the inherent limitations of the Sobel test is to use bootstrapping when testing for mediation (Preacher & Hayes, 2004). Bootstrapping is a non-parametric resampling procedure whereby data is resampled continuously to create a unique effect distribution. To do this, a researcher repeatedly takes a resample of \(N\) participants from the original obtained sample of \(N\); the same participant can be drawn multiple times (thus replacing
rows in the original data set), allowing for almost infinite potential variations in the resampled data. The original analysis is then re-run across many iterations of the resampled data (often between 1000 and 10 000 times), which effectively creates an effect sampling distribution that is tailored to the original sample – rather than relying on a strictly parametric effect sampling distribution. In doing this, bootstrapping approaches to mediation make no \textit{a priori} assumptions about the shape of the $ab$ distribution (Preacher & Hayes, 2004). Because the sample size in the present study fell short of the acceptable benchmarks for a Sobel test-based approach, I employed a bootstrapping approach based on Preacher and Hayes’ (2004) recommendations to test the significance of the proposed mediation effects.

**Applying Mediation Testing Logic to Nested Data**

Traditional approaches to mediation testing are often inappropriate with nested data. This is because the model test statistics will inherently come back biased due to the tendency of nested data to violate traditional regression assumptions of independence (Hox, 2002; Kreft & de Leeuw, 1998; Raudenbush & Bryk, 2002). Instead, special techniques need to be used to effectively test mediation effects when working with nested data. Some researchers have posited ways in which mediation testing may be accomplished using nested data (e.g., Raudenbush & Sampson, 1999; Bauer, 2003; Krull & MacKinnon, 2001); however, these techniques generally assume that the all proposed mediation effects are fixed, which is the case when data is analyzed at the team- rather than the individual-level (Bauer, Preacher, & Gil, 2006). However, when dealing with lower-order mediation (i.e., at least some of the variables in the mediation model are measured at the individual- rather than the team-level), effects may be random instead. This causes interpretation issues when fixed effects are assumed (Bauer, Preacher, & Gil, 2006). In
the present study, some of the variables (e.g., uncertainty, trust) were measured at the individual-level, necessitating a lower-order mediation analysis. This meant that random effects needed to be accounted for when assessing indirect effects.

Kenny, Korchmaros, and Bolger (2003), and more recently Bauer, Preacher, and Gil (2006) proposed a method for testing lower-order mediation with nested data. Specifically, one builds a regression model within a single lower-order equation using selection variables (Bauer, Preacher, & Gil, 2006); an approach that is commonly used in the estimation of other multivariate models with nested data (e.g., MacCallum, Kim, Malarkey, & Kiecolt-Glaser, 1997). By doing this, a new outcome variable is derived by combining each unit’s (i) outcome (Y) and mediator (M) variables within the grouping variable (j). This allows the derived data to fit a multivariate model using univariate multilevel modeling software (Bauer, Preacher, & Gil, 2006). An example of this technique is presented in Equation 8 below:

\[ Z_{ij} = S_{Mij}(d_{Mj} + b_{1j}X_{ij}) + S_{Yij}(d_{Yj} + b_{2j}M_{ij} + b_{3j}X_{ij}) + e_{Zij} \]

In this example, Z represents a combined outcome variable derived from the original mediator (M) and outcome (Y) variables; \(d_{Mj}\) and \(d_{Yj}\) represent intercepts for the mediator and outcome variable, respectively (no intercept is specified for Z); \(b_{1j}\), \(b_{2j}\), and \(b_{3j}\) represent slope coefficients; and \(e\) represents random error.

One important feature of this technique is the addition of selection variables, which are represented above using \(S_{Mij}\) and \(S_{Yij}\). When using this Bauer et al.’s (2006) approach, M and Y are combined into a single dependent variable (Z). Mediator scores (M) and outcome scores (Y) are stacked for each individual (i) within each team (j). The additional selection variables act like
dummy-coded predictors, and indicate which variable is being assessed in a given calculation. For example, $S_M$ will be set to 1.00 when the mediator is being assessed (i.e., $Z$ refers to $M$); and 0.00 when the outcome is being assessed (i.e., $Z$ refers to $Y$). When either selection variable is set to 0.00, the half of the equation predicting that outcome will be eliminated from the calculation of $Z$. Consequently, the calculation for $Z$ may alternatively represent either a calculation of $M$, or a calculation of $Y$ (depending on the values of $S_{Mij}$ and $S_{Yij}$). This technique allows a researcher to assess both outcomes within the context of a single regression equation. (Bauer, Preacher, & Gil, 2006). The logic underlying this technique will hold as long as the normal assumptions of multilevel models and multivariate regressions are met (Bauer, Preacher, & Gil, 2006).

Additional selection variables allow multiple mediators to be specified (Bauer, Preacher, & Gil, 2006). In the present study, four mediated effects were proposed; specifically, that participants’ uncertainty ratings would partially mediate the positive relation between media richness and trust (Hypothesis 3b); second, that uncertainty would partially mediate the positive relation between media richness and performance (Hypothesis 6b); third, that trust would partially mediate the positive relation between media richness and performance (Hypothesis 7b); and fourth, that trust would partially mediate the negative relation between uncertainty and performance (Hypothesis 8). The calculations for each of these mediated effects are respectively presented in Equation 9 through Equation 12 below:

\[ Z[Trust]_{ij} = S_{Uncertaintyij}(d_{Uncertaintyij} + b_{ij}MediaRichness_j) + S_{Trustij}(d_{Trustij} + b_{2j}MediaRichness_j + b_{3i}Uncertainty_{ij}) + e_{Zij} \]
Note that for Equation 10, Equation 11, and Equation 12, the regression equations specify participants’ performance beliefs as the outcome of interest. The regression equations for process performance and task performance were not calculated using a multilevel mediation analysis, because both of these variables were only collected at the team level. To assess these hypotheses in terms of the team process and task performance facets of performance, mediation was instead conducted at the team level using Preacher and Hayes’ (2004) bootstrapping-based approach.

**Estimation of Effect Size within Multilevel Regression Frameworks**

It is generally advisable to supplement traditional significance tests with an effect size index. In multilevel data analysis, this is possible; however, there no consensus surrounding the most appropriate indices of effect size in multilevel designs (Roberts & Monaco, 2006; Snijders & Bosker, 1991; Peugh, 2010). In general, there are two major forms of effect size that are calculated in measurement models: global effect sizes such as $R^2$ (which refer to the amount of variance in the response variable explained by all predictor variables in the proposed model), and
local effect sizes such as $r^2$ (which refer to the amount of variance in the response variable explained by a single predictor variable in the proposed model).

Two indices were used in the present study in order to assess both global and local effect sizes, following Peugh’s (2010) recommendations. In order to assess global effect size (i.e., the variability accounted for in an outcome variable by the model statistic), a pseudo-$R^2$ index can be derived by calculating the predicted score for each participant, calculating the correlation between these predicted scores and the observed scores, and squaring the resulting correlation (Singer & Willet, 2003; Peugh, 2010). Those familiar with single-level regression analyses may recognize that this is also how $R^2$ is calculated in the context of a single-level regression. What makes the multilevel variant of this calculation a pseudo-$R^2$ rather than a regular $R^2$ lies in the fact that the variance of any given outcome in a multilevel regression is partitioned into both lower-order components (e.g., individuals) and higher-order components (e.g., teams). This nested data structure means that there is a random effects variance component that needs to be accounted for. Failing to account for this random effects variance can lead researchers to input the wrong variance statistic into their $R^2$ calculation. A workaround (i.e., pseudo-$R^2$) that incorporates both fixed and random effects variance is presented in Equation 13 below:

\[
R^2_{GLMM(c)} = \frac{(\sigma_f^2 + \Sigma_{u=1}^{l=1}(\sigma_{u,j}^2))}{(\sigma_f^2 + \Sigma_{u=1}^{l=1}(\sigma_{u,j}^2) + \sigma_e^2 + \sigma_d^2)}
\]

In the equation above, $\sigma_f^2$ represents the variance of the fixed effects components in the model, whereas $\Sigma_{u=1}^{l=1}(\sigma_{u,j}^2)$ represents the sum of all higher-order “$u$” variance components (e.g., teams). Conversely, $\sigma_e^2$ represents the variance in outcome scores due to additive dispersion (that is, excess variation relative to what one might expected from a given distribution), whereas $\sigma_d^2$
represents the distribution-specific variance in the outcome. The resulting pseudo-$R^2$ statistic returns the variance in outcome scores that are accounted for by both fixed and random effects in the model (effectively representing all variance accounted for by the specified model, making this index conceptually similar to other global effect size indices).

Conversely, local effect sizes in a multilevel model can be assessed using the proportional reduction in variance ($PRV$) statistic, which calculates the individual-level residual variance present in a model before versus after adding the predictor for which the local effect size is being assessed. This is accomplished by subtracting the individual-level residual variance present after adding the predictor, from the individual-level residual variance present prior to adding the predictor; and then dividing the result of this calculation by the individual-level residual variance present prior to adding the predictor (expressing the final result as a proportion of reduced residual variance). This statistic is presented in Equation 14 below:

\[
PRV = \left( \sigma^2_{\text{NoPredictor}} - \sigma^2_{\text{Predictor}} \right) / \sigma^2_{\text{NoPredictor}}
\]

In the equation above, $\sigma^2_{\text{NoPredictor}}$ represents the individual-level residual variance calculated in a null model that does not include the predictor variable that the $PRV$ index is being calculated for. Conversely, $\sigma^2_{\text{Predictor}}$ represents the individual-level residual variance calculated in the proposed model (in which the predictor is included).

Although there is no consensus surrounding the single most-appropriate index of either global or local effect size in multilevel data analysis, both the pseudo-$R^2$ and the $PRV$ represent widely-accepted indices used in this line of work (Peugh, 2010; Singer & Willett, 2003, Raudenbush & Bryk, 2002). Consequently, the global and local effect sizes in the present study’s
multilevel analyses were assessed using these statistics. It is worth noting, however, that the values pertaining to the pseudo-$R^2$ and the $PRV$ are expressed in different, incomparable units (Peugh, 2010). Due to this difference in scaling, it is possible to calculate local effect sizes that exceed global effect sizes (see Hox, 2002; Roberts & Monaco, 2006; Snijders & Bosker, 1999).

**Pre-Registration of Final Analyses**

Prior to analyzing any collected data, all variables and analyses were agreed upon by the student and advisory committee members, and documented in a form provided by AsPredicted.org (see Appendix M). As data had already been collected, this form could not be submitted as a complete pre-registration; however, documenting the full analysis plan prior to beginning data analysis allowed the committee to promote transparency in the project.
DATA CLEANING AND PREPARATION

Missing Data Analysis and Imputation

Several outcomes at the individual level (i.e., uncertainty, trust in team members, propensity to trust, and performance beliefs) relied on self-report measures, which were susceptible to missing data. Missing data analyses showed that, across these outcomes, 54.24 percent of items had at least one missing case; and 6.40 percent of participants failed to provide data on at least one item. There were no missing values in the team-level outcomes (i.e., team process, task performance), which relied on ratings given by subject matter experts in the lab.

In multilevel analyses, missing data at the individual level is problematic, as it leaves estimators in the model undefined (van Buuren, 2011). Although one may circumvent this problem by simply removing cases with missing values via listwise deletion, best practices recommend imputing these values instead; as removing cases may reduce statistical power and bias regression weight estimates (Little, 1992). Although advisable, traditional imputation procedures are often difficult to apply to nested data. In order to estimate missing individual-level values within a larger nested data file, one must incorporate random effects into the imputation model (Schafer, 1997); and unfortunately, the relevant parameter distributions for these random effects are often not estimated with a high degree of precision (Longford, 2005). This issue often precludes the use of traditional imputation procedures when working with a sample made up of nested data (van Buuren, 2011).

Multiple imputation of nested data is possible, however, using a variation of the chained equations approach that includes a nested Markov chain Monte Carlo algorithm (i.e., a Gibbs sampler). Chained equations imputation is a form of fully-conditional specification in which a
multivariate imputation model is specified on a variable-by-variable basis using a set of conditional densities (one for each incomplete variable; van Buuren, Brand, Groothuis-Oudshoorn, & Rubin, 2006). Gibbs sampling, which uses a randomized rather the deterministic algorithm, has also been found to increase the precision of estimates in multilevel settings using simulated data (e.g., Fox & Glas, 2001). Imputing data using such a method compensates for the imprecision of random effects estimates in other approaches (van Buuren, 2011; Jacobusse, 2005). In line with these recommendations, missing values for all of individual-level outcomes in the study were imputed and averaged across five iterations using a chained equations approach with a nested Gibbs sampler. These imputations were conducted using a program called WinMICE, which is specifically designed for use with nested data (Jacobusse, 2005).

**Mahalanobis Distance Assessment to Detect and Remove Outliers**

After imputing missing values, participants’ scores on all outcome measures were vetted for any outliers. Outliers were detected and removed using Mahalanobis distance values, which provide a scale-invariant measure of the distance between each given data point and the mean of its constituent distribution in standard deviation units (Mahalanobis, 1936). These scores are compared to a critical value derived from the chi-square distribution in order to ascertain the probability of any given score coming from a different cluster than that which it is purported to represent. Using a critical value of \( p < .001 \), I calculated the squared distance between each row and the mean of each model’s outcome measures, with respect to each measure’s covariance matrix. This relationship is presented in Equation 15 below:
(15) \[ D_{M(x)}^2 = ((x - \mu)' S^{-1}(x - \mu)) \]

In this equation, \( x \) represents an individual’s score on a given outcome (for example, participants’ trust in their team members); \( \mu \) represents the mean of the corresponding cluster of scores (i.e., for that specific outcome); and \( S \) represents the outcome’s covariance matrix.

Inspection of the resulting squared Mahalanobis distance values revealed one outlying case at the individual-level, which was subsequently removed. Consequently, all 106 team-level data points, and 296 individual-level data points were retained in the final analysis. Control and covariate analyses on this vetted data set are presented in Appendix N.
MAIN ANALYSES

Did the Media Richness Manipulation Predict Uncertainty (Hypothesis 1)?

Hypothesis 1 predicted that the media richness manipulation would be negatively related team members’ uncertainty. That is, the members of teams assigned to higher media richness conditions were hypothesized to experience less uncertainty about the task and their team members than the members of teams assigned to lower media richness conditions. This hypothesis was assessed by using each team’s media richness condition assignment (team-level) to predict team members’ uncertainty ratings (individual-level) using a multilevel regression framework (see Equation 3). In order to account for that fact that individual uncertainty ratings may have clustered around teams as a function of the nested structure of the data, random intercepts in uncertainty ratings were also included in the regression equation using each team’s identification number. A summary of all fixed and random coefficients derived from this analysis is presented in Table 3.

In order to assess the omnibus effect of the media richness manipulation on participants’ uncertainty, I calculated the fit of a random intercept model predicting uncertainty; as well as the fit of a random intercept model that also used the media richness manipulation to predict uncertainty. I then calculated a likelihood ratio comparing the relative fit of these two models. The likelihood ratio suggested that there was a non-zero population-level relation between the media richness manipulation and uncertainty $D(5) = 27.73, p < .001, R^2 = .45, 95\% CI = [.32, .58]$. Inspection of the 95 percent confidence intervals around the associated pseudo-$R^2$ statistic suggested that the population-level effect of media richness on uncertainty could plausibly
(though not necessarily) range from anywhere between 32 and 58 percent of variance accounted for. Population-level effect sizes outside this range are possible, but are relatively less plausible².

**Table 3: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ uncertainty ratings**

**Dependent Variable: Uncertainty Ratings**

**Fixed: Intercept, Media Richness Manipulation (Base = Email)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.004 (0.07)</td>
<td>0.52 (0.11)**</td>
</tr>
<tr>
<td>Skype™</td>
<td>---</td>
<td>-0.77 (0.16)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>-0.76 (0.16)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.54 (0.03)</td>
<td>0.41 (0.02)</td>
</tr>
<tr>
<td><strong>Log-Likelihood</strong></td>
<td>-403.44</td>
<td>-389.41</td>
</tr>
</tbody>
</table>

*Note. Fixed effects are represented as standardized regression weights (i.e., \( \beta \)), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates \( p < .05 \), ** indicates \( p < .01 \).*

² This interpretation of confidence intervals follows Cumming and Finch’s (2005) article, which suggests interpreting confidence intervals as a range of plausible values in which the population-level effect may fall. Researchers cannot infer the absolute probability of any one set of confidence intervals containing a population-level effect, as point estimates of a given effect (and their associated confidence intervals) vary from study to study; whereas the population-level effect does not.
In order to ascertain the direction of this effect, I then conducted a series of post-hoc comparisons between each of the three media richness conditions. Participants in the medium media richness (Skype™) condition reported feeling significantly less uncertain than participants in the low media richness (email) condition \( t(103) = -4.88, d = -1.19, 95\% CI = [-1.70, -0.68], \beta = -0.77 \). Inspection of the 95\% confidence intervals around the standardized effect size (i.e., Cohen’s \( d \)) suggested that the population-level difference in uncertainty between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.68 to 1.70 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the high media richness (collocated) condition also reported feeling significantly less uncertain than participants in the low media richness (email) condition \( t(103) = -4.87, d = -1.16, 95\% CI = [-1.66, -0.64], \beta = -0.76 \). Inspection of the 95\% confidence intervals around the standardized effect size suggested that the population-level difference in uncertainty between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.64 and 1.66 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the medium media richness (Skype™) condition did not report significantly higher or lower uncertainty than participants in the high media richness (collocated) condition \( t(103) = 0.14, d = 0.03, 95\% CI = [-0.43, 0.50], \beta = 0.02 \).

Thus Hypothesis 1 was partially supported, in that participants’ self-reported uncertainty was lower in more media rich conditions. Specifically, teams in the medium and high media richness conditions reported feeling significantly less uncertainty about the task and their team members than team members in the low media richness condition. However, the members of
high media richness teams reported experiencing a comparable amount of uncertainty to that reported by the members of medium media richness teams.

**Did the Media Richness Manipulation Predict Trust (Hypothesis 2)?**

Hypothesis 2 predicted that the media richness manipulation would be positively related team members’ trust. That is, the members of teams assigned to higher media richness conditions were hypothesized to feel greater trust towards their team members than the members of teams assigned to lower media richness conditions. This hypothesis was assessed by using each team’s media richness condition assignment (team-level) to predict team members’ trust ratings (individual-level) using a multilevel regression (see Equation 4). In order to account for the possibility that individual trust ratings may have clustered around teams as a function of the nested structure of the data, random intercepts in trust ratings were also included in the regression equation using each team’s identification number. A summary of all fixed and random coefficients derived from this analysis is presented in Table 4.

In order to assess the omnibus effect of the media richness manipulation on participants’ trust, I calculated the fit of a random intercept model predicting trust; as well as the fit of a random intercept model that also used the media richness manipulation to predict trust. I then calculated a likelihood ratio comparing the relative fit of these two models. The likelihood ratio suggested that there was a non-zero population-level relation between the media richness manipulation and trust $D(5) = 13.12, p = .001, R^2 = .35, 95\% CI = [.21, .49]$. Inspection of the 95 percent confidence intervals around the associated pseudo-$R^2$ statistic suggested that the population-level effect of media richness on trust could plausibly (though not necessarily) range
from anywhere between 21 and 49 percent of variance accounted for. Population-level effect sizes outside this range are possible, but are relatively less plausible.

Table 4: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ trust ratings

**Dependent Variable: Trust Ratings**

**Fixed: Intercept, Media Richness Manipulation (Base = Email)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.004 (0.07)</td>
<td>-0.33 (0.11)**</td>
</tr>
<tr>
<td>Skype\textsuperscript{tm}</td>
<td>---</td>
<td>0.43 (0.16)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.55 (0.15)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.42 (0.02)</td>
<td>0.35 (0.02)</td>
</tr>
<tr>
<td><strong>Log-Likelihood</strong></td>
<td>-415.37</td>
<td>-408.81</td>
</tr>
</tbody>
</table>

*Note. Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.  

In order to ascertain the direction of this effect, I then conducted a series of post-hoc comparisons between each of the three media richness conditions. Participants in the medium media richness (Skype\textsuperscript{tm}) condition reported feeling significantly more trust towards their team members than participants in the low media richness (email) condition $t(103) = 2.71, d = 0.70, 95\% CI = [0.21, 1.18], \beta = 0.43$. Inspection of the 95% confidence intervals around the standardized effect size suggested that the population-level difference in trust between participants in the medium media richness condition and participants in the low media richness
condition could plausibly (though not necessarily) range from anywhere between 0.21 and 1.18 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the high media richness (collocated) condition also reported feeling significantly more trust towards their team members than participants in the low media richness (email) condition $t(103) = 3.57, d = 0.89, 95\% CI = [0.40, 1.38], \beta = 0.55$.

Inspection of the 95% confidence intervals around the standardized effect size suggested that the population-level difference in trust between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.40 and 1.38 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the medium media richness ($\text{Skype}^{\text{tm}}$) condition did not report significantly higher or lower trust towards their team members than participants in the high media richness (collocated) condition $t(103) = 0.82, d = 0.19, 95\% CI = [-0.27, 0.65], \beta = 0.13$

Thus, Hypothesis 2 was also partially supported, in that participants’ self-reported trust towards their team members was higher in more media rich conditions. Specifically, teams in the medium and high media richness conditions reported feeling significantly more trust towards their team members than team members in the low media richness condition. However, the members of high media richness teams reported experiencing a comparable amount of trust to that reported by members of medium media richness teams.

**Did Uncertainty Predict Trust (Hypothesis 3a)?**

Hypothesis 3a predicted that participants’ felt uncertainty would be uniquely and negatively related to participants’ trust in their team members, such that the more uncertainty participants’
perceived during the experiment, the lower their trust in their team members would be. This hypothesis was assessed by adding participants’ uncertainty ratings (individual-level) into a regression equation predicting participants’ trust ratings (individual-level), and assessing the local effects of uncertainty ratings on predicting trust ratings beyond the variance accounted for by the media richness manipulation (see Equation 4). As before, random intercepts in trust ratings were included in the regression equation using each team’s identification number in order to account for the possibility that individual trust ratings may have clustered around teams as a function of the nested structure of the data. A summary of all fixed and random coefficients derived from this analysis is presented in Table 5.

