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# Team Virtuality and Psychological Safety: An Experiment

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# TEAM VIRTUALITY AND PSYCHOLOGICAL SAFETY: AN EXPERIMENT

by

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## ABSTRACT

Working from home as part of a virtual team has become the status quo for many workers due to the COVID-19 pandemic. Moreover, modern organizations require teams skilled at complex problem-solving, innovation, and adaptability. Psychological safety enhances these skills, by means of fostering an environment in which team members can fully engage and learn. Given the theoretical possibility that team virtuality may dampen the development of team psychological safety, the present study empirically investigated relationship between these two constructs. A hypothesized model was tested, in which team virtuality has an indirect effect on team psychological safety, via intrateam perceived other-to-self peer support, and self-and-other anonymity. I recruited 213 participants via an online platform for pay. The participants were randomly assigned into 71 teams of three members to perform a 30-minute distributed expertise task. Each team was randomly assigned to one of three virtuality conditions, operationalized as the media richness of the computer technology they were required to use to communicate. Results demonstrated that, as team virtuality decreased (i.e., richer media technology), perceived peer support and team psychological safety increased, as did objective measures of team performance. In contrast, perceived anonymity decreased, but the relationship between anonymity and team psychological safety was not statistically significant. Scholarly and practical implications are discussed.

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# CHAPTER ONE: INTRODUCTION

Due to the COVID-19 pandemic, working from home as part of a *virtual* team has become necessary for many workers. Prior to the pandemic, the implementation of virtual teams (VTs) in organizations had already been predicted to increase tremendously (Dulebohn & Hoch, 2017). Despite the increased prevalence of virtual teams, research has illustrated a number of challenges they pose in terms of effective team process and outcomes (Greenberg et al., 2007; Schweitzer & Duxbury, 2010). Meanwhile, modern organizations require teams skilled at complex problem-solving, innovation, and adaptability (Djankov & Saliola, 2018; Edmondson & Lei, 2014). Extensive research has shown that the ability for a team to innovate, learn, and adapt is facilitated by team psychological safety (Edmondson, 1999; Frazier et al., 2017), which is broadly defined as a feeling or belief that people can take interpersonal risks within their team (e.g., speak up about problems, voice a contrary opinion, or publicly fail at a task) without fear of adverse consequences to one's image, status, work relationships, or job (Edmondson, 1999; Kahn, 1990; Schein & Bennis, 1965). However, we don't yet understand psychological safety within the context of virtual teams.

Researchers have theorized that levels of team psychological safety may be lower in VTs (Dzindolet et al., 2010; Edmondson, 2004; Edmondson & Lei, 2014), but this has yet to be investigated empirically. To the best of my knowledge, no studies to date have examined the relationship between team *virtuality* (i.e., the degree of how virtual a team is) and team psychological safety. Given the theoretical possibility that team virtuality may dampen the development of team psychological safety and consequently jeopardize the outcomes associated with psychological safety, the present study sought to empirically investigate the relationship between these two constructs by measuring the team psychological safety of ad hoc teams

assigned to one of three degrees of team virtuality. Team virtuality was manipulated by virtue of restricting each team to one of three common modes for computer-mediated communication: (1) video calls, (2) audio calls, and (3) instant text chat. In addition to clarifying the theoretical association between team virtuality and team psychological safety, the present findings carry practical implications for informing how to manage team virtuality to enhance team psychological safety within work teams and, by extension, leverage associated outcomes.

## CHAPTER TWO: THEORETICAL BACKGROUND

### Team Virtuality

Since the popularization of the Internet in the early 1990s, research on VTs[a] has grown rapidly. VTs can be broadly defined as teams in which members rely on computer-mediated communication rather than face-to-face interaction to perform their work. Furthermore, researchers in the past two decades have moved away from earlier dichotomous classifications of teams as being either *virtual* versus *face-to-face*, and toward a gradient and dimensional view of team *virtuality* (Dixon & Panteli, 2010). Numerous dimensions and corresponding measures of team virtuality have been proposed, but, perhaps due to the multifaceted and interdisciplinary nature of the construct, there is not yet clear consensus (Schweitzer & Duxbury, 2010; Foster et al., 2015; Orhan, 2017). Facets that have generally received more support in the literature include the amount of face-to-face interaction among teammates, the asynchronicity of teammate communications, and the geographic dispersion of teammates across separate rooms, buildings, cities, time zones, etc. (Dulebohn & Hoch, 2017). However, the necessity of geographic dispersion as a defining characteristic of VTs has been called into question, as teams can certainly display high virtuality with little—if any—geographic dispersion (Fiol & O'Connor, 2005; Orhan, 2017).