Participants’ uncertainty ratings were uniquely and negatively related to the trust they felt for their team members \( t(189) = -3.37, p < .001, PRV = .007, \beta = -0.20 \). However, adding uncertainty to the regression equation only resulted in 0.70 percent decrease in individual-level residual variance (\( PRV = .007 \); Raudenbush & Bryk, 2002; Singer & Willett, 2003). Thus, Hypothesis 3a was also supported; however, the results suggest that, despite being a statistically significant unique predictor, participants’ uncertainty ratings may have had a relatively small unique contribution to the prediction of participants’ trust ratings beyond the variance already accounted for by participants’ placement in the media richness manipulation.
Table 5: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and uncertainty ratings; and participants’ trust ratings

Dependent Variable: Trust Ratings

Fixed: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.004 (0.07)</td>
<td>-0.33 (0.11)**</td>
<td>-0.23 (0.11)*</td>
</tr>
<tr>
<td>Skype&lt;sup&gt;tm&lt;/sup&gt;</td>
<td>---</td>
<td>0.43 (0.16)**</td>
<td>0.27 (0.16)</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.55 (0.15)**</td>
<td>0.40 (0.16)*</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.20 (0.06)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.42 (0.02)</td>
<td>0.35 (0.02)</td>
<td>0.32 (0.02)</td>
</tr>
<tr>
<td><em>Log-Likelihood</em></td>
<td>-415.37</td>
<td>-408.81</td>
<td>-403.20</td>
</tr>
</tbody>
</table>

*Note. Fixed effects are represented as standardized regression weights (i.e., β), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates p < .05, ** indicates p < .01.*

**Did Uncertainty Mediate the Relation Between Media Richness and Trust (Hypothesis 3b)?**

Hypothesis 3b predicted that participants’ felt uncertainty would partially mediate the relation between the media richness manipulation and participants’ trust in their team members. As noted above, the media richness manipulation was negatively related to uncertainty in two of three instances, partially supporting the a-path of the proposed media richness-uncertainty-trust mediation model. This was true specifically when comparing teams in the low (email) versus medium (Skype<sup>tm</sup>) media richness conditions $t(103) = 2.71, d = 0.70, 95\% CI = [0.21, 1.18], \beta = 0.43$; and when comparing teams in the low (email) and high (collocated) media richness conditions $t(103) = 3.57, d = 0.89, 95\% CI = [0.40, 1.38], \beta = 0.55$. Moreover, uncertainty was
uniquely and negatively related to trust $t(189) = -3.37, p < .001, PRV = .007, \beta = -0.20$, supporting the proposed $b$-path of the mediation model.

Because both the $a$- and $b$-paths of the proposed mediation model were supported, statistical mediation was subsequently examined by assessing the indirect effect of media richness on trust using bootstrapping with bias-corrected confidence intervals, following recommendations made by Preacher and Hayes (2004), and by Bauer, Preacher, and Gil (2006). To accommodate the nested structure of the data, an outcome variable was calculated by combining each unit’s (i.e., individual’s) outcome (i.e., trust) and mediator (i.e., uncertainty) scores within their relevant grouping variable (i.e., team), to create an omnibus outcome variable. Additional selection variables were included to allow each path to be modelled within a single equation (see Equation 8 for a breakdown of this logic, generally; and Equation 9 for its application to the current Hypothesis). Indirect effects were only assessed for the difference between the low (email) and medium (Skype™) media richness conditions, as well as the low (email) and high (collocated) media richness condition; mediation was not assessed for the difference between the medium (Skype™) and high (collocated) media richness conditions, as the $a$-path of the mediation model was not supported in this case.

The results of the mediation analysis supported the unique mediating role of uncertainty when examining the indirect effect of media richness on trust (for email versus collocated teams). Participants in the high media richness (collocated) condition reported feeling greater trust towards their team members than participants in the low media richness (email) condition $\beta = 0.15, 95\% CI = [0.04, 0.29]$. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the indirect population-level difference in trust between participants in the high media richness condition and participants in the low media
richness condition could plausibly (though not necessarily) range from anywhere between 0.04 and 0.29 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. The direct effect of media richness on trust remained statistically significant after accounting for uncertainty; and, after accounting for uncertainty, participants in the high media richness (collocated) condition still reported feeling significantly greater trust towards their team members than participants in the low media richness (email) condition $\beta = 0.29$, 95% CI $= [0.02, 0.56]$. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the direct population-level difference in trust between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.02 and 0.56 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. This pattern of results suggested partial mediation.

The results of the mediation analysis also supported the unique mediating role of uncertainty when examining the indirect effect of media richness on trust (for email versus Skype™ teams). Participants in the medium media richness (Skype™) condition reported feeling greater trust towards their team members than participants in the low media richness (email) condition $\beta = 0.17$, 95% CI $= [0.06, 0.28]$. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the indirect population-level difference in trust between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.06 and 0.28 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. The direct effect of media richness on trust did not remain statistically significant after accounting for uncertainty; and, after accounting for uncertainty, participants in
the medium media richness (Skype™️) condition did not report feeling significantly more or less trust towards their team members than participants in the low media richness (email) condition. $\beta = 0.27$, $95\%$ CI = [-0.04, 0.58]. This pattern of results suggested full mediation, rather than partial mediation.

Thus Hypothesis 3b was fully supported with respect to the difference between low and high media richness teams; partially supported with respect to the difference between low and medium media richness teams (although suggested full rather than partial mediation); and not supported with respect to the difference between medium and high media richness teams (which did not significantly differ in terms of the uncertainty they engendered).

**Did Propensity to Trust Moderate the Relation Between Uncertainty and Trust (Hypothesis 4)?**

Hypothesis 4 predicted that participants’ trait-level propensity to trust others would moderate the relation between participants’ uncertainty ratings and participants’ trust ratings (such that the negative relation between uncertainty and trust would be attenuated for participants who had a higher propensity to trust others). This hypothesis was assessed by adding participants’ propensity to trust ratings (individual-level) into the aforementioned regression equation predicting participants’ trust ratings (individual-level); and assessing the local effects of propensity to trust ratings on predicting trust ratings beyond the variance accounted for by both the media richness manipulation (i.e., Hypothesis 2) and participants’ uncertainty ratings (i.e., Hypothesis 3a). To assess moderation specifically, the cross-product of participants’ mean-centred uncertainty ratings and mean-centred propensity to trust ratings was also included, and assessed in terms of its local effect on trust ratings beyond the variance accounted for by the other predictors (see Equation 4). As before, random intercepts in trust ratings were included in the
regression equation using each team’s identification number in order to account for the possibility that individual trust ratings may have clustered around teams as a function of the nested structure of the data. A summary of all fixed and random coefficients derived from this analysis is presented in Table 6.

Table 6: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation, uncertainty ratings, and propensity to trust ratings; and participants’ trust ratings

Dependent Variable: Trust Ratings

Fixed: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings, Propensity to Trust Ratings, Uncertainty*Propensity Interaction Term

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
<th>Model IV (Null + Manipulation + Uncertainty + Propensity)</th>
<th>Model V (Null + Manipulation + Uncertainty + Propensity + Int.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.004 (0.07)</td>
<td>-0.33 (0.11)**</td>
<td>-0.23 (0.11)*</td>
<td>-0.24 (0.11)*</td>
<td>-0.23 (0.11)*</td>
</tr>
<tr>
<td>Skype™</td>
<td>---</td>
<td>0.43 (0.16)**</td>
<td>0.27 (0.16)</td>
<td>0.33 (0.15)*</td>
<td>0.33 (0.15)*</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.55 (0.15)**</td>
<td>0.40 (0.16)*†</td>
<td>0.37 (0.15)*</td>
<td>0.36 (0.15)*</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.20 (0.06)**†</td>
<td>-0.19 (.06)**‡</td>
<td>-0.19 (.06)**‡</td>
</tr>
<tr>
<td>Propensity</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>0.30 (0.05)**‡</td>
<td>0.30 (0.05)**‡</td>
</tr>
<tr>
<td>Uncert*Prop</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>0.03 (0.05)</td>
</tr>
<tr>
<td>Random Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.42 (0.02)</td>
<td>0.35 (0.02)</td>
<td>0.32 (0.02)</td>
<td>0.33 (0.02)</td>
<td>0.33 (0.02)</td>
</tr>
<tr>
<td>Log-Likelihood</td>
<td>-415.37</td>
<td>-408.81</td>
<td>-403.20</td>
<td>-387.64</td>
<td>-387.46</td>
</tr>
</tbody>
</table>

Note. Fixed effects are represented as standardized regression weights (i.e., β), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates p < .05, ** indicates p < .01.
Participants’ propensity to trust others uniquely predicted participants’ trust ratings $t(188) = 5.69, p < .001, PRV = .13, \beta = 0.30$, resulting in a 13 percent decrease in individual-level residual variance ($PRV = .13$; Raudenbush & Bryk, 2002; Singer & Willett, 2003). Specifically, as participants’ propensity to trust others increased, so did participants’ trust in their team members. However, the interaction term between propensity to trust and uncertainty was not statistically significant $t(187) = 0.60, p = .55, PRV < .001, \beta = 0.03$; and resulted in less than a 0.10 percent decrease in individual-level residual variance ($PRV < .001$; Raudenbush & Bryk, 2002; Singer & Willett, 2003). Thus, although propensity to trust uniquely predicted participants’ trust ratings, its relation with trust appears to have been additive to the effects of uncertainty, and did not seem to moderate the relation between uncertainty ratings and trust ratings. Consequently, Hypothesis 4 was not supported.

**Did the Media Richness Manipulation Predict Team Performance (Hypothesis 5)?**

**Overview**

Hypothesis 5 predicted that the media richness manipulation would be positively related to team performance, such that teams assigned to higher media richness conditions would engage in greater performance than teams assigned to lower media richness conditions. This hypothesis was assessed by using each team’s media richness condition assignment (team-level) to predict each of the three performance outcomes in the present study, including: team members’ performance belief ratings (individual-level); teams’ process performance ratings (team-level), and teams’ task performance ratings (team-level). These relations are respectively presented in Equation 5 through Equation 7. In order to account for the possibility that individual performance belief ratings may have clustered around teams as a function of the nested structure
of the data, random intercepts in performance belief ratings were also included in the regression equation using each team’s identification number. This procedure was not followed for either process performance or task performance ratings, as these outcomes were assessed solely at the team-level (negating the need for random coefficients). Summaries for all fixed and (if applicable) random coefficients derived from these analyses are presented in Table 7, Table 8, and Table 9 for (respectively) performance beliefs, process performance, and task performance.

**Media Richness and Performance Beliefs**

In order to assess the omnibus effect of the media richness manipulation on participants’ performance beliefs, I calculated the fit of a random intercept model predicting performance beliefs; as well as the fit of a random intercept model that also used the media richness manipulation to predict performance beliefs. I then calculated a likelihood ratio comparing the relative fit of these two models. The likelihood ratio suggested that there was a non-zero population-level relation between the media richness manipulation and performance beliefs $D(5) = 13.83, p = .001, R^2 = .47, 95\% \text{ CI} = [.39, .55]$. Inspection of the 95 percent confidence intervals around the associated pseudo-$R^2$ statistic suggested that the population-level effect of media richness on performance beliefs could plausibly (though not necessarily) range from anywhere between 39 and 55 percent of variance accounted for. Population-level effect sizes outside this range are possible, but are relatively less plausible.
Table 7: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and participants’ performance belief ratings

**Dependent Variable: Performance Belief Ratings**

**Fixed: Intercept, Media Richness Manipulation (Base = Email)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.007 (0.07)</td>
<td>-0.37 (0.12)**</td>
</tr>
<tr>
<td>Skype™</td>
<td>---</td>
<td>0.54 (0.17)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.56 (0.16)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.52 (0.03)</td>
<td>0.45 (0.02)</td>
</tr>
<tr>
<td><strong>Log-Likelihood</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-409.78</td>
<td>-402.87</td>
</tr>
</tbody>
</table>

*Note*. Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.

In order to ascertain the direction of this effect, I then conducted a series of post-hoc comparisons between each of the three media richness conditions. Participants in the medium media richness (Skype™) condition reported significantly higher performance beliefs than participants in the low media richness (email) condition $t(103) = 3.27, d = 0.77, 95\% CI = [0.29, 1.27], \beta = 0.54$. Inspection of the 95% confidence intervals around the standardized effect size suggested that the population-level difference in performance beliefs between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.29 and 1.27 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the high media richness (collocated) condition also reported
significantly higher performance beliefs than participants in the low media richness (email) condition $t(103) = 3.42, p < .001, d = 0.84, 95\% \text{ CI} = [0.35, 1.32], \beta = 0.56$. Inspection of the 95\% confidence intervals around the standardized effect size suggested that the population-level difference in performance beliefs between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.35 and 1.32 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Participants in the medium media richness (Skype™) condition did not report significantly higher or lower performance beliefs than participants in the high media richness (collocated) condition $t(103) = 0.10, d = 0.02, 95\% \text{ CI} = [-0.43, 0.48], \beta = 0.02$.

**Media Richness and Process Performance**

In order to assess the omnibus effect of the media richness manipulation on teams’ process performance, I calculated the fit of an intercept-only, team-level model predicting process performance beliefs; as well as the fit of a team-level model that also used the media richness manipulation to predict process performance. The resulting $F$-test suggested that there was a non-zero population-level relation between the media richness manipulation and process performance $F(2, 103) = 13.48, p < .001, R^2 = .21, 95\% \text{ CI} = [.08, .34]$. Inspection of the 95 percent confidence intervals around the associated $R^2$ statistic suggested that the population-level effect of media richness on process performance could plausibly (though not necessarily) range from anywhere between eight and 34 percent of variance accounted for. Population-level effect sizes outside this range are possible, but are relatively less plausible.
Table 8: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and teams’ process performance ratings

Dependent Variable: Process Performance Ratings

Fixed: Intercept, Media Richness Manipulation (Base = Email)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.65 (0.15)**</td>
</tr>
<tr>
<td>Skype\textsuperscript{tm}</td>
<td>---</td>
<td>1.06 (0.22)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.85 (0.21)**</td>
</tr>
<tr>
<td><strong>Model R\textsuperscript{2}</strong></td>
<td>.00</td>
<td>.21**</td>
</tr>
</tbody>
</table>

*Note.* Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.

In order to ascertain the direction of this effect, I then conducted a series of post-hoc comparisons between each of the three media richness conditions. Teams in the medium media richness (Skype\textsuperscript{tm}) condition received significantly higher process performance ratings than teams in the low media richness (email) condition $t(103) = 4.91, d = 1.18, 95\% CI = [0.67, 1.69], \beta = 1.06$. Inspection of the 95\% confidence intervals around the standardized effect size suggested that the population-level difference in process performance between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.67 and 1.69 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Teams in the high media richness (collocated) condition also received significantly higher process performance ratings than teams in the low media richness (email) condition $t(103) = 3.98, d = 0.94, 95\% CI = [0.45, 1.43], \beta = 0.85$. Inspection of the 95\% confidence intervals...
around the standardized effect size suggested that the population-level difference in process performance between teams in the high media richness condition and teams in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.45 and 1.43 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Teams in the medium media richness (Skype™) condition did not receive significantly higher or lower process performance ratings than teams in the high media richness (collocated) condition t(103) = -1.01, \( d = -0.23 \), 95% CI = [-0.70, 0.23], \( \beta = -0.22 \).

**Media Richness and Task Performance**

In order to assess the omnibus effect of the media richness manipulation on teams’ task performance, I calculated the fit of an intercept-only, team-level model predicting task performance; as well as the fit of a team-level model that also used the media richness manipulation to predict task performance. The resulting F-test suggested that there was a non-zero population-level relation between the media richness manipulation and task performance \( F(2, 103) = 10.08, p < .001, R^2 = .16, 95\% CI = [.04, .28]. \) Inspection of the 95 percent confidence intervals around the associated \( R^2 \) statistic suggested that the population-level effect of media richness on task performance could plausibly (though not necessarily) range from anywhere between four and 28 percent of variance accounted for. Population-level effect sizes outside this range are possible, but are relatively less plausible.
Table 9: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and teams’ task performance ratings

**Dependent Variable: Task Performance Ratings**

**Fixed: Intercept, Media Richness Manipulation (Base = Email)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.52 (0.16)**</td>
</tr>
<tr>
<td>Skype™</td>
<td>---</td>
<td>0.54 (0.22)*</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.98 (0.22)**</td>
</tr>
<tr>
<td>Model R²</td>
<td>.00</td>
<td>.16**</td>
</tr>
</tbody>
</table>

*Note. Fixed effects are represented as standardized regression weights (i.e., β), with their associated standard errors in parentheses. * indicates p < .05, ** indicates p < .01.*

In order to ascertain the direction of this effect, I then conducted a series of post-hoc comparisons between each of the three media richness conditions. Teams in the medium media richness (Skype™) condition received significantly higher task performance ratings than teams in the low media richness (email) condition, \( t(103) = 2.45, d = 0.59, 95\% \text{ CI} = [0.10, 1.07] \), \( \beta = 0.54 \). Inspection of the 95% confidence intervals around the standardized effect size suggested that the population-level difference in task performance between teams in the medium media richness condition and teams in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.10 and 1.07 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Teams in the high media richness (collocated) condition also received significantly higher task performance ratings than teams in the low media richness (email) condition, \( t(103) = 4.49, d = 1.07, 95\% \text{ CI} = [0.56, 1.56] \), \( \beta = 0.98 \). Inspection of the 95% confidence intervals around the standardized effect size...
suggested that the population-level difference in task performance between teams in the high media richness condition and teams in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.56 and 1.56 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. Finally, teams in the high media richness (collocated) condition received significantly higher task performance ratings than teams in the medium media richness (Skype™) condition $t(103) = 2.03$, $d = 0.48$, $95\% \ CI = [0.01, 0.94]$, $\beta = 0.44$. Inspection of the 95% confidence intervals around the standardized effect size suggested that the population-level difference in task performance between teams in the high media richness condition and teams in the medium media richness condition could plausibly (though not necessarily) range from anywhere between 0.01 and 0.94 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible.

**Summary**

Thus, Hypothesis 5 was supported, in that both individual-level (i.e., performance beliefs) and team-level (i.e., process performance, task performance) performance ratings were higher in more media rich conditions. Placement in the media richness manipulation was most strongly predictive of participants’ performance beliefs; and was less strongly (though still statistically significantly) predictive of teams’ expert-rated process performance ratings, as well as their performance on the experimental task’s scoring system. These findings are consistent with the idea that subjective performance beliefs may be a proximal performance outcome, relative to objective actions and outcomes associated with performance (which are likely to be more distal).
**Did Uncertainty Predict Team Performance (Hypothesis 6a)?**

**Overview**

Hypothesis 6a predicted that participants’ uncertainty would uniquely and negatively predict team performance, such that the more uncertainty participants’ perceived during the experiment, the lower their performance would be. This hypothesis was assessed by adding participants’ uncertainty ratings (individual-level) into a regression equation predicting each of the three performance outcomes in the present study, including: team members’ performance belief ratings (individual-level), teams’ process performance ratings (team-level), and teams’ task-performance ratings (team-level); and then assessing the local effects of uncertainty ratings on predicting each dimension of performance beyond the variance accounted for by the media richness manipulation. In order to account for the possibility that individual performance belief ratings may have clustered around teams as a function of the nested structure of the data, random intercepts in performance belief ratings were also included in the regression equation using each team’s identification number. This procedure was not followed for either process performance or task performance ratings, as these outcomes were assessed solely at the team-level (negating the need for random coefficients). Summaries of all fixed and (if applicable) random coefficients derived from these analyses are presented in Table 10, Table 11, and Table 12 for (respectively) performance beliefs, process performance, and task performance.

**Uncertainty and Performance Beliefs**

On the whole, participants’ uncertainty and placement in the media richness manipulation jointly predicted performance beliefs at a statistically significant level $R^2 = .45$, 95% CI = [.32, .58]. Inspection of the 95% confidence intervals around the standardized omnibus effect size
(i.e., pseudo-$R^2$) suggested that the population-level proportion of variance in performance beliefs accounted for could plausibly (though not necessarily) range from anywhere between 32 and 58 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible.

After accounting for participants’ placement in the media richness manipulation, participants’ uncertainty ratings were uniquely and negatively related to participants’ performance beliefs; and accounted for a five percent decrease in individual-level residual variances $t(189) = -5.87, p < .001$, $PRV = .05, \beta = -0.33$.

Table 10: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation and uncertainty ratings; and participants’ performance beliefs

**Dependent Variable: Performance Beliefs**

**Fixed: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.007 (0.07)</td>
<td>-0.37 (0.12)**</td>
<td>-0.20 (0.11)</td>
</tr>
<tr>
<td>Skype&lt;sup&gt;tm&lt;/sup&gt;</td>
<td>---</td>
<td>0.54 (0.17)**</td>
<td>0.28 (0.16)</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.56 (0.16)**</td>
<td>0.31 (0.16)</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.33 (0.06)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.52 (0.03)</td>
<td>0.45 (0.02)</td>
<td>0.38 (0.02)</td>
</tr>
<tr>
<td><strong>Log-Likelihood</strong></td>
<td>-409.78</td>
<td>-402.87</td>
<td>-386.53</td>
</tr>
</tbody>
</table>

*Note.* Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.  

86
Uncertainty and Process Performance

On the whole, teams’ mean uncertainty and placement in the media richness manipulation jointly predicted process performance at a statistically significant level $R^2 = .21$, $95\% CI = [.07, .32]$. Inspection of the 95% confidence intervals around the standardized omnibus effect size (i.e., $R^2$) suggested that the population-level proportion of variance in process performance accounted for could plausibly (though not necessarily) range from anywhere between seven and 32 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible. However, despite a significant omnibus effect, uncertainty ratings were not uniquely related to teams’ process performance; and did not significantly predict this outcome beyond the variance already accounted for by teams’ placement in the media richness manipulation $t(102) = -0.17, sr^2 = .00, 95\% CI = [.00, .01], \beta = -0.02$.

Table 11: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and uncertainty ratings; and teams’ process performance ratings

Dependent Variable: Process Performance Ratings

Fixed: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.65 (0.15)**</td>
<td>-0.63 (0.17)**</td>
</tr>
<tr>
<td>Skype\textsuperscript{tm}</td>
<td>---</td>
<td>1.06 (0.22)**</td>
<td>1.04 (0.24)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.85 (0.21)**</td>
<td>0.83 (0.24)**</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.02 (0.10)</td>
</tr>
<tr>
<td>Model $R^2$</td>
<td>.00</td>
<td>.21**</td>
<td>.21**</td>
</tr>
</tbody>
</table>

Note. Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$. 

87
Uncertainty and Task Performance

On the whole, teams’ mean uncertainty and placement in the media richness manipulation jointly predicted task performance at a statistically significant level $R^2 = .21$, 95% CI = [.07, .33]. Inspection of the 95% confidence intervals around the standardized omnibus effect size (i.e., $R^2$) suggested that the population-level proportion of variance in task performance accounted for could plausibly (though not necessarily) range from anywhere between seven and 33 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible.

After accounting for teams’ placement in the media richness manipulation, aggregated uncertainty ratings were still uniquely and negatively related to teams’ task performance $t(103) = -2.50$, $sr^2 = .05$, 95% CI = [.02, .12], $\beta = -0.25$. Inspection of the 95 percent confidence intervals around the standardized effect size (i.e., squared semi-partial correlation) suggested that the population-level proportion of variance in task performance uniquely accounted for could plausibly (though not necessarily) range from anywhere between two and 12 percent.
Table 12: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation and uncertainty ratings; and teams’ task performance ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.52 (0.16)**</td>
<td>-0.34 (0.17)*</td>
</tr>
<tr>
<td>Skype&lt;sup&gt;tm&lt;/sup&gt;</td>
<td>---</td>
<td>0.54 (0.22)*</td>
<td>0.27 (0.24)</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.98 (0.22)**</td>
<td>0.73 (0.24)**</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.25 (0.10)*</td>
</tr>
<tr>
<td>Model R&lt;sup&gt;2&lt;/sup&gt;</td>
<td>.00</td>
<td>.16**</td>
<td>.21**</td>
</tr>
</tbody>
</table>

Note. Fixed effects are represented as standardized regression weights (i.e., β), with their associated standard errors in parentheses. * indicates p < .05, ** indicates p < .01.

Summary

These findings partially supported the idea that participants’ uncertainty about the task and their team members uniquely related to the team’s performance. At a global level, the media richness manipulation and uncertainty ratings were most strongly predictive of participants’ performance beliefs. And, at a global level, these variables were less strongly (though still statistically significantly) predictive of the team’s expert-rated process performance ratings, as well as their performance on the experimental task’s scoring system. However, after partialling out the variance in performance ratings that were accounted for by each team’s placement in the media richness manipulation, uncertainty ratings were only uniquely predictive of participants’ performance beliefs and teams’ task performance. Thus, Hypothesis 6a was partially supported, specifically across the performance belief dimension and task performance dimension of team performance.
Did Uncertainty Mediate the Relation Between Media Richness and Team Performance (Hypothesis 6b)?

The Indirect Effect of Media Richness on Performance Beliefs via Uncertainty

Hypothesis 6b predicted that participants’ uncertainty about the task and their team members would partially mediate the relation between the media richness manipulation and team performance. As noted earlier, media richness was negatively related to uncertainty in two of three instances (partially supporting the \( a \)-path of the proposed media richness-uncertainty-performance beliefs mediation model). This was the case when comparing teams in the low (email) versus medium (Skype\textsuperscript{tm}) media richness conditions \( t(103) = 2.71, d = 0.70, 95\% \ CI = [0.21, 1.18], \beta = 0.43 \); and when comparing teams in the low (email) and high (collocated) media richness conditions \( t(103) = 3.57, d = 0.89, 95\% \ CI = [0.40, 1.38], \beta = 0.55 \). Moreover, uncertainty was uniquely and negatively related to performance beliefs \( t(189) = -5.87, p < .001, PRV = .05, \beta = -0.33 \), supporting the proposed \( b \)-path of the mediation model.

Because both the \( a \)- and \( b \)-paths of the proposed mediation model were supported when using uncertainty as a mediator variable, statistical mediation was subsequently examined by assessing the indirect effect of media richness on performance beliefs using bootstrapping with bias-corrected confidence intervals, following recommendations made by both Preacher and Hayes (2004), and Bauer, Preacher, and Gil (2006). To accommodate the nested structure of the data, an outcome variable was calculated by combining each unit’s (i.e., individual’s) outcome (i.e., performance beliefs) and mediator (i.e., uncertainty) scores within their relevant grouping variable (i.e., team), to create an omnibus outcome variable. Additional selection variables were included to allow each path to be modelled within a single equation (see Equation 8 for a breakdown of this logic, generally; and Equation 10 for its application to the current Hypothesis).
This was assessed specifically for the difference between the low (email) and medium (Skype\textsuperscript{tm}) media richness conditions; as well as the low (email) and high (collocated) media richness condition. Mediation was not assessed for the difference between the medium (Skype\textsuperscript{tm}) and high (collocated) media richness conditions, as the $a$-path of the mediation model was not supported in this case.

Results of the mediation analysis supported the unique mediating role of uncertainty when examining the indirect effect of media richness on performance beliefs (for email versus collocated teams). Participants in the high media richness (collocated) condition reported higher performance beliefs than participants in the low media richness (email) condition $\beta = 0.29$, 95% CI $= [0.12, 0.41]$. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the indirect population-level difference in performance beliefs between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.12 and 0.41 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. The direct effect of media richness on performance beliefs remained statistically significant after accounting for uncertainty; and, after accounting for uncertainty, participants in the high media richness (collocated) condition still reported higher performance beliefs than participants in the low media richness (email) condition $\beta = 0.30$, 95% CI $= [0.003, 0.61]$. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the direct population-level difference in performance beliefs between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.003 and 0.61 standard
deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. This pattern of results suggested partial mediation.

Conversely, the results of the mediation analysis did not support the mediating role of uncertainty when examining the indirect effect of media richness on performance beliefs (for email versus Skype™ teams) $\beta = -0.28$, 95% CI = [-0.69, 0.12]. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the indirect population-level difference in performance beliefs between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible.

Thus, when examining performance beliefs, Hypothesis 6b was fully supported with respect to the difference between low and high media richness teams. Hypothesis 6b was not, however, supported with respect to the difference between low and medium media richness teams (which did not see a significant indirect effect); or the difference between medium and high media richness teams (which did not significantly differ in terms of the uncertainty they engendered).

The Indirect Effect of Media Richness on Process Performance via Uncertainty

As noted earlier, media richness was negatively related to uncertainty in two of three instances, partially supporting the $a$-path of the proposed media richness-uncertainty-process performance mediation model. This was the case when comparing teams in the low (email) versus medium (Skype™) media richness conditions $t(103) = 2.71, d = 0.70$, 95% CI = [0.21, 1.18], $\beta = 0.43$; and when comparing teams in the low (email) and high (collocated) media
richness conditions \( t(103) = 3.57, d = 0.89, 95\% CI = [0.40, 1.38], \beta = 0.55 \). However, uncertainty was not uniquely related to process performance \( t(102) = -0.17, \text{sr}^2 = .00, 95\% CI = [.00, .01], \beta = -0.02 \), failing to support the proposed \( b \)-path of the mediation model.

Consequently, the indirect effect of media richness on process performance via uncertainty was not further investigated. Thus, when examining process performance, Hypothesis 6b was not supported.

**The Indirect Effect of Media Richness on Task Performance via Uncertainty**

As noted earlier, media richness was negatively related to uncertainty in two of three instances, partially supporting the \( a \)-path of the proposed media richness-uncertainty-task performance mediation model. This was the case when comparing teams in the low (email) versus medium (Skype™) media richness conditions \( t(103) = 2.71, d = 0.70, 95\% CI = [0.21, 1.18], \beta = 0.43 \); and when comparing teams in the low (email) and high (collocated) media richness conditions \( t(103) = 3.57, d = 0.89, 95\% CI = [0.40, 1.38], \beta = 0.55 \). Moreover, uncertainty was uniquely and negatively related to task performance \( t(103) = -2.50, \text{sr}^2 = .05, 95\% CI = [.02, .12], \beta = -0.25 \), supporting the proposed \( b \)-path of the mediation model.

Because both the \( a \)- and \( b \)-paths of the proposed mediation model were supported when using uncertainty as a mediator variable, statistical mediation was subsequently examined by assessing the indirect effect of media richness on task performance using bootstrapping with bias-corrected confidence intervals, following recommendations made by Preacher and Hayes (2004). Results of the mediation analysis did not support the mediating role of uncertainty when examining the indirect effect of media richness on task performance (for email versus Skype™ teams) \( \beta = 0.37, 95\% CI = [-0.42, 1.16] \). Inspection of the 95% confidence intervals around the
standardized slope coefficient suggested that the *indirect* population-level difference in task performance between teams in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible.

The results of the mediation analysis also did not support the mediating role of uncertainty when examining the indirect effect of media richness on task performance (for email versus collocated teams) $\beta = 0.36, 95\% \text{ CI } = [-.41, 1.12]$. Again, inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the *indirect* population-level difference in task performance between teams in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible. Thus, when examining task performance, Hypothesis 6b was not supported.

**Summary**

These findings partially supported the idea that uncertainty can play a mediating role in the relation between media richness and performance; but only insofar as team members’ performance beliefs are concerned. In this case, uncertainty was found to partially mediate the indirect effect of media richness on performance beliefs (for low versus high media richness teams, specifically). These findings did not, however, extend to the difference between low versus medium media richness teams, or the difference between medium versus high media richness teams. Moreover, uncertainty was not found to play a mediating role in the relation
between media richness and either team process performance or team task performance. Thus, Hypothesis 6b was largely unsupported, except in terms of extreme differences in media richness; and even then, only for the performance beliefs dimension of team performance.

**Did Trust Predict Team Performance (Hypothesis 7a)?**

**Overview**

Hypothesis 7a predicted that participants’ trust would uniquely predict team performance, such that the more trust participants’ felt towards their team members, the greater their performance would be. This hypothesis was assessed by adding participants’ trust ratings (individual-level) into a regression equation predicting each of the three performance outcomes in the present study, including: team members’ performance belief ratings (individual-level), teams’ process performance ratings (team-level), and teams’ task-performance ratings (team-level); and then assessing the local effects of trust ratings on predicting each dimension of performance beyond the variance accounted for by the media richness manipulation. In order to account for the possibility that individual performance belief ratings may have clustered around teams as a function of the nested structure of the data, random intercepts in performance belief ratings were also included in the regression equation using each team’s identification number. This procedure was not followed for either process performance or task performance ratings, as these outcomes were assessed solely at the team-level (negating the need for random coefficients). Summaries for all fixed and (if applicable) random coefficients derived from these analyses are presented in Table 13, Table 14, and Table 15 for (respectively) performance beliefs, process performance, and task performance.
Trust and Performance Beliefs

On the whole, participants’ placement in the media richness manipulation, uncertainty, and trust in their team members jointly predicted performance beliefs at a statistically significant level $R^2 = .55$, 95% CI = [.47, .62]. Inspection of the 95% confidence intervals around the standardized omnibus effect size (i.e., pseudo-$R^2$) suggested that the population-level proportion of variance in performance beliefs accounted for could plausibly (though not necessarily) range from anywhere between 47 and 62 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible.

After accounting for participants’ placement in the media richness manipulation as well as their felt uncertainty, participants’ trust ratings were uniquely and positively related to participants’ performance beliefs; and accounted for a 23 percent decrease in individual-level residual variances $t(188) = 13.94, p < .001$, $PRV = .23, \beta = 0.60$. 
Table 13: Fixed and random coefficients derived from a multilevel linear regression examining the relation between the media richness manipulation, uncertainty ratings, and trust ratings; and participants’ performance belief ratings

### Dependent Variable: Performance Belief Ratings

**Fixed**: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings, Trust Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
<th>Model IV (Null + Manipulation + Uncertainty + Trust)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.007 (0.07)</td>
<td>-0.37 (0.12)**</td>
<td>-0.20 (0.11)</td>
<td>-0.06 (0.08)</td>
</tr>
<tr>
<td>Skype\textsuperscript{tm}</td>
<td>---</td>
<td>0.54 (0.17)**</td>
<td>0.28 (0.16)</td>
<td>0.12 (0.11)</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.56 (0.16)**</td>
<td>0.31 (0.16)</td>
<td>0.07 (0.11)</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.33 (0.06)**</td>
<td>-0.22 (0.04)**</td>
</tr>
<tr>
<td>Trust</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>0.60 (0.04)**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team</td>
<td>0.52 (0.03)</td>
<td>0.45 (0.02)</td>
<td>0.38 (0.02)</td>
<td>0.14 (0.01)</td>
</tr>
<tr>
<td><strong>Log-Likelihood</strong></td>
<td>-409.78</td>
<td>-402.87</td>
<td>-386.53</td>
<td>-313.16</td>
</tr>
</tbody>
</table>

*Note*: Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. Random effects are represented in standard deviation units, with standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.

### Trust and Process Performance

On the whole, teams’ placement in the media richness manipulation, mean uncertainty, and mean trust in their team members jointly predicted process performance at a statistically significant level $R^2 = .22$, 95% CI = [.07, .32]. Inspection of the 95% confidence intervals around the standardized omnibus effect size (i.e., $R^2$) suggested that the population-level proportion of variance in process performance accounted for could plausibly (though not necessarily) range
from anywhere between seven and 32 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible.

However, after accounting for teams’ placement in the media richness manipulation and uncertainty ratings, team’s mean trust in one another did not uniquely predict process performance $t(101) = 1.00, \sigma^2 = .01, 95\% \text{ CI} = [-.02, .04], \beta = 0.10$. Inspection of the 95 percent confidence intervals around the effect size (squared semi-partial correlation) suggested that the unique relation between teams’ mean trust and process performance could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible.

Table 14: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, and trust ratings; and teams’ process performance ratings

**Dependent Variable:** Process Performance Ratings

**Fixed: Intercepts, Media Richness Manipulation (Base = Email), Uncertainty Ratings, Trust Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
<th>Model IV (Null + Manipulation + Uncertainty + Trust)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.65 (0.15)**</td>
<td>-0.63 (0.17)**</td>
<td>-0.60 (0.17)**</td>
</tr>
<tr>
<td>Skype\textsuperscript{im}</td>
<td>---</td>
<td>1.06 (0.22)**</td>
<td>1.04 (0.24)**</td>
<td>1.01 (0.24)**</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>085 (0.21)**</td>
<td>0.83 (0.24)**</td>
<td>0.78 (0.24)**</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.02 (0.10)</td>
<td>0.01 (0.11)</td>
</tr>
<tr>
<td>Trust</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>0.10 (0.10)</td>
</tr>
<tr>
<td><strong>Model $R^2$</strong></td>
<td></td>
<td>.00</td>
<td>.21**</td>
<td>.21**</td>
</tr>
</tbody>
</table>

*Note.* Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$. 98
Trust and Task Performance

On the whole, teams’ placement in the media richness manipulation, mean uncertainty, and mean trust in their team members jointly predicted task performance at a statistically significant level $R^2 = .21$, 95% CI = [.07, .32]. Inspection of the 95% confidence intervals around the standardized omnibus effect size (i.e., $R^2$) suggested that the population-level proportion of variance in task performance accounted for could plausibly (though not necessarily) range from anywhere between seven and 32 percent. Population-level effect sizes outside this range are possible, but are relatively less plausible.

However, after accounting for teams’ placement in the media richness manipulation and uncertainty ratings, team’s mean trust in one another did not uniquely predict task performance $t(101) = -0.52$, $sr^2 = .00$, 95% CI = [-.01, .02], $\beta = -0.05$. Inspection of the 95 percent confidence intervals around the effect size (squared semi-partial correlation) suggested that the unique relation between teams’ mean trust and task performance could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible.
Table 15: Fixed coefficients derived from a team-level linear regression examining the relation between the media richness manipulation, uncertainty ratings, and trust ratings; and teams’ task performance ratings

Dependent Variable: Task Performance Ratings

Fixed: Intercept, Media Richness Manipulation (Base = Email), Uncertainty Ratings, Trust Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Model I (Null)</th>
<th>Model II (Null + Manipulation)</th>
<th>Model III (Null + Manipulation + Uncertainty)</th>
<th>Model IV (Null + Manipulation + Uncertainty + Trust)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>&lt; 0.001 (0.10)</td>
<td>-0.52 (0.16)**</td>
<td>-0.34 (0.17)*</td>
<td>-0.36 (0.17)*</td>
</tr>
<tr>
<td>Skype\textsuperscript{m}</td>
<td>---</td>
<td>0.54 (0.22)*</td>
<td>0.27 (0.24)</td>
<td>0.29 (0.25)</td>
</tr>
<tr>
<td>Collocated</td>
<td>---</td>
<td>0.98 (0.22)**</td>
<td>0.73 (0.24)**</td>
<td>0.75 (0.24)**</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>---</td>
<td>---</td>
<td>-0.25 (0.10)*</td>
<td>-0.27 (0.11)*</td>
</tr>
<tr>
<td>Trust</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-0.05 (0.10)</td>
</tr>
<tr>
<td>Model $R^2$</td>
<td>.00</td>
<td>.16**</td>
<td>.21**</td>
<td>.21**</td>
</tr>
</tbody>
</table>

Note. Fixed effects are represented as standardized regression weights (i.e., $\beta$), with their associated standard errors in parentheses. * indicates $p < .05$, ** indicates $p < .01$.

Summary

These findings partially supported the idea that participants’ trust towards their team members uniquely related to the team’s performance. At a global level, the media richness manipulation, uncertainty ratings, and trust ratings were most strongly predictive of participants’ performance beliefs. And, at a global level, these variables were less strongly (though still statistically significantly) predictive of the team’s expert-rated process performance ratings, as well as their expert-rated task performance on the experimental task’s scoring system. However, after partialling out the variance in performance ratings that were accounted for by the team’s placement in the media richness manipulation and team members’ uncertainty ratings, trust
ratings were only uniquely predictive of participants’ performance beliefs. Thus, Hypothesis 7a was partially supported; but only in terms of the performance beliefs dimension of performance.

**Did Trust Mediate the Relation Between Media Richness and Team Performance (Hypothesis 7b)?**

**The Indirect Effect of Media Richness on Performance Beliefs via Trust**

Hypothesis 7b predicted that participants’ trust towards their team members would partially mediate the positive relation between the media richness manipulation and team performance. As noted earlier, media richness was positively related to trust in two of three instances (partially supporting the a-path of the proposed media richness-trust-performance beliefs mediation model). This was the case when comparing teams in the low (email) versus medium (Skype™) media richness conditions \( t(103) = 2.71, d = 0.70, 95\% CI = [0.21, 1.18], \beta = 0.43 \); and when comparing teams in the low (email) and high (collocated) media richness conditions \( t(103) = 3.57, d = 0.89, 95\% CI = [0.40, 1.38], \beta = 0.55 \). Moreover, trust was uniquely and positively related to performance beliefs \( t(188) = 13.94, p < .001, PRV = .23, \beta = 0.60 \), supporting the proposed b-path of the mediation model.

Because both the a- and b-paths of the proposed mediation model were supported when using trust as a mediator variable, statistical mediation was subsequently examined by assessing the indirect effect of media richness on performance beliefs using bootstrapping with bias-corrected confidence intervals, following recommendations made by both Preacher and Hayes (2004), and Bauer, Preacher, and Gil (2006). To accommodate the nested structure of the data, an omnibus outcome variable was calculated by combining each unit’s (i.e., individual’s) outcome (i.e., performance beliefs) and mediator (i.e., trust) scores within their relevant grouping variable (i.e., team). Additional selection variables were included to allow each path to be modelled.
within a single equation (see Equation 8 for a breakdown of this logic, generally; and Equation 11 for its application to the current Hypothesis). This was assessed specifically for the difference between the low (email) and medium (Skype\textsuperscript{tm}) media richness conditions, as well as the low (email) and high (collocated) media richness condition; mediation was not assessed for the difference between the medium (Skype\textsuperscript{tm}) and high (collocated) media richness conditions, as the $a$-path of the mediation model was not supported in this case.

Results of the mediation analysis supported the unique mediating role of trust when examining the indirect effect of media richness on performance beliefs (for email versus collocated teams). Participants in the high media richness (collocated) condition reported higher performance beliefs than participants in the low media richness (email) condition $\beta = 0.44$, $95\%$ CI $= [0.14, 0.52]$. Inspection of the $95\%$ confidence intervals around the standardized slope coefficient suggested that the indirect population-level difference in performance beliefs between participants in the high media richness condition and participants in the low media richness condition could plausibly (though not necessarily) range from anywhere between 0.14 and 0.52 standard deviations. Population-level effect sizes outside this range are possible, but are relatively less plausible. The direct effect of media richness on performance beliefs did not remain statistically significant after accounting for trust; and, after accounting for trust, participants in the high media richness (collocated) condition did not report feeling significantly higher or lower performance beliefs than participants in the low media richness (email) condition. $\beta = 0.21$, $95\%$ CI $= [-0.01, 0.43]$. This pattern of results suggested full mediation, rather than partial mediation.

Conversely, the results of the mediation analysis did not support the mediating role of trust when examining the indirect effect of media richness on performance beliefs (for email
versus Skype\textsuperscript{tm} teams) $\beta = 0.28$, 95\% CI = [-0.16, 1.03]. Inspection of the 95\% confidence intervals around the standardized slope coefficient suggested that the *indirect* population-level difference in performance beliefs between participants in the medium media richness condition and participants in the low media richness condition could plausibly (though not necessarily) include a population-level effect of zero. Population-level effect sizes outside this range are possible, but are relatively less plausible.

Thus, when examining performance beliefs, Hypothesis 7b was partially supported with respect to the difference between both low and high media richness teams (although suggested full rather than partial mediation). Hypothesis 7b was not, however, supported with respect to the difference between low and medium media richness teams (which did not see a significant indirect effect); or the difference between medium and high media richness teams (which did not significantly differ in terms of the trust they engendered).