Other team characteristics (e.g., national diversity, changing team membership, workplace mobility, and the degree of dependence on information technology) have been proposed as dimensions of team virtuality because such characteristics have been frequently observed in virtual teams or may be enabled by technology (Schweitzer & Duxbury, 2010).

[a] Several synonyms for *virtual team* are found in the literature, including *distributed team*, *geographically dispersed team*, and *remote team*, but their use appears to have declined in favor of *virtual team*. Additionally, *team virtuality* is much more popular than *team virtualness*.

However, the ubiquity of a characteristic within virtual teams does not necessarily make said characteristic a defining component of team virtuality (Schweitzer & Duxbury, 2010, p. 277; Orhan, 2017). For example, although national diversity among teammates may frequently occur in more virtual teams (particularly in global virtual teams), national diversity itself does not measure virtuality nor is it a component of virtuality.

Careful consideration of the definition of *virtuality* can help guide researchers towards consensus. The most relevant entry for *virtual* in the Oxford English dictionary is, "a computerized or digitized simulation of something; *spec.* (esp. in earlier use) simulated in virtual reality. Also: established or conducted using computer technology rather than more traditional means" (Oxford English Dictionary, n.d., sec. 9.b.). In designating a degree of virtuality to a team, it is not sufficient for the team to merely lack face-to-face contact, nor for the team to use information and communication technology (ICT) merely for purposes not related to intrateam interaction. This is exemplified in co-located teams that use the internet to perform tasks (e.g., internet-based research, or data-entry) but who interact with one another primarily (or even exclusively) via in-person conversation. Rather, team virtuality is developed by the extent to which the team members use ICT to (1) communicate with each other (e.g., conversations via email, phone calls, and video calls) and (2) generally experience each other (e.g., non-interactive observations). Non-interactive observations can likewise be mediated by ICT, as is the case when teammates watch pre-recorded videos of their other teammates (e.g., a pre-recorded video presentation), and "silent video-calls" where teammates on a video-call with each other work independently on their individual assignments—without interacting with one another—to attempt to simulate the experience of working in a shared office environment. Such silent video-calls allow team members to indirectly learn about each other when they periodically glance at

computer displays and observe the appearance, mannerisms, and behaviors of their coworkers and/or the individual environment (often a home) in which each of their coworkers is situated.

With a working definition of what team virtuality is, we can turn to a brief discussion of how to measure it. In broad terms, it can be measured via the magnitude of the influence that ICT has on the nature of (1) intra-team communication and (2) the team members' general experiences of one another. This influence can be investigated with respect to: (a) the media richness[b] of the ICT; (b) measures of absolute time and proportions of time in which team members are experiencing each other via ICT; and (c) measures of the absolute number of team members as well as the proportion of team members that experience each other via ICT (per some unit of time or work session). Although all of the aforementioned dimensions are important for the measurement of team virtuality, the present study focuses on ICT media richness, and maintaining the other dimensions constant in the experiment design. This way, the present study disentangles and investigates the impact of media richness on psychological safety and other team-level constructs (i.e., peer support and anonymity).

Media richness refers to the characteristics of interactions that a communication medium affords (Dennis & Valacich, 1999). An intuitive sense of media richness can perhaps be obtained by considering that video calls are richer than phone calls, and phone calls are generally richer than phone text messages. In modern work, ubiquitous modes of communication that have received the most attention in the research literature include (1) email, (2) instant messaging, (3) phone calls, and (4) video calls (Raghuram et al., 2019). Each of these correspond to a different

[b] Kirkman and Mathieu (2005) introduced the concept of *informational value*, which is similar to media richness but focuses on the utility of a tool for a particular team's needs (e.g., 3D modeling software being particularly useful for a team of architects). However, as Schweitzer and Duxbury (2010) point out, the issue of tool utility is something that even co-located teams must address and is not actually a measure of virtuality per se.

degree of virtuality, respectively, by virtue of their richness. Generally speaking, richer media tend to allow users to approximate the feeling of being co-located (i.e., more like in-person face-to-face interactions, and less virtual). This is a simplification that is appropriate for the purposes of the present study. Those who wish to explore the nuance of specific dimensions of media richness should consult Dennis and Valacich (1999) and Daft and Lengel (1986). Teams that primarily use rich ICT have an increased likelihood of approximating the feeling of being co-located with their members in any given interactive session. Likewise, teams that primarily use *lean* ICT have an increased likelihood of developing a greater sense of team virtuality.