**The Indirect Effect of Media Richness on Process Performance via Trust**

As noted earlier, media richness was negatively related to trust in two of three instances, partially supporting the *a*-path of the proposed media richness-trust-process performance mediation model. This was the case when comparing teams in the low (email) versus medium (Skype\textsuperscript{tm}) media richness conditions ($t(103) = 2.71, d = 0.70$, 95\% CI = [0.21, 1.18], $\beta = 0.43$; and when comparing teams in the low (email) and high (collocated) media richness conditions $t(103) = 3.57, d = 0.89$, 95\% CI = [0.40, 1.38], $\beta = 0.55$. However, trust was not uniquely related to process performance ($t(101) = 1.00$, $sr^2 = .01$, 95\% CI = [-.02, .04], $\beta = 0.10$, failing to support the proposed *b*-path of the mediation model.
Consequently, the indirect effect of media richness on process performance via trust was not further investigated. Thus, when examining process performance, Hypothesis 7b was not supported.

The Indirect Effect of Media Richness on Task Performance via Trust

As noted earlier, media richness was negatively related to trust in two of three instances, partially supporting the $a$-path of the proposed media richness-trust-task performance mediation model. This was the case when comparing teams in the low (email) versus medium (Skype™) media richness conditions $t(103) = 2.71$, $d = 0.70$, 95% CI $= [0.21, 1.18]$, $\beta = 0.43$; and when comparing teams in the low (email) and high (collocated) media richness conditions $t(103) = 3.57$, $d = 0.89$, 95% CI $= [0.40, 1.38]$, $\beta = 0.55$. However, trust was not uniquely related to task performance $t(101) = -0.52$, $sr^2 = .00$, 95% CI $= [-.01, .02]$, $\beta = -0.05$, failing to support the proposed $b$-path of the mediation model.

Consequently, the indirect effect of media richness on task performance via trust was not further investigated. Thus, when examining task performance, Hypothesis 7b was not supported.

Summary

These findings partially supported the idea that trust can play a mediating role in the relation between media richness and performance; but only insofar as team members’ performance beliefs are concerned. In this case, trust was found to fully mediate the indirect effect of media richness on performance beliefs (for low versus high media richness teams, specifically). These findings did not, however, extend to the difference between low versus medium media richness teams, or the difference between medium versus high media richness teams. Moreover, trust was not found to play a mediating role in the relation between media
richness and either team process performance or team task performance. Thus, Hypothesis 7b was largely unsupported, except in terms of extreme differences in media richness; and even then, only for the performance beliefs dimension of team performance.

**Did Trust Mediate the Relation Between Uncertainty and Team Performance (Hypothesis 8)?**

**The Indirect Effect of Uncertainty on Performance Beliefs via Trust**

As noted earlier, uncertainty was negatively related to trust $t(189) = -3.37, p < .001$, $PRV = .007, \beta = -0.20$, supporting the $a$-path of the proposed uncertainty-trust-performance beliefs mediation model. Moreover, trust was uniquely and positively related to performance beliefs $t(188) = 13.94, p < .001$, $PRV = .23, \beta = 0.60$, supporting the proposed $b$-path of the mediation model.

Because both the $a$- and $b$-paths of the proposed mediation model were supported when using trust as a mediator variable, statistical mediation was subsequently examined by assessing the indirect effect of uncertainty on performance beliefs using bootstrapping with bias-corrected confidence intervals, following recommendations made by both Preacher and Hayes (2004) and Bauer, Preacher, and Gil (2006). To accommodate the nested structure of the data, an omnibus outcome variable was calculated by combining each unit’s (i.e., individual’s) outcome (i.e., performance beliefs) and mediator (i.e., trust) scores within their relevant grouping variable (i.e., team). Additional selection variables were included to allow each path to be modelled within a single equation (see Equation 8 for a breakdown of this logic, generally; and Equation 12 for its application to the current Hypothesis).

Results of the mediation analysis supported the unique mediating role of trust when examining the indirect effect of uncertainty on performance beliefs, such that uncertainty was
indirectly and negatively related to performance beliefs $\beta = -0.19$, 95% CI = [-0.24, -0.07]. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the *indirect* population-level effect of uncertainty on performance beliefs could plausibly (though not necessarily) range from anywhere between a standardized slope coefficient of -0.07 and -0.24. Population-level effect sizes outside this range are possible, but are relatively less plausible.

The direct effect of uncertainty on performance beliefs remained statistically significant after accounting for trust; and, after accounting for trust, uncertainty was still negatively related to performance beliefs $\beta = -0.24$, 95% CI = [-0.32, -0.15]. Inspection of the 95% confidence intervals around the standardized slope coefficient suggested that the *direct* population-level effect of uncertainty on performance beliefs could plausibly (though not necessarily) range from anywhere between a standardized slope coefficient of -0.15 and -0.32. Population-level effect sizes outside this range are possible, but are relatively less plausible. This pattern of results suggested partial mediation. Thus, when examining performance beliefs, Hypothesis 8 was fully supported.

**The Indirect Effect of Uncertainty on Process Performance via Trust**

As noted earlier, uncertainty was negatively related to trust $t(189) = -3.37$, $p < .001$, $PRV = .007$, $\beta = -0.20$, supporting the *a*-path of the proposed uncertainty-trust-process performance mediation model. However, trust was not uniquely related to process performance $(101) = 1.00$, $sr^2 = .01$, 95% CI = [-.02, .04], $\beta = 0.10$, failing to support the proposed *b*-path of the mediation model. Consequently, the indirect effect of uncertainty on process performance via trust was not
further investigated. Thus, when examining process performance, Hypothesis 8 was not supported.

**The Indirect Effect of Uncertainty on Task Performance via Trust**

As noted earlier, uncertainty was negatively related to trust $t(189) = -3.37, p < .001$, $PRV = .007, \beta = -0.20$, supporting the $a$-path of the proposed uncertainty-trust-task performance mediation model. However, trust was not uniquely related to task performance $t(101) = -0.52, sr^2 = .00, 95\% CI = [-.01, .02], \beta = -0.05$, failing to support the proposed $b$-path of the mediation model. Consequently, the indirect effect of uncertainty on task performance via trust was not further investigated. Thus, when examining task performance, Hypothesis 8 was not supported.

**Summary**

These findings partially supported the idea that trust can play a mediating role in the relation between uncertainty and performance; but only insofar as team members’ performance beliefs are concerned. In this case, trust was found to partially mediate the indirect effect of uncertainty on performance beliefs. These findings did not, however, extend to either the process performance or task performance dimensions of team performance. Thus, Hypothesis 8 was partially supported, specifically for the performance beliefs dimension of team performance.
DISCUSSION

Overview

The results of the present study support the idea that media richness may act as an antecedent of both uncertainty and trust in one’s team members. These variables may in turn play a mediating role in translating differences in media richness into various performance-related affects, behaviours, and outcomes. These effects were most pronounced when examining more extreme differences in media richness (e.g., email communication versus either Skype™ communication or collocated communication), rather than more subtle differences in media richness (e.g., Skype™ communication versus collocated communication). Moreover, media richness was found to directly predict all performance dimensions; however, both uncertainty and trust in one’s team members were more clearly related to performance when examining affective, proximal forms of performance (i.e., performance beliefs), rather than more distal, objective behaviours or outcomes (i.e., process performance or task performance). A summary of all supported hypotheses is presented in Figure 2.
Figure 2: Standardized path coefficients (i.e., $\beta$) and their associated 95% confidence intervals for proposed moderated mediation model.

Note. Numbers in parentheses represent 95 percent confidence intervals for each estimated path coefficient. * indicates $p < .05$. ** indicates $p < .01$.

**Felt Uncertainty: A Matter of Media Richness**

The media richness manipulation predicted participants' uncertainty, consistent with Hypothesis 1. Specifically, participants reported feeling greater uncertainty when completing the Non-Combatant Evacuation Operation simulation in the low media richness condition (i.e., email).
versus in the medium media richness condition (i.e., Skype™); as well in the low media richness condition (i.e., email) versus in the high media richness condition (i.e., collocated).

However, there was no statistically significant difference in participants’ uncertainty when they completed the Non-Combatant Evacuation Operation simulation in the medium media richness condition (i.e., Skype™) versus in the high media richness (collocated) condition.

One possible reason for this discrepancy is that, from a Media Richness Theory perspective, teams in the Skype™ media richness condition actually had more in common with collocated teams than they did with email teams. Specifically, Skype™ team members had access to five of the six characteristics of collocated communication; whereas email teams had none of these six characteristics available (see Table 1). Media Richness Theory posits that electronically-mediated communication environments begin to approximate collocated communication environments when the technology being used exhibits a greater number of the verbal and non-verbal characteristics that make a collocated communication environment unique (though the relative importance of any single cue is difficult to disentangle; see Clark & Brennan, 1991). These cues assist individuals in interpreting the behaviour of their communication partners (e.g., Nohria & Eccles, 1992; Grundy, 1998). Consequently, the uncertainty engendered by the media richness manipulation likely varied based on the relative number of communication cues available; rather than varying based on the mere distinction of communicating in a virtual versus a collocated environment.
Trust in Team Members: Media Richness, Uncertainty, and Propensity to Trust

Media Richness and Trust

A similar pattern of results emerged when examining the relation between the media richness manipulation and participants’ self-reported trust in their teammates, consistent with Hypothesis 2. Participants reported greater trust in their teammates when completing the Non-Combatant Evacuation Operation simulation in the medium media richness condition (i.e., Skype™) versus in the low media richness condition (i.e., email); as well in in the high media richness condition (i.e., collocated) versus in the low media richness condition (i.e., email). However, as with uncertainty, there was no statistically significant difference in team members’ self-reported trust in their teammates when they completed the Non-Combatant Evacuation Operation simulation in the medium media richness condition (i.e., Skype™) versus in the high media richness (collocated) condition.

As with uncertainty, trust decisions are often made using a combination of verbal and non-verbal cues (Weiss & Cropanzano, 1996; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Holtz, 2014). For example, benevolence may be inferred through a Duchene smile or through other non-verbal facial indicators that suggest kindness or good intentions (Krumhuber, Manstead, Cosker, Marshall, Rosin, & Kappas, 2007; Holtz, 2014; Stouten & De Cremer, 2010). As these non-verbal cues are less readily-available in lean media environments like email, it follows that participants’ trust would be affected specifically when comparing lean media communication environments that lack these non-verbal cues (such as email communication) to richer media environments that do have non-verbal cues available despite being virtual (such as Skype™).
Uncertainty and Trust

Participants’ self-reported uncertainty was negatively related to participants’ self-reported trust in their teammates, consistent with Hypothesis 3a. Moreover, the effect of the media richness manipulation on trust attenuated in the presence of uncertainty, suggesting a mediated or indirect effect of media richness on trust via uncertainty (consistent with Hypothesis 3b). These indirect effects were supported specifically when considering the difference in trust between participants in the low (i.e., email) versus medium (i.e., Skype™) media richness conditions; as well as the difference in trust between the low (i.e., email) and high (i.e., collocated) media richness conditions. An indirect effect of media richness on trust via uncertainty was not supported when considering the difference in trust between the medium (i.e., Skype™) and high (i.e., collocated) media richness conditions, due to a lack of support for either the a-path (i.e., media richness to uncertainty) or the c-path (i.e., media richness to trust) of the proposed mediation model.

These findings point towards two major conclusions. First, these findings support the idea that trust decisions are – at their core – risk-taking behaviours in which trustors attempt to minimize the likelihood of potential loss by withholding trust when uncertainty is high (see Das & Teng, 2004). Although no decision to accept vulnerability can be made in complete certainty (barring some form of omniscience), trustors are likely to feel more comfortable accepting vulnerability when they have sufficient information to make a well-reasoned guess concerning a trustee’s likely behaviour (Jarvenpaa & Leidner, 1999; Ben-Ner, & Putterman, 2006; Loomis, 1959; Peters, Covello, & McCallum, 1997). Consequently, trusting decisions are more likely to occur when the relative uncertainty trustors feel is lower (Das & Teng, 2004).
Second, these findings also suggest that the negative effects of virtual communication on team trust may be at least partly due to the relative uncertainty fostered by lean media. In the present study, participants’ self-reported uncertainty was found to partially mediate the relation between the media richness manipulation and trust when comparing lean media teams to rich media teams (i.e., email teams versus Skype™ teams); and to fully mediate the relation between media richness manipulation and trust when comparing lean media teams to collocated teams (i.e., email teams versus collocated teams). Richer forms of media afford team members a greater number of verbal and non-verbal cues during conversations (Clark & Brennan, 1991); and these cues help team members interpret one another’s intentions and behaviours (Berger & Calabrese, 1975; Nohria & Eccles, 1992; Grundy, 1998), allowing more informed trust decisions to be made (Weiss & Cropanzano, 1996; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Holtz, 2014). Consequently, understanding the relation between media richness and trust may effectively hinge on understanding the role that uncertainty plays in informing trust decisions, consistent with an Uncertainty Reduction Theory perspective.

Propensity to Trust and Trust

Participants’ self-reported propensity to trust others was not found to attenuate the negative relation between participants’ uncertainty and participants’ trust (failing to support Hypothesis 4). That said, propensity to trust was found to uniquely predict trust beyond the variance accounted for by either the media richness manipulation or uncertainty. This relation was positive, suggesting that participants were more likely to trust one another when they had a higher propensity to trust others in general (regardless of the uncertainty they felt during their time working together; or the richness of the media they used to communicate).
Propensity to trust represents a narrow personality facet that affords individuals a basis to trust others that is not contingent on a trustee’s characteristics or the context of the trust decision (Rosenberg, 1956; Stack, 1978; Rotter, 1971, 1980; Mayer, Davis, & Schoorman, 1995; Kramer, 1999). Conversely, trust decisions based on assessments of a trustee’s trustworthiness are, by definition, contextually-specific and tailored to a given trustee and situation (Gabarro, 1978; Mayer, Davis, & Schoorman, 1995; Flores & Solomon, 1998; Rousseau, Sitkin, Burt, & Camerer, 1998). Stated another way, propensity to trust affords trustors a basis for making trait-based trust decisions; whereas trustworthiness assessments afford trustors a basis for making state-based trust decisions (Mooradian, Renzl, & Matzler, 2006). Therefore, it should come as little surprise that propensity to trust uniquely predicted participants’ trust in their teammates beyond the variance accounted for by participants’ uncertainty and placement in the media richness manipulation (both of which represent contextual factors in participants’ trust decisions, and are likely part of a state- rather than trait-based avenue for making trust decisions).

The lack of evidence for moderation is more surprising, and may represent a statistical artifact rather than a theoretically-grounded nil relation. The failure to support Hypothesis 4 may be due to the study’s relatively low power to detect a moderation effect, even if one were to exist at the population level. Although moderated multiple regression analyses are a fairly common practice in psychological research, they are often underpowered. Consequently, researchers often face high Type-II error rates when testing for hypothesized interaction effects (see Aguinis, Boik, & Pierce, 2001; Aguinis, Culpepper, & Pierce, 2010). Some estimates go so far as to suggest that detecting an interaction effect requires 16 times the sample size required to detect a corresponding main effect (Gelman, 2018). As a result, the predicted interaction effect may have found no support due to a lack of statistical power to detect the proposed relation.
Team Performance (Performance Beliefs): Media Richness, Uncertainty, and Trust

Media Richness and Performance Beliefs

The media richness manipulation predicted participants’ self-reported performance beliefs, consistent with Hypothesis 5. Specifically, participants reported higher performance beliefs when completing the Non-Combatant Evacuation Operation simulation in the medium media richness condition (i.e., Skype™) versus in the low media richness condition (i.e., email); as well in in the high media richness condition (i.e., collocated) versus in the low media richness condition (i.e., email). However, as with uncertainty and trust, there was no statistically significant difference in participants’ self-reported performance beliefs when they completed the Non-Combatant Evacuation Operation simulation in the medium media richness condition (i.e., Skype™) versus in the high media richness (i.e., collocated) condition.

As with the other self-reported outcomes in the study, the media richness manipulation predicted differences in team members’ performance beliefs specifically when comparing conditions with more extreme differences in media richness. Participants who completed the Non-Combatant Evacuation Operation simulation virtually using a rich form of media (i.e., Skype™) reported performance beliefs that were more similar to collocated participants than they were to those of participants in virtual teams using a lean form of media (i.e., email). The study’s measure for performance beliefs asked participant to rate the extent to which they felt that their team had engaged in effective performance behaviours (for example, developing an overall strategy and contingency plans, monitoring the team’s workflow, and encouraging one another to perform as best they could). By virtue of having access to a greater number of visual, auditory, and other communication cues, participants completing the Non-Combatant Evacuation Operation simulation under higher media richness conditions may have been in a position where
they were better able to observe their teammates’ behaviours (Wigand, Picot & Reichwald, 1997; Swagerman, Dogger & Maatman, 2000); and to interpret those behaviours with sufficient contextual grounding (Clark & Brennan, 1991; Lea & Spears, 1992; Forster, Friedman, & Liberman, 2004; Whitford & Moss, 2009). Conversely, teams operating in a more lean media condition would not have had such grounding, and would be more likely to interpret their teammates’ behaviours at a more shallow level (Lea & Spears, 1992; Forster, Friedman, & Liberman, 2004; Whitford & Moss, 2009).

If this is the case, then these findings further support the idea that virtualization should be understood as a continuum based on Media Richness Theory, rather than a dichotomous split that distinguishes “virtual” teams from collocated teams (see Watson-Manheim, Chudoba, & Crowston, 2002; Clark & Brennan, 1991). Dichotomizing virtuality rather than approaching it as a continuum may dilute important nuances in the exact nature of how teams communicate with one another across different computer-mediated settings; and lead to inconsistent findings when considering the varied outcomes that these different communication methods produce.

Uncertainty and Performance Beliefs

Participants’ self-reported uncertainty was negatively related to participants’ self-reported performance beliefs, consistent with Hypothesis 6a. Moreover, the effect of the media richness manipulation on participants’ performance beliefs attenuated in the presence of participants’ uncertainty, supporting the notion of an indirect effect of media richness on performance beliefs via uncertainty (consistent with Hypothesis 6b). These indirect effects were supported specifically when considering the difference in performance beliefs between participants in the low (i.e., email) versus medium (i.e., Skype™) media richness conditions; as well as the
difference in performance beliefs between the low (i.e., email) and high (i.e., collocated) media richness conditions. An indirect effect of media richness on performance beliefs via uncertainty was not supported when considering the difference in performance beliefs between the medium (i.e., Skype™) and high (i.e., collocated) media richness conditions, due to a lack of support for either the $a$-path (i.e., media richness to uncertainty) or the $c$-path (i.e., media richness to performance beliefs) of the proposed mediation model.

These findings support the idea that lean media is detrimental to performance beliefs at least partly because the lack of verbal and non-verbal cues that lean media environments foster increase the relative uncertainty between team members (Clark & Brennan, 1991); and thus increase the relative difficulty involved in interpreting the behaviour of those team members (Berger & Calabrese, 1975; Nohria & Eccles, 1992; Grundy, 1998). The members of lean media teams may have been less confident that they were engaging in effective performance behaviours due to the relative uncertainty they felt during the task. This idea is consistent with previous work that links increases in team ambiguity with decreases in outcomes such as team confidence and efficacy (e.g., Hu & Liden, 2011; Eys & Carron, 2001).

**Trust and Performance Beliefs**

Participants’ self-reported trust was positively related to participants’ self-reported performance beliefs, consistent with Hypothesis 7a. Moreover, the effect of the media richness manipulation on participants’ performance beliefs also attenuated in the presence of participants’ self-reported trust, supporting the notion of an indirect effect of media richness on performance beliefs via uncertainty (consistent with Hypothesis 7b). The negative relation between participants’ self-reported uncertainty and participants’ self-reported performance beliefs also
attenuated in the presence of participants’ self-reported trust, supporting the notion of an indirect relation between uncertainty and performance beliefs via trust (consistent with Hypothesis 8). However, it is worth noting that the former indirect effect was supported only when considering the difference in performance beliefs between participants between the low (i.e., email) and high (i.e., collocated) media richness conditions. An indirect effect of media richness on performance beliefs via trust was not supported when considering the difference in performance beliefs between the medium (i.e., Skype™) and high (i.e., collocated) media richness conditions, due to a lack of support for either the $a$-path (i.e., media richness to trust) or the $c$-path (i.e., media richness to performance beliefs) of the proposed mediation model. An indirect effect of media richness on performance beliefs via trust was also not supported when considering the difference in performance beliefs between the medium (i.e., Skype™) and low (i.e., email) media richness conditions, despite support for both the $a$-path (i.e., media richness to trust) and the $c$-path (i.e., media richness to performance beliefs) of the proposed mediation model.

In the present study, trust positively predicted performance beliefs, consistent with previous work that has linked trust to team performance (e.g., Brahm & Kunze, 2012; Salamon & Robinson, 2008; Costa, 2003). The results of the mediation analyses supported the idea that trust may also play a role in explaining why virtual teams tend to underperform collocated teams (e.g., McLeod, 1992; Armstrong & Cole, 2002; Cramton & Orvis, 2003; Suh, 1999) – at least, when sizable differences in media richness are taken into account. Interestingly, this latter finding did not extend to situations involving more subtle differences in media richness (either email versus Skype™ teams, or Skype™ teams versus collocated teams). This may be due to the fact that – from a Media Richness Theory perspective – Skype™ teams have more in common with collocated teams than they do with lean media teams such as those that rely on email. If
trust explains the covariance between media richness and performance beliefs specifically because media richness deprives team members of the verbal and non-verbal cues necessary to make informed trust decision (Weiss & Cropanzano, 1996; Wicks, Berman, & Jones, 1999; Ekman & Friesen, 1974; Holtz, 2014), then trust might only act as a mediator of the relation between media richness and performance beliefs when considering the difference between extremely lean communication environments that offer a dearth of communication cues (allowing little basis for trust decisions), versus extremely rich communication environments that offer an abundance of these cues (affording most if not all of the contextual information necessary for informed trust decisions).