**Team Psychological Safety**

While media richness is a key consideration in defining team virtuality, research has yet to examine its impact on psychological states that the literature has shown to be instrumental in team learning and effectiveness—one such state of interest is psychological safety. In the organizational sciences, team psychological safety is broadly defined as a feeling or belief that it is safe to take risks within one's team (e.g., speak up about problems, voice a contrary opinion, or publicly fail at a task) without fear of adverse consequences to one's self-esteem, image, status, relationships, or job (Edmondson, 1999; Kahn, 1990; Schein & Bennis, 1965). Team psychological safety is somewhat conceptually different from individual psychological safety. Whereas individual psychological safety refers to one's feeling in a given situation or with a given set of people (e.g., "I often feel psychologically safe with this person"), team psychological safety refers to an aggregate or *shared* belief held by team members about how psychologically safe the *team* is (e.g., "Our team knows we are a psychologically safe team"; Tynan, 2005). Although there are merits to the study of psychological safety at each level of

analysis, studies at the team-level are by far the most popular (Edmondson & Lei, 2014). Indeed, teams continue to be a focal unit of analysis with regard to the performance of organizations (Morgeson et al., 2010). As such, the present study investigates psychological safety at the team level of analysis.

Empirical research has established the importance of team psychological safety with respect to work and organizations by virtue of its associated outcomes. Specifically, greater levels of team psychological safety among workers has been extensively linked with information sharing, voice-behaviors, learning-behaviors, performance, innovation, and creativity (see Edmondson & Lei, 2014; Frazier et al., 2017; Newman et al., 2017), all of which are arguably critical for modern organizations to survive in rapidly changing economies.

## CHAPTER THREE: HYPOTHESIS DEVELOPMENT

Although the relationship between team virtuality and team psychological safety has yet to be examined empirically, I propose two opposing mechanisms, one rooted in the literature on peer support and the other in the literature on anonymity(Figure 1). Specifically, with regard to peer support, theory suggests that high team virtuality will contribute to decreased perceptions of peer support (Greenberg et al., 2007; Sole & Edmondson, 2002), which leads to *lower* perceptions of team psychological safety. In opposition to this, the literature on anonymity (Nunamaker et al., 1996; Pinsonneault & Heppel, 1997) suggests that high team virtuality contributes to increased disinhibition due to feelings of anonymity, which leads to *greater* perceptions of team psychological safety.

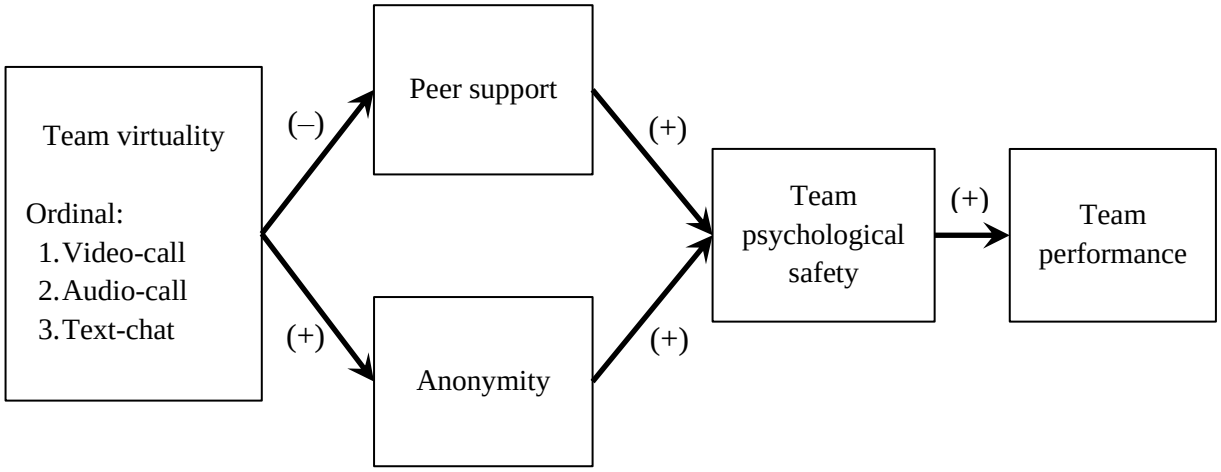



**Figure 1.** *Hypothesized Team-Level Model of the Effects of Team Virtuality on Team Psychological Safety and Performance*

**Peer Support**

Explanations of the effect of team virtuality on the development of intrateam relationships most frequently point at stunted relationships due to the limitations of computer-mediated communication. For example, Greenberg et al. (2007) described factors that led to the differential development of interpersonal relationships in VTs as compared to co-located teams. Specifically, co-located team members can more easily develop social bonds with each other by not being limited by communication technology (e.g., lack of intonation in emails, lack of body language during phone calls, difficulty of engaging in fast-paced back-and-forth dialogue in video calls). Furthermore, the constraints imposed by team virtuality limit informal spontaneous interactions among team members (e.g., brief chats in passing by a coworker in a hallway at the office), which hinders the development of trusting relationships (Sole & Edmondson, 2002).