**Team Performance (Process Performance): Media Richness, Uncertainty, and Trust**

**Media Richness and Process Performance**

A similar pattern of results emerged when examining team’s expert-rated process performance behaviours. Teams’ process performance ratings were positively related to the media richness condition, consistent with Hypothesis 5. Specifically, teams engaged in more effective process performance when completing the Non-Combatant Evacuation Operation in the medium media richness condition (i.e., Skype™) versus in the low media richness condition (i.e., email); as well in in the high media richness condition (i.e., collocated) versus in the low media richness condition (i.e., email). However, as with uncertainty and trust, there was no statistically significant difference in teams’ process performance when they completed the Non-Combatant Evacuation Operation in the medium media richness condition (i.e., Skype™) versus in the high media richness (i.e., collocated) condition.
Uncertainty and Process Performance

Unlike with performance beliefs, teams’ mean self-reported uncertainty was not found to predict teams’ process performance behaviours (contrary to Hypothesis 6a). Because the $b$-path of the proposed ‘media richness-uncertainty-process performance’ mediation model was not supported, the indirect effect of the media richness manipulation on team process via uncertainty was, by extension, also not supported (contrary to Hypothesis 6b).

There are at least two theoretical reasons that may explain why uncertainty failed to predict process performance, despite predicting performance beliefs. First, previous research suggests that performance beliefs often act as a proximal measure of later team performance (e.g., Gully, Incalcaterra, Joshi, & Beaubien, 2002). If this is the case, then it is possible that the constraints of the short-term Non-Combatant Evacuation Operation did not give teams the time they needed to translate their early performance beliefs into later performance behaviours. That said, the media richness did have a direct effect on teams’ process performance, suggesting that teams in higher media richness conditions did have the opportunity to develop more effective performance behaviours (even if uncertainty was not a mediator of this relation).

A second potential explanation surrounds the design of the experimental task. The Non-Combatant Evacuation Operation was chosen partly because the specific competencies required for success were assumed to be unknown and unfamiliar to all participants. This prevented teams from beginning the simulation with any clarity. This is a strength of the research design, in that it ensured all teams began the simulation on equal footing. However, because the task requirements were unfamiliar, teams who engaged in higher “process performance” may have simply been teams who understood some of the general communications behaviours that effective teams engage in (e.g., organizational ability, coordination, ability to set goals, etc.); rather than teams
who understood more about the Non-Combatant Evacuation Operation specifically. If this was the case, then it would be less important for teams to resolve their uncertainty surrounding the Non-Combatant Evacuation Operation simulation itself. Rather, teams could simply fall back on their schemas of what makes an effective team in general, and then engage in behaviours consistent with that schema. This explanation is consistent with the study’s measure of process performance, which involved rating participant teams on a taxonomy of general process performance behaviours (rather than simulation-specific behaviours).

There are also at least two methodological reasons that could explain why self-reported uncertainty failed to predict process performance. First, it is possible that the supported link between participants’ self-reported uncertainty and participants’ self-reported performance beliefs may have been inflated by common method bias; as both measures were collected at the same time using self-reported Likert-type response scales. That said, methodologists argue that common method bias – though a cause for concern – is usually not so large as to call into question the results of empirical studies that use common methods (see Doty & Glick, 1998). Consequently, this explanation may be insufficient. A second, perhaps more compelling explanation is a lack of statistical power to detect a population-level relation. Because process performance was collected at the team- rather than the individual-level, all analyses testing this outcome were conducted using aggregated team-level data. Conversely, analyses pertaining to participants’ self-reported performance beliefs were conducted using multilevel modelling. The lack of support for the former relation may be at least partly due to a loss in degrees of freedom following data aggregation.
Trust and Process Performance

As with uncertainty, teams’ mean self-reported trust was not found to predict teams’ process performance (contrary to Hypothesis 7a). Because the $b$-path of the proposed ‘media richness-trust-process performance’ mediation model was not supported, the indirect effect of the media richness manipulation on team process via trust was also not supported (contrary to Hypothesis 7b). Similarly, because both the $b$-path and the $c$-path of the proposed ‘uncertainty-trust-process performance’ mediation model were not supported, the indirect relation between uncertainty and team process via trust was also not supported (contrary to Hypothesis 8).

These findings mirror the results surrounding uncertainty and process performance, and many of the same explanations can be posited. First, it is possible that team members did not have sufficient time to develop trust, precluding the examination of meaningful differences in trust altogether. This is unlikely, however, as trust was predicted by both the media richness manipulation and uncertainty, suggesting that it was a viable outcome within the constraints of the experimental task. Second – and perhaps more compellingly – it is also possible that trust failed to predict teams’ process performance due to the task-focussed nature of the Non-Combatant Evacuation Operation. Participant teams were formed on a temporary basis, and completed a single, temporary task together. Successful completion of this task necessitated information sharing and coordination. However, given its task-focussed nature, it is possible that participant teams focussed their limited time engaging in the task-focussed performance behaviours that were immediately necessary for the task; rather than using that time to engage in relational behaviours that may have been more important if repeated team interactions were expected (and which trust would have been more likely to predict).
In terms of methodology, it is also possible that teams’ mean self-reported trust failed to predict teams’ process performance either due to common method bias (which may have inflated estimates of the relation between trust and self-reported performance beliefs); or due to decreased statistical power due to data aggregation.

**Team Performance (Task Performance): Media Richness, Uncertainty, and Trust**

**Media Richness and Task Performance**

A slightly different pattern of results emerged when examining team’s objectively-rated task performance (i.e., their final score on the Non-Combatant Evacuation Operation). As with performance beliefs and process performance, the media richness condition predicted teams’ task performance (consistent with Hypothesis 5). Specifically, teams engaged in higher task performance when completing the Non-Combatant Evacuation Operation in the medium media richness condition (i.e., Skype™) versus in the low media richness condition (i.e., email); as well as in the high media richness condition (i.e., collocated) versus in the low media richness condition (i.e., email). However, unlike with performance beliefs and process performance, teams also engaged in higher task performance when completing the Non-Combatant Evacuation Operation in the high media richness condition (i.e., collocated) versus in the medium media richness condition (i.e., Skype™).

Objectively-rated task performance is the only outcome where teams in the medium media richness (i.e., Skype™) significantly differed from teams in the high media richness (i.e., collocated) condition. Although this is partly attributable to the predictors in the model, it is possible that the constraints of the Non-Combatant Evacuation Operation also made performance more difficult for more lean media teams due to technological barriers (which would be
unrelated to team members’ uncertainty or trust in one another). One reason for examining performance in terms of its related affects, behaviors, and outcomes, is that teams are often only partially in control of the actual outcomes of their performance (Campbell, McCloy, Oppler, & Sager, 1993). It is possible that the outcome of the Non-Combatant Evacuation Operation was, to some extent, independently predicted through some alternative causal pathway than the one posited in the study’s theoretical model.

**Uncertainty and Task Performance**

Teams’ mean self-reported uncertainty was negatively related to teams’ objectively-related task performance, consistent with Hypothesis 6a. However, the effect of the media richness manipulation on teams’ task performance failed to attenuate in the presence of team’s mean uncertainty, failing to support the notion of an indirect effect of media richness on task performance via uncertainty (contrary to Hypothesis 6b).

These findings support the idea that uncertainty may negatively and uniquely predict the extent to which a team can effectively complete its task. However, these findings do not support the idea that uncertainty explains why lean media hampers team task performance per se. It is possible that uncertainty in the Non-Combatant Evacuation Operation came from the nature of the scenario itself, rather than being embedded in the richness of the media. As mentioned, the Non-Combatant Evacuation Operation was likely quite foreign to participants. Consequently, completing this task may have created a base level of uncertainty that was unrelated to the way in which teams were communicating. Teams that managed to resolve this uncertainty would be likely to perform more effectively (regardless of their means of communication).
It is also worth noting that the media richness manipulation was negatively related to uncertainty. This supports the notion that there may have been two distinct causes of uncertainty: uncertainty surrounding the team (related to media richness), and uncertainty pertaining to the task itself (related to the Non-Combatant Evacuation Operation). Although media richness would have predicted the former, the latter may represent uncertainty that hampered performance, as getting to know one’s team members was not entirely necessary for successful completion of the task. This idea is consistent with research that differentiates clarity pertaining to the goals and requirements for a given task (i.e., goal clarity), versus clarity pertaining to the roles and structure of the team completing that task (i.e., process clarity; see Sawyer, 1992).

Methodologically, it is also possible that the lack of support for the proposed indirect relation may simply be due to lower power to detect a population level effect, which would have been exacerbated by the fact that task performance was a team-level outcome (necessitating data aggregation).

**Trust and Task Performance**

Teams’ mean self-reported trust was not found to predict teams’ objectively-rated task performance (contrary to Hypothesis 7a). Because the $b$-path of the proposed ‘media richness-trust-task performance’ mediation model was not supported, the indirect effect of the media richness manipulation on task performance via trust was also not supported (contrary to Hypothesis 7b). Similarly, because the $b$-path of the proposed ‘uncertainty-trust-task performance’ mediation model was not supported, the indirect relation between uncertainty and task performance via trust was also not supported (contrary to Hypothesis 8).
These findings further build on the idea that there may have been two different forms of uncertainty that emerged: one pertaining to the task itself; and one pertaining to the team. Uncertainty was negatively related to both trust in team members and task performance. However, trust was also unrelated to task performance, and failed to explain the relation between uncertainty and task performance. It is possible that teams’ mean trust in one another was negatively related to uncertainty when that uncertainty pertained specifically to one’s team members (i.e., process ambiguity; Sawyer, 1992); whereas teams’ mean trust in one another may have been unrelated to uncertainty when that uncertainty pertained specifically to the goals of the Non-Combatant Evacuation Operation itself (i.e., goal ambiguity; Sawyer, 1992). Logically, process ambiguity (which pertains to team members) is more likely to be influenced by the communications media being used by a team; and is less likely to predict actual team performance. Conversely, goal ambiguity (which pertains to the means and ends of a task) is less likely to be influenced by communications media; but is more likely to be related to task performance. Both of these patterns are consistent with the study’s observed results. Consequently, examining uncertainty in terms of goal- versus process ambiguity (rather than as a single overarching construct) may offer some valuable insight to understanding the role that uncertainty actually played in the present study.

It is also possible that trust failed to predict teams’ task performance because trust may have not been required to successfully complete the Non-Combatant Evacuation Operation. Because the task was temporary and largely task-focussed, relational behaviours may have been less important for success than they would have been if the team needed to work together over a longer duration. Although some team members did develop trust in one another, this trust may have been ultimately tangential to the team’s success, given the time constraints and nature of the
simulation. Consequently, examining other, more task-oriented mediators such as emergent leadership behaviours (e.g., Glückler, & Schrott, 2007; Yoo & Alavi, 2004; Misiolek & Heckman, 2005) or team goal setting (e.g., Hertel, Konradt, & Orlikowski, 2004) may offer some insight into why more media rich teams outperformed more media lean teams in the present study.

**Limitations and Future Directions**

**The Use of a Laboratory-Based Research Design**

As with many experimental studies, some questions may be raised concerning the Non-Combatant Evacuation Operation’s generalizability to applied settings. Experimental research designs have a long history of being criticized for lacking “real world” validity (for historical criticisms on this topic, see Allport, 1968; Harré & Secord, 1972; Strickland, Aboud, & Gergen, 1976; Gilmour & Duck, 1980). However, experimental researchers and methodologists generally agree that “the primary goal of most laboratory research is the development of theories designed to explain underlying processes and mechanisms” (Anderson & Bushman, 1997, pp. 22). It is these theoretical principles – not the specifics of the study’s sample, manipulation, scenario, or measures – that are meant to generalize across settings (for seminal discussion, see Kruglanski, 1975; Henshel, 1980; Berkowitz & Donnerstein, 1982; Mook, 1983; Banaji & Crowder, 1989). Because the aim of the present study was to investigate a theoretical explanatory mechanism for the relation between media richness and trust, an experimental design that assessed this process under controlled settings was an appropriate design choice.

Although experimental studies are designed with the intention of uncovering generalizable theories and processes – not generalizable situations – it is also worth noting that a
seminal meta-analysis of over 200 experimental and 300 field studies within industrial and organizational psychology suggests that the results of experimental studies are often consistent with the results of field studies on the same outcomes (Dipboye & Flanagan, 1979). Moreover, when designing the study, the Non-Combatant Evacuation Operation was selected in order to develop a research design that capitalized on the strengths of experimental research (e.g., causal inference, control of extraneous variables), while also maintaining some degree of organizational-relevance. Specifically, the Non-Combatant Evacuation Operation was characterized by being fast-paced, ambiguous, and highly interdependent; mimicking the defining aspects of actual jobs in which high levels of team coordination and decision-making are important for success (e.g., Mathieu, Heffner, Goodwin, Cannon-Bowers & Salas, 2000). Moreover, the Non-Combatant Evacuation Operation materials were designed using input from subject matter experts based on real-world military rescue operations. Similarly, the scoring system was designed by a team of three subject matter experts from the United States Office of Naval Research, each of whom conducted similar operations in the field (Biron, Burkman, & Warner, 2008). Consequently, the Non-Combatant Evacuation Operation simulation and its task performance measure may be argued to represent a more externally-valid work simulation experiment than many of the other experimental work simulations used in research (as these may lack a sufficient degree of input from related field operations).

The Use of Undergraduate Student Participants

The present study employed a student sample in which participants were only recruited for a single session. One might raise concerns that the study’s student sample would be unlikely to approach the simulation in the same manner as an organizational or military sample. That said,
previous work with the Non-Combatant Evacuation Operation supports the idea that the simulation can be effectively completed across both military and civilian samples; and the simulation has been previously completed by university student samples (McComb, Kennedy, Perryman, Warner, & Letsky, 2010).

Consequently, it is not out of the question to employ a student sample for this kind of task. Indeed, doing so may have been a strength of the research design. The expertise that team members had on the Non-Combatant Evacuation Operation was likely (if not entirely) explained by the standardized training that each participant received. This may have helped isolate and establish the process or processes through which media richness led teams to develop on a novel task. Future work could help test the applicability of this theorized process to organizational settings or other more experienced samples, to help test the applicability of the general underlying principles when experience is considered as a moderator.

The Use of Temporary, Swift Starting Action Teams

A related concern is that the short-term teams used in the present study may be unlikely to mimic the dynamics of teams in more applied settings (where team formations are likely to be more stable and long-lived). Although this is true, an increasing number of organizations do employ temporary project teams in which team members work together temporarily on specific, finite projects (e.g., Ginnett, 1990; Eisenhardt & Tabrizi, 1995; Whittington, Pettigrew, Peck, Fenton, & Conyon, 1999; Bryde, 2005; Sorenson & Waguespack, 2006; Bouncken, 2011; Bakker, Boroș, Kenis, & Oerlemans, 2013). To date, little research has focused on team dynamics specifically within these “swift starting action teams” (e.g., Sydow, Lindkvist, & DeFillippi, 2004; Jones & Lichtenstein, 2008; Bakker, 2010). Therefore, examining temporary
project teams may help address a current gap surrounding a growing but understudied organizational phenomenon.

Moreover, the current literature on temporary project teams suggests that swift starting action teams and other temporary project teams may be a good starting point for isolating and studying the development of team processes and performance within longer-term teams (Zika-Viktorsson, Hovmark, & Nordqvist, 2003). This is because short-term teams are often faced with ambiguous and unpredictable situations, and require a significant amount of within-project planning and intense social interaction (Barrett & Sexton, 2006). Following this idea, these teams may offer a more accelerated microcosm of that same team dynamics that – in other, more stable team environments – may emerge more slowly and subtly.

The Use of a Single Experimental Session

Trust is theorized to develop over time, as team members gain more information one another’s ability, benevolence, and integrity (i.e., the theoretical bases for assessing someone’s trustworthiness; see Mayer, Davis, & Schoorman, 1995). However, in the present study, teams were formed on a temporary basis, and only engaged in a short-term task together. Their short time together may have precluded team members from developing trust in a traditional sense of the word. Consequently, it is possible that lean media teams (e.g., email teams) would report higher levels of trust that are more in line with that of rich media teams (e.g., Skype™ teams) or collocated teams if they were examined across a longer series of team sessions; as the relative gaps in certainty engendered by an initial lack of communication cues would be filled through interaction. Conversely, it is also possible that lean media simply lacks the contextual cues to foster the development of sufficient knowledge about one’s team members at all (Handy, 1995;
Jarvenpaa & Leidner, 1999; Henttonen & Blomqvist, 2005); in which case trust in lean media teams would be unlikely to approximate that of rich media trust over time. Unfortunately, these competing hypotheses cannot be tested in the span of a relatively brief experimental simulation. Therefore, one future direction for research would be to examine the development of trust in various technologically-mediated teams over a longer span of time (likely encompassing multiple interactions).

**The Use of Limited Combinations of Media Richness Cues**

The present study supports the idea that virtualization is a continuum that is best operationalized using the number of communication cues that are present versus absent (consistent with Media Richness Theory; see Clark & Brennan, 1991). That said, the present study only examined three potential combinations of these communications cues. In doing so, the study does offer some insight into the uncertainty, trust, and performance implications of three common methods of organizational communication; however, more work could be done to examine how specific communications cues encourage versus inhibit team uncertainty, trust, and performance.

One direction for future research would be to replicate the present study’s findings using a wider variety of communications media that encapsulate a broader range of communication cue combinations. In doing so, future work may be able to offer insight into the relative importance of individual communication cues such as simultaneity, sequentiality, and audibility. That said, the communication cues subsumed under Media Richness Theory are unlikely to be entirely independent of one another on either a theoretical or a practical level (Clark & Brennan, 1991). For example, being able to hear one’s partner (audibility) should necessitate the ability to receive
messages as soon as they’re sent (cotemporality). Similarly, seeing one’s partner (visibility) should necessitate the ability to send feedback while simultaneously receiving messages (simultaneity). Consequently, it may not be possible to effectively create and test communications media with every potential combination of cues. Following this idea, a more realistic future direction would be to replicate the present study’s findings using other commonly-used communications media that have been characterized along the six dimensions of media richness.

**Implications for Research**

**Towards an Understanding of How Trust Operates in Virtual Teams**

One of the major barriers facing virtual trust researchers to date has been the lack of a unifying framework for understanding the process or processes through which trust between team members develops in virtual settings. To date, much of the literature has centred on the idea of “swift trust”, which suggests that trust in temporary or virtual teams is a matter of cognitive heuristics rather than informed decision-making (Meyerson, Weick, & Kramer, 1996). This (admittedly-fragile) trust is subsequently bolstered or disintegrated by regular checking-in and monitoring (Meyerson, Weick, & Kramer, 1996; Iacono & Weisband, 1997; Rousseau, Sitkin, Burt, & Camerer, 1998). Through this process, teams may be able to make trusting decisions without needing to undergo the traditional investigative work required to assess a potential trustee’s trustworthiness (which may require time that is unavailable to swift-starting action teams, or communication information that is unavailable to virtual teams).

Although previous work has applied swift trust to virtual work teams (e.g., Crisp & Jarvenpaa, 2013; Jarvenpaa & Leidner, 1999; Henttonen & Blomqvist, 2005; Iacono &
Weisband, 1997; Wilson, Straus & McEvily, 2006), the present study supports the idea that there is more driving virtual trust decisions than a trustor’s cognitive heuristics and regular monitoring. Although participants’ propensity to trust others did predict the trust they felt for their team members (consistent with the idea of swift trust), trust was also predicted by the extent to which team members managed to resolve their uncertainty about the task and their team members. Lean media teams struggled to develop trust at least partly due to the fact that these teams lacked the media richness cues necessary to resolve their uncertainty as effectively; this uncertainty subsequently resulted in lower trust between team members.

These findings are more in line with traditional, calculative views of trust that position trustors as risk assessors. This logic assumes that trustors essentially make decisions based on their interpretation of available trustworthiness cues and the ambiguity of the trust scenario (e.g., Deutsh, 1960; Kee & Knox, 1970; Sitkin & Roth, 1993; Das & Teng, 2004). Under this framework, trust and perceived risk may be better regarded as calculative probabilities of: 1) a desirable outcome occurring (trust); versus, 2) an undesirable outcome occurring (risk; Fischhoff, 1985; Luhmann, 1993). A trustor will theoretically attempt to maximize the chances of a desirable result occurring, while minimizing the chances of an undesirable result occurring. To do this, they should try to reduce their uncertainty as much as possible before choosing to accept some degree of informed risk and – consequently – choosing to trust.

If virtual trust is a matter of resolving uncertainty, then relying on broad heuristic decisions like “swift trust” may not be enough to develop a substantive theory of virtual team trust. Rather, researchers would be well-advised to explore the specific challenges that virtual team members face in terms of role and task ambiguity, norms and expectations, and scaffolding opportunities; and then develop a more qualified view of virtual trust that incorporates these
sources of potential disinformation into understanding what social information lessens uncertainty and perceived risk. Doing so may help to foster trust in settings like virtual teams, where this social information is less readily available to those who would benefit from it.

**Towards an Understanding of the Nuances of Virtual Communication**

The results of the present study also stress the importance of approaching virtual teams from a Media Richness Theory perspective; and in doing so, highlight the need for a more nuanced approach to understanding the structure of virtual work teams. Uncertainty, trust, and performance beliefs differed to a statistically significant degree when comparing collocated teams to virtual teams; but only when those virtual teams relied on lean media (e.g., email). Virtual teams that had access to more rich forms of media (e.g., Skype™) reported outcomes that were more in line with those of a collocated team rather than a lean media virtual team. This is not to say that virtual teams perfectly mimicked collocated teams when they used rich media; actual task performance in the present study still differed between Skype™ and collocated teams. However, operationalizing virtuality as a binary may fail to account for important nuances in the varied ways in which virtual teams communicate. Future researchers would be well-advised to consider operationalizing virtuality continuously (rather than categorically), using the degree of removal from collocated communication.

Moving forward, this idea could be expanded on in at least two important ways. First, future work should explore other forms of media that vary in their media richness (as the present study relied on comparing extremely lean versus extremely rich media). Second, as many virtual teams are only virtual part of the time, or on an “as needed basis”, future work should also consider the degree of virtual teams’ removal from collocated communication longitudinally.
This could be accomplished by operationalizing virtual teams in terms of how much time the team spends interacting virtually versus in a collocated setting.

**Implications for Management**

**The Current State of Virtual Team Practice**

In the late 1990s, virtual work teams were rated as one of the top five emerging trends in industry (Bassie, Cheney, & Van Buren, 1997); and this trend does not appear to have changed over the course of the new millennium to date. Currently, 64 percent of US Millennials (Deloitte, 2017) – and 43 percent of the US workforce generally (Gallup, 2017) – report working virtually at least part of the time. Virtual work structures afford many benefits to organizations, such as reduced housing costs for employees (Apgar, 1998; Dannhauser, 1999), a reduced carbon footprint (Banister, Newson, & Ledbury, 2007; Gressgard, 2010), and the ability to attract and retain diverse talent without limiting one’s hiring pool (Hertel, Geister, & Konradt, 2005; Gressgard, 2010). However, both theoretical review of the literature (Hollingshead & McGrath, 1995), and meta-analytic evidence (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002) suggest that virtual teams also face sizable coordination and performance challenges. As a result, many corporations have adopted an increasingly-lukewarm stance towards virtual work teams. Perhaps most strikingly, several large-scale technology organizations that were strong proponents of the initial move towards virtual work have abandoned their virtual work policies in recent years; including Altaba, Inc. (formerly Yahoo!, Inc.) in 2013 (Goudreau, 2013); and IBM, Inc. in 2017 (Sen, 2017).
Improving Virtual Team Knowledge, Trust, and Performance in Practice

Overview. Previous research already suggests that virtual teams face unique challenges in terms of trust, team process, and team performance relative to their collocated counterparts. What is less clear is how researchers and practitioners should approach virtual team dynamics in order to address these challenges. Without an overarching framework for understanding how trust and communication develop specifically within virtual teams, practitioners and team leaders must rely on management approaches that were designed for collocated teams (and which may be less appropriate for virtual team settings). The present study helps to bridge this gap by examining the ways in which trust develops in virtual teams specifically, under varying degrees of media richness.

The “bottom line”: Is trust actually important for virtual team performance? The present study supports the role that trust plays in predicting teams’ performance beliefs – though not necessarily their process performance or task performance (at least, not within the context of a relatively brief simulation). Consequently, the study highlights the need to build trust early in a team’s development in order to foster positive team affective states. From these results, it may be tempting to conclude that trust is not central to virtual team performance (insofar as concrete behaviours or outcomes are concerned; see Aubert & Kelsey, 2003). However, it should be noted that task performance was still lower in rich media virtual teams relative to collocated teams (and even lower in lean media virtual teams). These findings suggest that other factors beyond trust may play a role in predicting virtual team performance. For example, virtual teams in the present study may have also failed to develop shared goals (Hertel, Konradt, & Orlikowski, 2004); or may have lacked sufficient time to see an emergent develop and help structure the virtual communication environment (Glückler, & Schrott, 2007).
On the whole, these results support the idea that virtual teams face unique performance challenges; and that these challenges may be at least partly linked to trust (despite the lack of clear evidence for a mediating effect). Although trust was not found to mediate the relation between media richness and performance per se, trust has been linked to performance in meta-analytic research, with meta-analytic correlation estimates ranging from .17 (Dirks & Ferrin, 2002) to .33 (Colquitt, Scott, & LePine, 2007). Moreover, team trust has been linked specifically to team performance, with a number of single study correlation estimates ranging from .17 to .59 (Brahm & Kunze, 2012; Costa, 2003; Porter & Lilly, 1996). Furthermore, meta-analytic evidence suggests that performance beliefs are an early predictor of later team performance (Gully, Incalcetara, Joshi, & Beaubien, 2002); and in the present study, team performance beliefs were predicted by team member trust. Following this idea, fostering trust in virtual teams would likely translate to differences in more distal modes of objective performance. However, these effects may only occur over the course of a longer team interaction. Consequently, fostering trust in virtual teams may be most beneficial to team leaders when those virtual teams will be ongoing rather than temporary in nature.

*How can practitioners realistically build trust in virtual teams?* The present study also highlights the idea that virtual teams face specific challenges in overcoming the inherent uncertainty that is engendered by virtual communication. If this is the case, then early virtual team dynamics might best be characterized as a knowledge discovery process in which team members use the limited information available to them in order to develop a contextual knowledge base from which risk-taking decisions like trust can be confidently made (consistent with Uncertainty Reduction Theory).
If this is the case, then practitioners and virtual team leaders should focus on clarifying roles, team processes, and team norms within their teams in order to bolster the knowledge that team members already have. Because this knowledge base may initially be weaker in virtual teams due to their reliance on leaner forms of media, these expectations may need to be stated in more explicit detail than would be the norm in a collocated team meeting. This is consistent with work that suggests virtual teams partly struggle due to a lack of norms that bind team members together (as team members do not necessarily follow the same communication rules and nuances as they would in a collocated setting; see Leinonen, Järvelä, & Häkkinen, 2005). Establishing these norms during early team interactions may be an effective step towards giving virtual team members the tools they need to succeed.

What structural supports can be made available to virtual teams? The present study also supports the idea that many of the challenges that virtual teams face (including uncertainty, trust, and performance) are exacerbated by constraining virtual communication to lean forms of media such as email. Following this idea, practitioners and virtual team leaders should also ensure that team members have consistent access to richer modes of electronic communication. This is consistent with previous research supporting the link between company-sponsored technological support and remote worker experiences (Kowalski & Swanson, 2005; Grant, Wallace, & Spurgeon, 2013). Providing this technical support in the form of richer modes of communication (e.g., videoconferencing software), and the necessary computer bandwidth and connectivity to run them (e.g., dedicated servers, high-speed wireless Internet access plans) would build much of the contextual grounding information that team members need directly into the initial structure of the team.
Conclusion

Virtual work teams are increasingly common across several industries; their rise due in part to the rapid advancement and proliferation of communications technology, as well as to more broad economic shifts from manufacturing-based to information-based modes of production (Gurstein, 1998; Nilles, 1998). However, the wide-scale incorporation of virtual work teams has been met with only limited success to date, as these teams often face barriers to effective communication, trust development, and team performance.

If researchers are to promote the successful incorporation of virtual work into industry, more substantive work is needed to uncover the dynamics that underlie effective virtual teams. To that end, the present study makes a number of theoretical and empirical strides towards better understanding the role that uncertainty plays in translating differences in media richness into differences in team member trust and, ultimately, performance. By studying these relations experimentally and in the context of small, temporary project teams, the present study tests these relations at a basic level – while also affording experimental control to reduce the impact of confounds and contextual moderating variables. In doing so, the study will hopefully act as an accessible and straightforward catalyst for more applied work on the ways in which trust and team performance may be fostered across more nuanced and complicated virtual team structures.

Despite the challenges they face, virtual work teams remain ubiquitous (Deloitte, 2017; Gallup, 2017; FlexJobs, 2017), and are projected to see further increases in the near future (Leonard, 2011). Finding ways to afford these teams the structural and informational resources that they need may help address some of the most prominent challenges that they face in terms of communication, collaboration, and – ultimately – performance. By clarifying the specific processes that underlie virtual trust development, organizational psychologists stand to make a
lasting positive impact on the way in which teams and organizations function in an increasingly electronic world.
REFERENCES CITED


150


Gelman, A. (2018). You need 16 times the sample size to estimate an interaction than to estimate a main effect. Retrieved March 27, 2018 from


http://www.virtual-organization.net.


Van den Bos, K. (2001). Fairness heuristic theory: Assessing the information to which people are reacting has a pivotal role in understanding organizational justice. In S. Gilliland, D. Steiner, & D. Skarlicki (Eds.), Theoretical and Cultural Perspectives on Organizational Justice (pp. 63–84). Greenwich, CT: Information Age.


B. M. Staw (Eds.), *Research in Organizational Behavior, vol. 18* (pp. 1–74). Greenwich, CT: JAI Press.


The Mission

The time is 2:00 am, January 15th. Three American Red Cross workers are trapped in a church basement on a remote island in the South Pacific, caught in the middle of guerilla warfare. Your mission is to rescue them within 24 hours.

The situation is described in the next few pages along with the assets of U.S. forces available to rescue the workers. Work together to develop a course of action, using ANY assets available to you. The detailed plan can be made up of Army, Marine or Navy Seal assets (or a combination of the three), but must include the following:

- A description of how the rescuers will get to the church
- A description of how they will evacuate the Red Cross workers
- And a description of how they will return to the Army base or aircraft carrier.

Choose the best and most efficient solution to rescue the workers safely. Minimize damage to the village and villagers, and avoid contact with the enemy if possible. Keep in mind, however, the rules of engagement state that any forces will defend themselves if needed.

Good Luck!
Background Information

Drapo Island

Date:
January 15th, 0200 (2:00 AM), Drapo Time Zone

Location:
Drapo Island, located 750 miles north of Australia, slightly northeast of the Solomon Islands. (See Map 1)

Size:
The island is 400 miles wide by 400 miles long

Topography:
Drapo Island is made up of volcanic mountains, atolls (ring-like coral island and reef), some swampy lowlands, and rugged mountainous terrain with some low dense rainforest. Because much of the island is made up of volcanic mountains, there is a constant threat of volcanic activity. The terrain consists of coastal plains, swampy lowlands, a large rainforest and mountain ranges.

Location:
The church where the workers are trapped is located 3 miles from the northern-most shore of the island. Directly in front of the church is a dirt road, which leads to the ocean in one direction and
into the main village on the island in the other direction. The village is 1.5 miles from the church. The road also passes homes and farms of the natives on the way into the town. The church has some vegetation around it, primarily coconut trees and some brush, but no heavy forest or swampland. The land around it is mostly cultivated for farming.

A small port is located on the opposite end of the island from the church, and is heavily guarded by the local military. To reach the church from the port, you must cross an uninhabited volcanic mountain pass, which is covered by dense rainforest.

Because of the coral reefs, it is impossible to bring large ships any closer than 1 mile from the coast. The shore is only accessible by small boats. Significant amounts of coral can be seen above the surface of the water at low tide.

There is one paved highway around the perimeter of the island. This road also leads to the dirt road where the church is located. (See Maps 2 and 3)

Climate and Weather:
The climate on Drapo is tropical with rainy seasons from December through March and May through October. There are also periodic tropical monsoons. In January, there are periods of heavy fog in the morning, which burns off as the day progresses. Visibility is usually clear by noon. There are strong winds throughout the day.
Military:
The local military is made up of about 100 volunteers who support their government. It has recently been built up in response to increasing threats from rebel forces. The government has limited military intelligence and limited analysis capability. Drapo is in good and peaceful standing with the United States.

Village:
The village is home to the government center, school, church, markets, and communication center for the island. Any weapons and military intelligence possessed by the island will be centered in the village. The majority of the island’s homes are located within 1 mile of the village. There are between 100 and 150 huts housing 5 to 10 natives each. The village is about 1.5 miles from the church and 4.5 miles from the northern-most point of the island. The local language is Draponese. The locals do NOT speak English, so if any attempt is going to be made to communicate with the local military, a translator will be needed.

Transportation:
One main paved highway surrounds the perimeter of the island. (See Map 2) Dirt roads connect the airport, homes, village, and the church where Red Cross workers are trapped.

There is one main port, which is used for the export and import of goods. Directly off the shore of most of the island are atolls, which make it impossible for large ships to come within one mile of the shore (with the exception of the port).
There is one main airport with a paved runway, located 200 miles from the village. The airport is heavily guarded by the local military to keep rebel forces out. The airport flies into Australia, the nearest mainland (750 miles away), and from there can connect to other countries. (See Map 3)

Communication:
Communication on the island and off the island is possible, but is limited by the remoteness of the island. The Red Cross workers have working mobile phones, however the batteries died soon after they contacted the American Red Cross Headquarters. The church where the workers are trapped does not have a telephone. There is limited radio communication on the island (3AM, no FM stations). There are no television stations on the island. Internet access on the island is limited to government workers only.

Condition of Red Cross Workers:
The workers are somewhat safe in one room of the church. They have no source of water except rainwater. They are able to collect food easily from areas around them but that supply is limited and venturing too far to collect food is dangerous. Rescuers should be aware that workers will most likely be dehydrated and suffering from malnutrition. One of the workers is a diabetic in need of insulin. He will most likely go into insulin shock if not treated within 24 hours. Another worker has a broken leg. The third worker appears to be healthy at this time. There is a chance that workers could be injured from the outside warfare and that their location may not be safe for long. They must be rescued within 24 hours.
Background Information: Rebel Forces

- The Rebel Forces consists of 500 trained soldiers.
- They guard the perimeters of their captured areas at ALL times.
- They have no night vision capability.
- They have Stinger missiles. (Stinger missiles are hand-held, infrared, heat-seeking rockets with a range of 1 – 5 miles.)
- Their small arms fire consists of M-16 rifles (range: 500 yards) and 9mm pistols (range: 25 yards).
- They have land mines. (It is possible that local roads might be mined.)
- Their weapons storage, communication centers and anti-aircraft locations are not known to the U.S or Drapo military.
- They have RPG’s (rocket propelled grenades).
- Warfare is constant between rebels and local military.
- They have easy access to trucks and jeeps.
- They are aware the Red Cross workers are on the island, but unaware of their exact location. They are on-guard for possible rescue operations.
Navy SEALs Assets

- Personnel: 7-person squad consisting of:
  - 1 Corpsman
  - 1 Radioman
  - 1 Heavy Gunners
  - 2 Riflemen with M-16 rifles
  - 2 Riflemen with M-16 rifles and grenade launchers

- Night vision capability
- Need local translator if communicating with villagers.
- Ability to be virtually undetected
- All Navy SEALs are trained as medics.
- Navy SEALs usually initiate covert operations from the sea.
- All weapons and personnel are located on the USS Enterprise.
- The USS Enterprise has full medical facilities.

- Transportation & Weapons:
  - Navy Seahawk (SH-60): A twin-engine helicopter used for anti-submarine warfare, drug interdiction, cargo lifts and special operations in the day or night regardless of the weather conditions.
  - Navy Hornet (F-18): A one or two seat supersonic jet used for air-to-air or air-to-ground support.
  - Zodiac: A 7-man inflatable boat which can travel at speeds up to 15 miles/hour.
Army Special Forces Assets

- 6-person Special Forces Team consisting of:
  - 1 Team Lead
  - 2 Snipers
  - 2 Team Medics
  - 1 Translator (Speaks several languages, but NOT Draponese.)

- Highly trained in multiple languages.

- Night vision capabilities

- Weapons: M-16, M-60, Grenades

- Army Special Forces usually initiate covert operations from the land.

- Transportation & Weapons:
  - Abram Tanks: Used for enemy suppression.
  - Blackhawk Helicopter (UH-60): A twin engine helicopter used for special ops in the day or night, regardless of the weather conditions.
  - AH-64 Apache: A twin engine helicopter used for enemy suppression.
  - C-130 Hercules: A large aircraft used for troop and cargo transport, paratrooper deployment and airborne refueling.
Marine Special Forces Assets

- 12-person Team that includes:
  - 2 Medical Corpsmen
  - Use of M-16, M-60, Grenades
  - Night vision capabilities

- Marine personnel are stationed on the USS Enterprise.

- Transportation & Weapons:
  - AH-1: An attack force helicopter used to suppress enemy troops and provide air support
  - CH-53: A cargo/transport helicopter used in amphibious and shore operations.
Map 2

Map 3
Environmental Expert Information*

- Coral reefs are impassable except during high tide.
- Highest peaks in the mountain range reach 20,000 feet, while the lowest peaks reach 5,000 feet.
- The water temperature is 84 degrees F.
- Daytime temperature is 90 degrees F.
- Night temperature is 80 degrees F.
- Fog is present on the island from 6 am to 12 noon.
- Sunrise occurs at 6am.
- Sunset occurs at 7pm.
- Although Drapo is home to many indigenous animals, no snakes can be found on the island.
- High tide is between 7 and 9am and 8 and 10 pm.
- On average, high tide is about 2 feet.
- The rebels can see 12 miles from the beach (the distance of the horizon).
- The morning of January 15 there is heavy fog and light drizzle. The night of January 16 there is a full moon, cloudy skies and light drizzle.
- The waters around Drapo are a breeding ground for Great White sharks and barracuda.

*This page is only provided to the participant playing the Environmental Expert*
Intelligence Expert Information*

- It takes a SEAL team or an Army Special Forces team 45 minutes to reach the church from the shore.
- It takes a SEAL team or an Army Special Forces team 30 minutes to reach the church from the village, and 30 minutes to return to the village.
- Airfield has fuel available if ground re-fueling is needed.
- Navy SEAL and Army Special Forces teams can parachute from a C-130 (day or night).
- Church Layout is attached.
- Initial contact has been made with local military.
- SEAL and Army Special Forces teams can use element of surprise.
- US Army Special Forces are currently using a deserted army base for training. The base is 200 miles west of the church where the workers are trapped.
- The deserted army base where the Special Forces are training and the aircraft carrier USS Enterprise are considered safe locations.
- The USS Enterprise is anchored 200 miles east of the church.
- The airport is 200 miles from the village.
- The local military has 3 Toyota trucks, bikes, and donkeys available for U.S. force transportation.

*This page is only provided to the participant playing the Intelligence Expert*
Church Floorplan

*This page is only provided to the participant playing the Intelligence Expert*
Weapons Expert Information*

- Riflemen carry M-16s (effective range 500 yards) and grenades
- Small Arms fire can disable low-flying aircrafts
- Heavy gunners in SEAL unit carry M-60s (large caliber machine guns) with a range of 1500 yards.
- Suppressive fire by aircraft can be used to keep rebels from interfering with rescue mission, but collateral damage can result.
- Helicopters can be heard for 5 miles.

US Navy or Marine F-18 Hornet:

- One or two seat supersonic jets that can be used for air-to-air or air-to-ground support
- Speed: Mach 1.7+
- Range: 1500 miles (Range is defined as the total miles that can be flown without refueling)
- Ceiling: 50,000 feet
- Weapons: Air-to-air missiles, Air-to-ground smart bombs, 6000 rounds per minute cannon
- Can be flown in any weather, day or night
- In-flight refueling capabilities
- F-18s are located on the USS Enterprise

US Army Blackhawk (UH-60) OR US Navy Seahawk (SH-60)

- Twin engine helicopter used for special ops in any weather, day or night
- Speed: 184 miles/hour
- Range: 395 miles
- Ceiling: 14,700 feet
- Weapons: 2 machine guns and missiles for air-to-air and air-to-ground support
- Rescue hoist cable: 250 feet with a 600 pound lift capacity
- Can be refueled in flight
- Crew: 4
- Can carry 11 additional people
Blackhawks are located on the deserted army base where the Army Special Forces are conducting their exercises
Seahawks are based on the USS Enterprise

*US Army Apache (AH-64):*

- Twin engine helicopter used for suppression of enemy troops and enemy targets
- Speed: 165 miles/hour
- Range: 372 miles
- Ceiling: 12,500 feet
- Weapons: Missiles for air-to-air or air-to-ground support
- Must be refueled on the ground
- Crew: 2
- Cannot carry any additional people
- Located on the deserted army base

*US Marine Cobra (AH-1):*

- Attack force helicopter used to provide air support (anti-armor, anti-helicopter, armed escort)
- Speed: 170 miles/hour
- Range: 300 miles
- Ceiling: 12,500 feet
- Can fly day or night, but cannot fly in fog
- Rescue hoist cable: 250 feet with a 600 pound lift capacity
- Must be refueled on the ground
- Crew: 2
- Cannot carry any additional people
- Located on the USS Enterprise
**US Marine CH-53:**

- Cargo/transport helicopter used in amphibious and shore operations
- Speed: 200 miles/hour
- Range: 500 miles
- Ceiling: 21000 feet
- Weapons: None
- Rescue hoist cable: 250 feet with a 600 pound lift capacity
- Capable of refueling in flight
- Crew: 3
- Can carry 38 additional people
- Cannot fly in fog
- Two inflated Zodiacs can be air-dropped out the back ramp
- Located on the USS Enterprise

**US Army Hercules (C-130):**

- A large aircraft used for troop and cargo transport, paratrooper deployment and airborne refueling.
- Speed: 335 miles/hour
- Range: 2,500 miles
- Ceiling: 33,000 feet
- Weapons: 7.62 mm mini-guns, 40 mm cannons, 105 mm cannon
- Crew: 5 - 9
- Can carry 92 additional people
- Located on the army base being used for training exercises

**US Army Abram Tank:**

- Speed: 45 miles/hour maximum (The Abram tank slows considerable when riding on a grade or slope.)
- Range: 275 miles
- Weapons: 105 mm rifled cannon, .50 caliber machine gun, 7.62 mm swivel mounted machine gun
• Crew: 4
• Requires jet fuel

_US Navy Zodiac:_

• A 7 man inflatable raft made of durable rubber and polyurethane fabric
• Speed: 15 miles/hour
• Weight: 80 pounds
• Can be deflated and stowed in minutes
• Sits flat on top of the water when empty
• 8” displacement when loaded to full capacity
• It takes approximately one hour to inflate with a hand pump
• Can be parachuted fully inflated from a height of no more than 2000 feet from the back of a CH-53 or C-130.
• Zodiacs are considered expendable items

*The previous four pages are only provided to the participant playing the Weapons Expert*
APPENDIX B. UNCERTAINTY SCALE DERIVED FROM COLQUITT, LEPINE, PICCOLO, ZAPATA, & RICH (2012).

Please indicate how strongly you agree with each of the following items:

1. There is a lot of uncertainty in the Non-Combatant Evacuation Operation simulation.
2. Many things seem unsettled in the Non-Combatant Evacuation Operation simulation.
3. If I think about the Non-Combatant Evacuation Operation simulation, I feel a lot of uncertainty.
4. I cannot predict how things will go in the Non-Combatant Evacuation Operation simulation.
APPENDIX C. INTERNATIONAL PERSONALITY ITEM POOL PROPENSITY TO TRUST ITEMS.

Please indicate how strongly you agree with each of the following items:

1. I trust others.
2. I believe that others have good intentions.
3. I trust what people say.
4. I believe that people are basically moral.
5. I believe in human goodness.
6. I distrust people. (R)
7. I suspect hidden motives in others. (R)
8. I am wary of others. (R)

Note. “(R)” indicates reverse-keyed item.
Please indicate how strongly you agree with each of the following items:

1. If I had my way, my team members wouldn’t be in charge of their parts of the information package.

2. I would be comfortable putting my team members in charge of my part of the information package.

3. I really wish I could keep a better eye on my team members while we worked together on the *Escape from Drapo Island* simulation.

4. I was comfortable having my team members in charge of their parts of the information package, even though I couldn’t watch or monitor their work.

5. I would be comfortable leaving my team members in charge of coming up with our rescue plan.

6. If I had my way, my team members would have less influence over our final rescue plan.

7. I wish I had a way to check up on the information that my team members were put in charge of reading.

8. I feel confident with how my team members interpreted and communicated the information they were in charge of.
Please indicate to what extent our team actively works to…

**Transition Processes Subscale**

1. Identify our main tasks
2. Identify the challenges we expect to face
3. Determine the resources that we need to be successful
4. Set goals for the team
5. Ensure that everyone on our team clearly understands our goals
6. Link our goals with the strategic direction of the simulation
7. Develop an overall strategy to guide our team activities
8. Prepare contingency (“if-then”) plans to deal with uncertain situations
9. Know when to stick with a given working plan, and when to adopt a different one

**Action Processes Subscale**

10. Regularly monitor how well we are meeting our team goals
11. Use clearly defined metrics to assess our progress
12. Seek timely feedback from about how well we are meeting our goals
13. Monitor and manage our resources
14. Monitor important aspects of our work environment
15. Monitor events and conditions outside the team that influence our operations
16. Develop standards for acceptable team member performance
17. Balance the workload among our team members
18. Assist each other when help is needed
19. Communicate well with each other
20. Smoothly integrate our work efforts
21. Coordinate our activities with one another

**Interpersonal Processes Subscale**

22. Deal with personal conflicts in fair and equitable ways
23. Show respect for one another
24. Maintain group harmony
25. Take pride in our accomplishments
26. Develop confidence in our team’s ability to perform well
27. Encourage each other to perform our very best
28. Share a sense of togetherness and cohesion
29. Manage stress
30. Keep a good emotional balance in the team
APPENDIX F. IDEAL SOLUTION TO THE NON-COMBATANT EVACUATION OPERATION SIMULATION BASED ON SUBJECT MATTER EXPERT FEEDBACK.

Solution:

Key Points:

- Covert operation
- Conducted at night, during high tide
- Use Navy SEALs and Marine CH-53 (doesn’t need refueling)
- Weapons: M-16 rifles and grenade launchers

Timing:

1. 1800 hrs: SEAL team leaves Enterprise on a CH-53.
2. 1900 hrs: SEAL team drops from a height of 500’ into the ocean with 2 inflated Zodiacs. The drop is 12 miles off the shore (over the horizon. The CH-53 returns to the base or Enterprise for refueling.
3. 2000 hrs: SEAL team reaches the shore and hides the Zodiacs. Proceeds to the church, being careful to stay off the roads because of possible mines.
4. 2045 hrs: Reaches church, makes contact with workers
5. 2100 hrs: Leaves church, carrying wounded and providing medical care along the way
6. 2145 hrs: Reaches shore. Uses the two hidden Zodiacs to motor out 12 miles.
7. 2245 hrs: Rendezvous with CH-53 (altitude: no higher than 250’). Airlifts workers onto the helicopter. Seal team sinks Zodiacs.
8. 2345 hrs: Return to Enterprise for additional medical treatment.
# APPENDIX G. NON-COMBATANT EVACUATION OPERATION SIMULATION SCORING MATRIX.

<table>
<thead>
<tr>
<th>Planning Card</th>
<th>Error</th>
<th>Error Type</th>
<th>Points Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>Omitting Personnel Card</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>Transportation</td>
<td>Omitting Transportation Card</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Using aircraft that requires in-flight refueling without calculating refueling needs</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Calculation error rendering the solution impossible</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Using aircraft that requires in-flight refueling (with correct calculations)</td>
<td>D</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Performing calculations incorrectly with minimal impact</td>
<td>E</td>
<td>2</td>
</tr>
<tr>
<td>Weapons</td>
<td>Omitting Weapons Card</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Using unavailable weapons</td>
<td>D</td>
<td>3</td>
</tr>
<tr>
<td>Times</td>
<td>Omitting Times Card</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Failing to include required critical times (onset of operation, contact with workers, evacuation, return)</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Failing to account for tides or coral reef – if using sea approach</td>
<td>D</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Rescuing workers during daylight hours</td>
<td>D</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Performing calculations incorrectly with minimal impact</td>
<td>E</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Calculation error rendering the solution impossible</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>More than 0.5 hours spent in the church</td>
<td>E</td>
<td>2</td>
</tr>
<tr>
<td>Plan</td>
<td>Omitting Plan Card</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>Neglecting to include all requirements of the plan as listed in the Mission Statement (getting to the church, evacuating the workers and returning to the base or ship)</td>
<td>B</td>
<td>5 for each</td>
<td></td>
</tr>
<tr>
<td>Unrealistic solution (tanks, etc.)</td>
<td>B</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Failing to address medical treatment (insulin/broken leg)</td>
<td>C</td>
<td>2.5 each</td>
<td></td>
</tr>
<tr>
<td>Harming the enemy unnecessarily</td>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Damaging the village unnecessarily</td>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Failing to avoid land mines</td>
<td>D</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Failing to arrange for translator if indicated</td>
<td>D</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Failing to avoid detection by rebels</td>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Type A error (e.g. omitting planning card)</td>
<td>A</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Other Type B error (e.g. serious violation of mission statement, unrealistic solution)</td>
<td>B</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Other Type C error (e.g. moderate violation of mission statement, calculation error with serious impact)</td>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Other Type D error (e.g. minor violation of mission statement)</td>
<td>D</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other Type E error (e.g. calculation error with minimal impact)</td>
<td>E</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX H. INITIAL (PRE-STUDY) CONSENT FORM.

CONSENT TO PARTICIPATE IN RESEARCH

“Escape from Drapo Island”: Teamwork in a Military Rescue Operation

You are asked to participate in a research study conducted by Dr. Harjinder Gill and Scott Cassidy from the Psychology Department at the University of Guelph. Results will contribute to the completion of a psychology dissertation project at the University of Guelph.

If you have any questions or concerns about the research, please feel free to contact Harjinder Gill by email @ gillh@uoguelph.ca, or daytime phone @ (519) 824-4120 ext. 52197

PURPOSE OF THE STUDY

The purpose of this study is to analyze teams working together towards a common goal while being supervised.

PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

The experimenter will show you a short training video to brief you on the experimental task (described in detail in the following paragraph). This should take approximately 10 minutes.

Participate in a team-based simulation task that requires you to interact with two other participants to work towards a common goal. You will be assigned one of three unique roles with specialized information (e.g., environmental information). The goal of the simulation is to work together as a team to decide on a detailed plan for rescuing a simulated group of trapped Red Cross workers on a fictional island. In order to complete the simulation effectively, you will have to communicate with your teammates to strategize how to come up with the best personnel and resources possible. This session will be recorded in at least one of the following ways: video recordings of your session; audio recordings of your session; chat logs from your session. Any questions during the simulation can be directed towards the experimenter. You will be given 60
minutes as a team to work on this task. This task will take place in the lab you are presently in (Blackwood Hall, room 111).

Following this, you will be asked to complete a booklet of questionnaires assessing your perceptions of you team. This should take approximately five to ten minutes. You will then enter into a debriefing session where any questions or concerns can be addressed.

Note. To participate in this study, you were asked to complete the study: “The Makings of an Effective Team: Personality and Team Composition Variables Survey” as a prerequisite. This study will draw on your responses when data is analyzed. You already consented to have your data collected for that study; please note that consent to participate in this study also includes consent to link your responses from The Makings of an Effective Team: Personality and Team Composition Variables Survey” with the results of the current study.

Results of the study will be available to you upon request. Results, as well as any questions regarding the study can be answered by emailing the lead student experimenter at cassidys@uoguelph.ca.

POTENTIAL RISKS

This study involves a great deal of interaction and communication between participants. Because of this, it is possible that participants may feel some degree of pressure while completing the experimental task. In addition, the high level of interaction involved may be somewhat uncomfortable for highly introverted or shy participants. These risks are not considered more than those you would encounter on a normal day. Any risks will be managed by having the experimenter observe your session. You may end the study at any time. In addition, the experimenter may end the session is circumstances warrant it.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Benefits to the Participant
Participants will receive the opportunity to learn about team processes while having the experience of being involved in psychological research at the University.

Benefits to Society
This study will add to the existing research on teamwork. The results of this study will aid organizations in developing more effective teams by establishing the behaviours that make teams effective and how they can be trained and encouraged.
PAYMENT FOR PARTICIPATION

Participants who enrolled through the SONA system participation pool will receive a 1.5 percent course credit compensation for their attendance at the beginning of the study. This course credit compensation is offered through SONA as a part of participating courses in the Psychology department, and can only be offered to students enrolled in one of these courses. Consequently, participants who did not enroll through the SONA system will not be compensated in this way.

All participants (regardless of how they enrolled), will be entered into a draw to win one of ten gift cards worth $25.00 CAD (odds of winning are approximately one in 60); winners will be contacted by email after all data has been collected.

All participants (regardless of how they enrolled), are also eligible for the cash prize being offered to the top performing team. Team performance on the simulation (described in the “procedures” section above) will be objectively scored after all data has been collected. Each member of the team with the highest performance will be contacted at this time and awarded a $250.00 CAD cash prize (approximately 200 teams will be competing for this prize).

CONFIDENTIALITY

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. Participant names and personally identifying information will not be used in analyzing the data from this study. Paper-based records, including the only copy of Participant names will be destroyed immediately after the following conditions are satisfied: 1) data collection is complete and all de-identified data (e.g., survey responses) has been entered electronically, and 2) all prizes (see “Payment for Participation” section) have been distributed to appropriate parties. All other records (including audio and video recordings) will be kept electronically on a secure, password-protected and encrypted server located in Blackwood Hall. Survey data and all audio and video recordings will be stored electronically for a period of seven years following publication of the results. No other outside party (i.e., barring the two experimenters listed on this form, and a team of trained undergraduate research assistants working in the lab under the direct supervision of Dr. Gill and Scott Cassidy) will have access to the data and there will be no way to connect the participant data to the emails of the participants. Any paper copies of the data will be shredded and disposed of after analyses are complete. Audio and video recordings will be retained in a secure location (encrypted, password-protected server in the lab). The research team working under Dr. Harjinder Gill will use these recordings to conduct content analyses of your team’s performance (a content analysis refers to a type of analysis whereby researchers look at videos or transcripts to find important themes in them that they can assign numeric scores to); the scores these coders give to your team after viewing your
recordings may then be used to look at overall trends in teams’ performance. The recordings will only be observed in order to generate these scores, and all scores will be reported in an aggregated format (i.e., scores for specific teams, specific quotes, or actual recordings will not be reported or shared with anyone outside the coders themselves). Because you will be working in a team with other participant(s), confidentiality cannot be guaranteed. To encourage participants remain confidential, we ask tat you keep what was said during this study confidential and not discuss it outside of the study period.

FURTHER ARCHIVAL USE OF DATA

Electronic data, including audio and video recordings will be retained for a period of seven years following the publication of the results. During this period, future archival work may tentatively be run on the video and audio data to get a better sense of how your team communicates. Specifically, members of Dr. Gill’s lab who are trained in correct and ethical handling of data, may use the recordings to conduct further content and thematic analyses of communication patterns and team process in your team. Please refer to the “Confidentiality” section above for a description of what these analyses entail.

Because audio and video recordings are directly identifiable, this archival work will only be done if all comprising members of your agree to have their data used in for future archival work (by signing this form), and will only involve work on team communication and team processes as specified here.

FUNDING

This study is funded through a Social Sciences and Humanities Research Council of Canada (SSHRC) institutional grant (i.e., general research grant), which was offered through the University of Guelph’s Office of Research. These grants are awarded each year through an internal competition held at the University of Guelph in order to allocate the funding it receives from SSHRC.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don’t want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.
Should you choose to withdraw from the study at any point, the researchers will remove and destroy all individual data you have contributed from the study, as well as all of the data for the other individual(s) who were part of your team, in order to ensure that all data pertaining to the withdrawing participant is removed.

**RIGHTS OF RESEARCH PARTICIPANTS**

This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact: Director, Research Ethics; (519) 824-4120, ext. 56606; sauld@uoguelph.ca

**SIGNATURE OF RESEARCH PARTICIPANT**

I have read the information provided for the study “Escape from Drapo Island: Teamwork in a Military Rescue Operation” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. Moreover, I agree to link my results of this study with those from the pre-measure “The Makings of an Effective Team: Personality and Team Composition Variables Survey”, and to have my data used for further archival content and thematic analyses of team communication and process during the seven years after publication that electronic data is retained. I have been given a copy of this form.

________________________________________
Name of Participant (please print)

________________________________________
Signature of Participant

Date

**SIGNATURE OF WITNESS**

________________________________________
Name of Witness (please print)

________________________________________
Signature of Witness

Date
APPENDIX I. PARTICIPANT DEMOGRAPHICS QUESTIONNAIRE.

My age is: _______ Years
☐ Prefer not to disclose

I identify as:
☐ Male
☐ Female
☐ Trans*/Genderqueer/Other
☐ Prefer not to disclose

I identify as:
☐ White/Caucasian
☐ Black/African American
☐ Hispanic/Latin(o/a)
☐ Native American/ First Nations Person)
☐ East Asian (e.g., Chinese, Thai)
☐ South Asian (e.g., Indian, Pakistani)
☐ Middle Eastern (e.g., Persian, Israeli)
☐ Hawaiian or other Pacific Islander
☐ Other (please specify): _________________
☐ Prefer not to disclose

I am presently employed:
☐ Yes (Full-time status)
☐ Yes (Part-time status)
☐ No
☐ Prefer not to disclose

If yes, I have been employed for: _______ Years, _______ Months
☐ Prefer not to disclose
My grade in my last *high school*-level English class was (approximately): ☐ Prefer not to disclose

On a normal week, I play video games for: ☐ I do not play video games ☐ Prefer not to disclose

If I do play video games, I usually play (list below):

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX J. LAB LAYOUT DEPENDING ON TEAM’S MEDIA RICHNESS CONDITION ASSIGNMENT.

Scenario 1: Collocated team assignments

All three stations are placed together in Meeting Room 2.
Scenario 2: Skype™ and email team assignments

Each laptop is in its own room. The computers in Meeting Room 1 and 2 keep the users facing away from each other.
APPENDIX K. SECOND (POST-STUDY) CONSENT FORM

GETTING TEAMS TO ‘CLICK’: UNCERTAINTY REDUCTION AS A BASIS FOR TRUST DEVELOPMENT IN VIRTUAL WORK TEAMS

PURPOSE OF THE STUDY

Thank you for participating in this study; we greatly appreciate your contribution to our research.

When conducting research, it is occasionally necessary to withhold the true purpose of a study in order to look at the phenomenon under investigation. Sometimes, when participants know which of their behaviours are being studied, they may change that behaviour in order to be “good” participants and act the way they think the researcher wants them to act. For this reason, researchers often withhold the true purpose of the study when 1) it is absolutely necessary in order to investigate a phenomenon (i.e., it cannot be observed in another way), and b) the study has scientific and social importance. Under such conditions, researchers may provide a “cover story” for their study.

You were told the purpose of this study was to examine team behaviours. This is partially correct. However, the true purpose of the study was more specifically to examine the effect of different forms of communications media (for example, email or videoconferencing) on trust and performance between team members. Your team was randomly assigned to one of three media conditions (an email condition, a videoconferencing condition, or a face-to-face condition). After receiving training on the, you were asked to complete the military rescue simulation task (i.e., together using this form of media, and were then asked to complete two surveys, corresponding to your perceptions of trust towards your team members.

Our research team opted not to tell you about the true purpose of the study in order to keep any participants from responding differently on the task or trust measures due to knowing the experimental hypotheses. On behalf of the research team, I would like to extend an apology for any negative feelings that were caused by withholding this information.
You were also told that you would be able to look over the specialized information your team members were given, so that you could formulate your own rescue plan to be graded on (rather than relying on your team members). There was actually no such option; all rescue plans are marked on the team level based on all members’ input. You were told this was an option so that you would be in a position where you could choose to either accept or not accept vulnerability to your team members. Because vulnerability is a key component in conceptual definitions of trust, it was important to make you feel like this choice was real so that you level of vulnerability-acceptance (and therefore, trust) could be observed. Once again, on behalf of the research team, I would like to extend an apology for any negative feelings that were caused by this deception.

PROCEDURE
During this study you were asked to do the following:

1) Give your consent and fill out a demographics questionnaire
2) Watch a training video for the experimental task that included a trust-building intervention
3) Work together for 60 minutes on the military rescue simulation
4) Fill out a booklet of surveys regarding your perceptions of (felt) trust towards your team member(s)
5) Enter a debriefing session where you were informed of the true purpose of the study

SIGNATURE OF RESEARCH PARTICIPANT

I have read and understood the information regarding the true purpose of the study, “Getting teams to ‘click’: Uncertainty reduction as a basis for trust development in virtual work” as described herein. Moreover, I recognize that the purpose stated above in this (second) consent form is the true purpose of the study, and that the stated re-weighing option after the simulation was not a genuine option in the study, I have been told of the deception in this study, and I approve that the data collect can remain in the study. By signing this form, I recognize that I am giving my informed consent to keep my data in the study after being told its true purpose.
Name of Participant (please print)

Signature of Participant Date

SIGNATURE OF WITNESS

Name of Witness (please print)

Signature of Witness Date
APPENDIX L. SCRIPT FOR STUDY SESSIONS.

*** Because some participants are to communicate electronically without seeing each other, they will be scheduled to arrive with a short delay between them ***

- A participant arrrives at the lab -

**Experimenter**: Hello. Are you all here for the “Drapo Island” military teamwork study?

- Participant confirms they are in the right place -

**Experimenter**: Excellent. My name is <<insert name here>>, and I’ll be taking you through the study today. Please have a seat anywhere and we’ll get started.

- Participant is directed to the couches in the lab’s waiting area -

**Experimenter**: Now, as you may or may not know, we are looking at how teams work together to reach a common goal. You’ll be working as a team with two other people on a computer simulation that is meant to simulate a day as a NAVY search and rescue operative. Specifically, you’ll be asked to provide some basic demographic information. After this, you’ll watch a brief training video to prepare you for the task. After that you’ll work together on a 60-minute simulation. Finally, I’ll ask you to complete a booklet of questionnaires about the team. You should also note that you sessions using the simulation software will be recorded as part of our data collection on your team. Before we begin, I’ll brief you on the consent process...

- Experimenter reads through each section of the consent form with the participant -

**Experimenter**: If you agree with all of this, I’ll ask you now to sign your consent form. Please remember that even after you sign the consent form, you are still free to stop the study if you need to or opt not to include your data in the final analysis. This will not affect your course credit for research participation.
Participant reads and signs the consent forms and returns it to the experimenter

Experimenter: Thank you. Now I’m going to give you these forms to fill out your demographic information. Please complete it to the best of your ability. If there are any items you are uncomfortable answering, please select the “prefer not to disclose” option provided.

Participant completes the demographics questionnaire

Experimenter: Thank you. Now I can brief you on the study task. Please follow me.

Participant goes to a conference room in the lab, where their computer station is set up

Experimenter: Please wait here while the other participants are briefed and brought to their stations.

Once all three participants arrive and are seated at their stations, the experimenter comes to each of them

Experimenter: Each of you will have your own computer station where you will be able to play through the simulation while you talk to one another. The simulation is called the Non-combatant Evacuation Operation, and your goal as a team is to save three Red Cross workers from behind hostile territory. I’m going to play an instructional video for you that contains basic training information on the task. You also have the binder in front of you, with complete information, which you will hear more about in the video. Do you have any questions before I do this?

Experimenter answers any questions the participant may have

Experimenter plays video containing the training talking points

Experimenter: Do you have any questions after watching the video?

Experimenter answers any questions the participant may have
**Experimenter:** What I’ll do now is start the recording software. You will have 60 minutes to work together with your team. You must do this with the technology provided and without leaving the room you are in. After 60 minutes, you will be asked to complete a few surveys. Are you ready to begin?

- *Participants play one sixty-minute round of the Non-combatant Evacuation Operation*

**Experimenter:** I’m now going to ask you to fill out this booklet of surveys regarding your feelings about your team. Please complete these independently and let me know when you’re finished.

- *Participants complete the self-report questionnaires, including the re-weight form*

**Experimenter:** Thank you for your participation. We can now debrief about the study. Please follow me back to the lab’s waiting area.

- *All three participants go back to lab’s waiting area*

**Experimenter:** Does anyone have an idea about the purpose of today’s study?

- *Participants give any opinions they may have on the study*

**Experimenter:** What I was actually looking at today was the type of electronic media you used to communicate and the amount of trust that developed between you and your team members. Although there is a lot of research that shows trust is important for teamwork, other researchers believe that trust is much harder to develop in virtual settings (where participants communicate using electronic media like email or Skype). Our lab wanted to study this by randomly assigning teams to different electronic media conditions and seeing how much team members trusted one another depending on the media they used.

**Experimenter:** Previous research has shown that accepting vulnerability is a central component of trust. So one of the best ways to study trust is to give participants an option where they decide
to be vulnerable to another party or not vulnerable. In this case, we did this by asking whether you wanted your task’s performance score to be based on your individual performance by letting you re-submit a plan, or alternatively rely on your team members’ overall plan. The re-weight option we gave you was not an actual option; rather, we needed to see which you would hypothetically choose to assess your trust.

**Experimenter:** In addition, knowing that trust was being studied may have changed the way you acted during the simulation or how you answered the surveys. This is a common issue when doing psychology research. Because of this, I was also not able to tell you the true purpose of the study until now. Because you were not told the actual purpose of the study, I have a second consent form for you. If you would like, you can opt to remove your data. This will not affect your course credit for research participation.

**Experimenter** I also have a debriefing information letter that is yours to keep. They contain some background information on the study, as well as the contact information for the lead investigators.

- *Hand out consent form and debrief form, participants read, and sign and return consent form*

**Experimenter:** I want to thank you once again for your participation; these studies are not possible without you. If you have any questions or concerns at all, then do not hesitate to the lead investigators. I’ll also ask you to not talk to anyone in your classes about this study, because we rely on the participants not knowing the true purpose of the study before they come into the lab. Thank you again for your participation!

- *Participants leave the lab*
APPENDIX M. ASPREDICTED.ORG ANALYSIS PLAN FORM.

1) Have any data been collected for this study already?

- Yes, at least some data have been collected for this study already
- No, no data have been collected for this study yet
(Note: You must answer 'No' to submit this pre-registration)

2) Hypothesis. What's the main question being asked or hypothesis being tested in this study?

Does media richness (i.e., the extent to which virtual communication mimics collocated communication) affect performance-related team outcomes (specifically, performance beliefs, team process, and task performance)? If so, what are the means by which (i.e., mediating variables) these relations occur?

3) Dependent variable. Describe the key dependent variable(s) specifying how they will be measured.

Uncertainty: Four-item self-report measure filled out following the experimental task (individual-level measure).
Trust in Team: Fourteen-item self-report measure filled out following the experimental task (individual-level measure).
Propensity to Trust: Eight-item self-report measure filled out following the experimental task (individual-level measure).
Performance Beliefs: Thirty-item self-report measure filled out following the experimental task (individual-level measure).
Team Process: Thirty-item measure filled out by trained coders using a latent content analysis approach (team-level measure).
Team Performance: Simulation score derived from expert-created metrics and assessed by trained coders (team-level measure).

4) Conditions. How many and which conditions will participants be assigned to?

Three media-richness conditions in a lab study: 1) Collocated communication; 2) Media-rich virtual communication (i.e., Skype); 3) Media-lean virtual communication (i.e., email).

5) Analyses. Specify exactly which analyses you will conduct to examine the main question/hypothesis.

Data was collected at both the individual- and the team-level. Consequently, a multilevel regression analysis with bootstrapping based on recommendations from Bauer, Preacher, and Gil (2006) will be used to analyze the experimental hypotheses. This approach will help avoid the inherent statistical- and conceptual interpretation issues that often arise when analyzing nested data using a single level of analysis, while also conforming to best practices on effective mediation testing with smaller samples, as described by Preacher and Hayes (2004).
Three multilevel regression analyses will be conducted using Bauer, Preacher, and Gil’s (2006) recommendations for assessing multilevel mediation. Each of these will predict a different performance-related outcome (performance beliefs; team process; team performance) using media richness, uncertainty, and trust. Uncertainty will be examined as a mediator of the relation between media richness and trust; and trust will be examined as a mediator of the relation between uncertainty and performance. This is represented in the equation below:

\[ Z_{ij} = \text{SUncertainty}_{ij} + b1j[Virtualization]_{ij} + STrust_{ij} - b2j[Uncertainty]_{ij} + b3j[Virtualization]_{ij} + SPerformance_{ij} - b4j[Uncertainty]_{ij} + b5j[Trust]_{ij} + b6j[Virtualization]_{ij} + e_{Zij} \]

6) More analyses. Any secondary analyses?

Propensity to trust is hypothesized to moderate the relation between uncertainty and trust. Consequently, the slope coefficient between uncertainty reduction and trust will be correlated with participants’ propensity to trust scores. This is consistent with recommendations suggesting that moderated multilevel mediation can be tested by assessing whether the proposed moderator significantly predicts the appropriate slope in the mediation’s regression equation (Bauer, Preacher, & Gil, 2006).

7) Sample Size. How many observations will be collected or what will determine sample size?
No need to justify decision, but be precise about exactly how the number will be determined.

Data was already collected prior to completing this form. We ran the study with 297 individuals.

8) Other. Anything else you would like to pre-register?
(e.g., data exclusions, variables collected for exploratory purposes, unusual analyses planned?)

Missing values for all of individual-level outcomes in the study were imputed and averaged across five iterations using a chained equations approach with a nested Gibbs sampler.

Alternative measures of both uncertainty (i.e., a four-item expert rating from trained coders, and a manifest content analysis of uncertainty-reducing behaviours), and trust (i.e., a manifest content analysis of trust-demonstrating behaviours, and a binary, vulnerability-acceptance behavioural measure) were collected for exploratory reasons. These alternative variables will not be included in the dissertation results’ main analyses proposed above. They will, however, be noted as part of a "disclosure of measures" section in the dissertation paper to promote transparency in the project; and may be looked at in an exploratory (i.e., using a non-NHST approach) in order to contextualize results from the proposed variables and inform future directions and recommendations.

9) Name. Give a title for this AsPredicted pre-registration
Suggestion: use the name of the project, followed by study description.

Getting 'Teams to 'Click' (Cassidy Dissertation)
Did General Mental Ability Moderate the Relation between the Media Richness Manipulation and Team Performance?

*Overview and Rationale for Control Analysis*

General mental ability is likely to be important for performance in virtual teams due to the overarching task focus in virtual teams (Powell, Piccoli, & Ives, 2004). Although there is limited empirical research on this relation specifically insofar as virtual teams are concerned, a meta-analysis on team composition and its effect on general team performance found that team general mental ability predicts performance more strongly than many other team composition variables (Bell, 2007). Consequently, team-level general mental ability was included as a control variable in the present study.

In the present study, general mental ability was assessed by proxy, specifically by having participants provide their final grade for their senior-year English studies course in high school. Academic grades can often effectively serve as a proxy measure of general mental ability, as academic grades are largely based on general mental ability (Frey & Detterman, 2004). Participants’ grades in their senior-year English studies course were chosen specifically because the majority of participants were assumed to have this information. Many of participants in the present study were lower-year undergraduate students (many of whom were in their first year of undergraduate studies), and so may not have any undergraduate-level grades to provide. Moreover, unlike other subjects in high school, English is required during one’s senior year in Ontario; therefore, all participants were assumed to have access to this grade.
General mental ability was specifically expected to present a confounding finding by accounting for redundant variance in the relation between media richness and team performance. Consequently, to control for the possible confounding effects of general mental ability on the relation between media richness and team performance, the team’s mean general mental ability score was used to predict the slope coefficient between the media richness manipulation and each of the three facets of team performance. If mean general mental ability were to significantly predict this coefficient for any given facet of performance, it would suggest a moderating or confounding effect of general mental ability on the relation between media richness and team performance scores (Bauer, Preacher, & Gil, 2006).

**General Mental Ability and the Relation between Media Richness and Team Performance**

*Performance beliefs.* General mental ability – as operationalized by the mean self-reported senior high school English grade across team members – was not found to moderate the relation between the media richness manipulation and teams’ mean performance beliefs. This was the case when examining the difference between low media richness (email) and medium media richness (Skype™) teams \( t(100) = -0.004, sr^2 = .00, 95\% CI = [-.00, .00], \beta = -0.001; \) the difference between low media richness (email) versus high media richness (collocated) teams \( t(100) = 0.20, sr^2 = .00, 95\% CI = [-.01, .01], \beta = 0.04; \) and the difference between medium media richness (Skype™) and high media richness (collocated) teams \( t(100) = 0.18, sr^2 = .00, 95\% CI = [-.00, .00], \beta = 0.04.\)

*Process performance.* General mental ability – as operationalized by the mean self-reported senior high school English grade across team members – was not found to moderate the relation between the media richness manipulation and teams’ process performance ratings. This was the case when examining the difference between low media richness (email) and medium
media richness (Skype\textsuperscript{TM}) teams $t(100) = 0.86$, $sr^2 = .01$, 95\% CI = [-.02, .03], $\beta = 0.19$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = -0.71$, $sr^2 = .00$, 95\% CI = [-.02, .02], $\beta = -0.14$; and the difference between medium media richness (Skype\textsuperscript{TM}) and high media richness (collocated) teams $t(100) = -1.02$, $sr^2 = .02$, 95\% CI = [-.03, .06], $\beta = -0.22$.

**Task performance.** General mental ability – as operationalized by the mean self-reported senior high school English grade across team members – was not found to moderate the relation between the media richness manipulation and teams’ task performance ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype\textsuperscript{TM}) teams $t(100) = -0.13$, $sr^2 = .00$, 95\% CI = [-.00, .00], $\beta = -0.03$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = -1.25$, $sr^2 = .01$, 95\% CI = [-.02, .05], $\beta = -0.25$; and the difference between medium media richness (Skype\textsuperscript{TM}) and high media richness (collocated) teams $t(100) = -1.49$, $sr^2 = .01$, 95\% CI = [-.02, .04], $\beta = -0.33$.

**Did Age Moderate the Relation Between either Trust and its Predictors; or Team Performance and its Predictors?**

*Overview and Rationale for Control Analysis*

Previous research has linked age to both trust (Rhodes, 1983; Salamon & Robinson, 2008) and task performance (McEvoy & Cascio, 1989; Salamon & Robinson, 2008). Consequently, age was expected to present a confounding finding by accounting for redundant variance in the relation between trust and its predictors (i.e., media richness and uncertainty); as well as between team performance and its predictors (i.e., media richness and uncertainty).
Because participants were being drawn primarily from an undergraduate participant pool, their age was expected to hover around 18 to 25 (the age of most undergraduate university students). Age was – to some extent – controlled for methodologically by primarily recruiting participants from a relatively narrow age bracket. In order to further control for any confounding effects of age on either the relation between uncertainty and trust, or the relation between trust and team performance, the slope coefficient between uncertainty and trust, as well as the slope coefficient between virtualization and trust, was regressed onto the team’s mean age (i.e., calculated by adding the age of all participants and dividing by three).

Teams’ mean age was subsequently used to predict the slope coefficient between media richness and trust; the slope coefficient between uncertainty and trust; the slope coefficient between the media richness manipulation and each facet of team performance; and the slope coefficient between uncertainty and each facet of team performance. If the team’s mean age were to significantly any of these coefficients, this would suggest a moderating or confounding effect of age (Bauer, Preacher, & Gil, 2006).

Age and the Relation between Media Richness and Trust

The age of participants within teams – as operationalized by the team’s mean age – was not found to moderate the relation between the media richness manipulation and teams’ mean trust ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype™) teams $t(100) = -1.69$, $sr^2 = .02$, 95% CI = [-.03, .08], $\beta = -0.51$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = -0.06$, $sr^2 = .00$, 95% CI = [-.00, .00], $\beta = -0.01$; and the difference between medium media richness (Skype™) and high media richness (collocated) teams $t(100) = 1.85$, $sr^2 = .03$, 95% CI = [-.03, .09], $\beta = 0.50$. 
Age and the Relation between Uncertainty and Trust

The age of participants within teams – as operationalized by the team’s mean age - was not found to moderate the relation between team’s mean uncertainty ratings and teams’ mean trust ratings. $t(102) = 1.22, sr^2 = .01, 95\% CI = [-.16, .18], \beta = 0.10.$

Age and the Relation between Media Richness and Team Performance

Performance beliefs. The age of participants within teams – as operationalized by the team’s mean age – was not found to moderate the relation between the media richness manipulation and teams’ mean performance belief ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype™) teams $t(100) = -0.12, sr^2 = .00, 95\% CI = [-.00, .00], \beta = -0.04$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = 1.19, sr^2 = .01, 95\% CI = [-.03, .05], \beta = 0.26$; and the difference between medium media richness (Skype™) and high media richness (collocated) teams $t(100) = 1.11, sr^2 = .01, 95\% CI = [-.03, .05], \beta = 0.27$.

Process performance. The age of participants within teams – as operationalized by the team’s mean age – was not found to moderate the relation between the media richness manipulation and teams’ process performance ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype™) teams $t(100) = 0.91, sr^2 = .01, 95\% CI = [-.02, .03], \beta = 0.27$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = 0.04, sr^2 = .00, 95\% CI = [-.00, .00], \beta = 0.009$; and the difference between medium media richness (Skype™) and high media richness (collocated) teams $t(100) = -1.00, sr^2 = .01, 95\% CI = [-.02, .04], \beta = -0.26$.

Task performance. The age of participants within teams – as operationalized by the team’s mean age – was not found to moderate the relation between the media richness
manipulation and teams’ task performance ratings. This was the case when examining the
difference between low media richness (email) and medium media richness (Skype\textsuperscript{tm}) teams
\( t(100) = -0.90, sr^2 = .01, 95\% CI = [-.02, .03], \beta = -0.27; \) the difference between low media
richness (email) versus high media richness (collocated) teams \( t(100) = -0.59, sr^2 = .00, 95\% CI
= [-.02, .02], \beta = -0.13; \) and the difference between medium media richness (Skype\textsuperscript{tm}) and high
media richness (collocated) teams \( t(100) = 0.53 \) \( sr^2 = .00, 95\% CI = [-.01, .02], \beta = 0.14. \)

\textit{Age and the Relation between Uncertainty and Team Performance}

\textit{Performance beliefs.} The age of participants within teams – as operationalized by the
team’s mean age – was not found to moderate the relation between teams’ mean uncertainty
ratings and teams’ mean performance belief ratings \( t(102) = -0.76, sr^2 = .004, 95\% CI = [-.16, .17], \beta
= -0.06. \)

\textit{Process performance.} The age of participants within teams – as operationalized by the
team’s mean age – was not found to moderate the relation between teams’ mean uncertainty
ratings and teams’ process performance ratings \( t(102) = 0.18, sr^2 = .00, 95\% CI = [-.18, .18], \beta = 0.02. \)

\textit{Task performance.} The age of participants within teams – as operationalized by the
team’s mean age – was not found to moderate the relation between teams’ mean uncertainty
ratings and teams’ task performance ratings \( t(102) = 0.48, sr^2 = .002, 95\% CI = [-.17, .18], \beta = 0.04. \)
Did Video Game Experience Moderate the Relation between Team Performance and its Predictors?

Overview and Rationale for Control Analysis

Due to the background of the sampling pool, participants in the present study were not expected to have any previous military experience that would give them an advantage in completing the Non-Combatant Evacuation Operation task; however, the Non-Combatant Evacuation Operation task relies more generally on spatial abilities (due to the use of maps), and the ability to memorize and assess different weapons. Because these skills are also used in many military-themed video games, it is possible that seasoned military video game players could have an advantage on the Non-Combatant Evacuation Operation relative to other participants. Consequently, video game experience was specifically expected to present a confounding finding by accounting for redundant variance in performance with its proposed predictors (i.e., media richness, uncertainty, and trust). To control for any confounding effect of video game experience on these relations, participants were asked to estimate the average number of hours they spent playing video games during a normal week. Because military-themed or other similar games were assumed to be particularly likely to affect performance on the Non-Combatant Evacuation Operation, participants were also be asked to list the games that they normally played during this time. Each participant’s list of games was subsequently coded as being either relevant to the Non-Combatant Evacuation Operation based on containing military-themed content (e.g., Call of Duty, Hearts of Iron), or as being irrelevant to the Non-Combatant Evacuation Operation based on not having military-themed content (e.g., Angry Birds, The Sims).
A video game experience variable was then created for each participant, corresponding to the number of hours spent playing military-themed video games per week. From this, the mean video game experience for the team was calculated across all members of each team. The team’s mean video game experience was then used to predict the slope coefficient between the media richness manipulation, the teams’ mean uncertainty, and the teams’ mean trust, and each of the three facets of team performance. If mean video game experience were to significantly predict this coefficient for any given facet of performance, it would suggest a moderating or confounding effect of video game experience on the relation between the corresponding predictor (i.e., media richness, uncertainty, or trust) and team performance scores (Bauer, Preacher, & Gil, 2006).

**Video Game Experience and the Relation between Media Richness and Team Performance**

*Performance beliefs.* The video game experience of participants within teams – as operationalized by the mean hours team members spent playing military-themed video games – was not found to moderate the relation between the media richness manipulation and teams’ mean performance belief ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype™) teams $t(100) = -0.60$, $sr^2 = .00$, 95% CI = [-0.02, 0.02], $\beta = -0.17$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = -0.93$, $sr^2 = .01$, 95% CI = [-0.02, 0.04], $\beta = -0.19$; and the difference between medium media richness (Skype™) and high media richness (collocated) teams $t(100) = -0.08$, $sr^2 = .00$, 95% CI = [-0.00, 0.00], $\beta = -0.02$.

*Process performance.* The video game experience of participants within teams – as operationalized by the mean hours team members spent playing military-themed video games – was not found to moderate the relation between the media richness manipulation and teams’
process performance ratings. This was the case when examining the difference between low media richness (email) and medium media richness (Skype\textsuperscript{tm}) teams $t(100) = 0.65$, $sr^2 = .00$, $95\% CI = [-.02, .02]$, $\beta = 0.17$; the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = 1.44$, $sr^2 = .02$, $95\% CI = [-.03, .06]$, $\beta = 0.28$; and the difference between medium media richness (Skype\textsuperscript{tm}) and high media richness (collocated) teams $t(100) = 0.41$, $sr^2 = .00$, $95\% CI = [-.01, .01]$, $\beta = 0.11$.

Task performance. The video game experience of participants within teams – as operationalized by the mean hours team members spent playing military-themed video games – was not found to moderate the relation between the media richness manipulation and teams’ task performance ratings. This was the case when examining the difference between low media richness (email) versus high media richness (collocated) teams $t(100) = 1.23$, $sr^2 = .01$, $95\% CI = [-.02, .05]$, $\beta = 0.24$; as well as the difference between medium media richness (Skype\textsuperscript{tm}) and high media richness (collocated) teams $t(100) = -1.74$, $sr^2 = .00$, $95\% CI = [-.03, .08]$, $\beta = -0.46$; as well as the difference between the low media richness (email) and medium media richness (Skype\textsuperscript{tm}) teams $t(100) = 2.62$, $sr^2 = .05$, $95\% CI = [-.02, .13]$, $\beta = 0.69$.

Video Game Experience and the Relation between Uncertainty and Team Performance

Performance beliefs. The video game experience of participants within teams – as operationalized by the mean hours team members spent playing military-themed video games – was not found to moderate the relation between teams’ mean uncertainty ratings and teams’ mean performance belief ratings $t(102) = -0.29$, $sr^2 = .00$, $95\% CI = [-.01, .01]$, $\beta = -0.03$.

Process performance. The video game experience of participants within teams – as operationalized by the mean hours team members spent playing military-themed video games –
was not found to moderate the relation between team’s mean uncertainty ratings and teams’
process performance ratings $t(102) = 0.37$, $sr^2 = .00$, 95% CI = [-.01, .01], $\beta = 0.04$.

Task performance. The video game experience of participants within teams – as
operationalized by the mean hours team members spent playing military-themed video games –
was not found to moderate the relation between teams’ mean uncertainty ratings and teams’ task
performance ratings $t(102) = -1.99$, $sr^2 = .03$, 95% CI = [-.03, .09], $\beta = -0.19$.

Video Game Experience and the Relation between Trust and Team Performance

Performance beliefs. The video game experience of participants within teams – as
operationalized by the mean hours team members spent playing military-themed video games –
was not found to moderate the relation between teams’ mean trust ratings and teams’ mean
performance belief ratings $t(102) = 0.77$, $sr^2 = .00$, 95% CI = [-.01, .01], $\beta = 0.05$.

Process performance. The video game experience of participants within teams – as
operationalized by the mean hours team members spent playing military-themed video games –
was not found to moderate the relation between team’s mean trust ratings and teams’ process
performance ratings $t(102) = 1.46$, $sr^2 = .02$, 95% CI = [-.03, .07], $\beta = 0.15$.

Task performance. The video game experience of participants within teams – as
operationalized by the mean hours team members spent playing military-themed video games –
was not found to moderate the relation between teams’ mean trust ratings and teams’ task
performance ratings $t(102) = 0.92$, $sr^2 = .01$, 95% CI = [-.03, .04], $\beta = 0.09$. 

226
Did Previous Familiarity Between Team Members Moderate the Relation between Trust and its Predictors?

Overview and Rationale for Control Analysis

Because trust is theorized to increase over time as team members become more familiar with one another (e.g., Iacono & Weisband, 1997), all study advertisements asked prospective participants to avoid signing up for the study with their friends. In doing so, it was hoped that all teams would complete the study with the same level of familiarity between team members at the start of the experiment. To confirm this was the case, during the final debrief each team was asked if they knew any of their team members from before the experiment. In the final sample, 73 of the 106 teams did not report having any previous familiarity between team members. Conversely, 12 of the 106 teams reported having partial familiarity between team members (i.e., two of three members had some previous acquaintanceship); and the remaining 21 teams reported having full familiarity between team members (i.e., all members of the team had some previous acquaintanceship).

Previous familiarity between team members was specifically expected to present a confounding finding by accounting for redundant variance in the relation between the media richness manipulation and trust; as well as the relation between uncertainty and trust. In order to statistically control for these effects, a previous familiarity variable was created for each team, corresponding to the whether the team members had some previous familiarity with one another prior to the start of the experiment. This previous familiarity variable was then used to predict the slope coefficient between the media richness manipulation, the teams’ mean uncertainty, and the team’s mean trust. If previous familiarity were to significantly predict this coefficient when using either media richness or uncertainty as a predictor, it would suggest a moderating or
confounding effect of previous familiarity on the relation between the corresponding predictor (i.e., media richness or uncertainty) and trust (Bauer, Preacher, & Gil, 2006).

**Previous Familiarity and the Relation between Media Richness and Trust**

Previous familiarity between team members – which was operationalized using a dummy-coded variable to distinguish teams in which no members knew one another before the study, versus teams where two or more members did know one another before the study – was not found to moderate the relation between the media richness manipulation and teams’ mean trust ratings $F(2, 100) = 0.50$, $\text{partial } \eta^2 = .001$, 95% CI = [.00, .06].

**Previous Familiarity and the Relation between Uncertainty and Trust**

Previous familiarity between team members – which was operationalized using a dummy-coded variable to distinguish teams in which no members knew one another before the study, versus teams where two or more members did know one another before the study – was not found to moderate the relation between teams’ mean uncertainty ratings and teams’ mean trust ratings $t(102) = 1.65$, $sr^2 = .02$, 95% CI = [-.03, .07], $\beta = 0.31$. 