The quality of interpersonal relationships among team members has been established as a key antecedent to team psychological safety (Carmeli & Gittell, 2009; Edmondson & Mogelof, 2006; Frazier et al., 2017; Gu et al., 2013; Huang & Jiang, 2012; Schulte et al., 2012). A noteworthy example comes from a longitudinal empirical study by Edmondson and Mogelof (2006) which found that positive team interactions were significantly positive predictors of team psychological safety. Specific facets of interpersonal relationships that have been examined with respect to psychological safety include supportive leadership and peer support. Among these two, meta-analytic evidence identifies peer support as the more significant antecedent of team psychological safety (Frazier et al., 2017). In explaining this link, May et al. (2004) posit that peer support is associated with feelings of mutual respect and value for each other's contributions, which are integral to the development of team psychological safety. Given that team psychological safety is largely determined by shared perceptions of intrateam behaviors, I

decided it would be more appropriate to focus on other-to-self peer support—which refers to peer support that a person (i.e., the self) perceives they receive from others—rather than self-to-other peer support because the latter could be more susceptible to measurement error via contamination from participants believing their own helpful intentions were actually perceived as peer support by their team members. Throughout the remainder of this paper, I will refer to other-to-self peer support as merely *peer* support. Thus, I hypothesized the following:

> Hypothesis 1: Team virtuality will be negatively related to team-aggregated[c] peer support.

> Hypothesis 2: Team-aggregated peer support will be positively related to team psychological safety.

> Hypothesis 3: Team virtuality will have an indirect effect on team psychological safety via team-aggregated peer support.

**Anonymity**

*Anonymity* refers to a condition in which one or more characteristics of a message source are unknown to the message recipient(s) (Scott, 2004). *Self-anonymity* refers to a message sender's self-perceived anonymity to others, whereas *other-anonymity* refers to the anonymity

[c] Peer support and anonymity are not defined to require within-group agreement in the present study, but they were nonetheless aggregated to the team level of analysis because the hypothesized model includes team performance as an endogenous variable and multilevel path models require endogenous variables to be at the lowest level of analysis. Therefore, the entire model needed to be specified at the team level of analysis.

that a message recipient perceives the sender to have. Throughout the remainder of this paper, I will refer to the combination of self- and other-anonymity as either *self-and-other anonymity* or simply *anonymity*. It is important to note that anonymity is conceptualized not as a dichotomous condition of absolute anonymity versus no anonymity, but rather as a gradient condition such that one's anonymity can span a range (e.g., from *somewhat* anonymous to *very* anonymous; Scott, 2004).

### *Anonymity and Team Virtuality*

Whereas the term *anonymity* generally refers to one's identity as a whole, researchers also distinguish among various types of anonymity, such as *visual anonymity*, in which one cannot see a message source, and *discursive anonymity*, in which verbal communication (whether written or spoken) cannot be attributed to the message source (Scott, 2004). One can quite easily extend the concept of specific types of anonymity and derive variations such as *vocal anonymity*, in which the sound of the speech of a messenger cannot be heard (e.g., when a message is sent via text), and *name anonymity*, in which one's name is not known. Furthermore, more complex types of anonymity can be derived by combining basic types, as in the case of creating *gender anonymity* via the combination of visual anonymity, vocal anonymity, and name anonymity.

Because lower levels of the media richness facet of virtuality inhibit the transmittance of a variety of cues (e.g., visual and auditory), it is reasonable to believe that greater degrees of team virtuality are associated positively with perceptions of greater levels of anonymity. Thus, I hypothesized the following:

Hypothesis 4: Team virtuality will be positively related to team-aggregated anonymity.

### *Anonymity and Team Psychological Safety*

The relationship between anonymity and team psychological safety can be hypothesized by virtue of the disinhibiting effect of anonymity. The large body of theoretical and empirical research on the effects of computer-mediated anonymity on group members—particularly within group support systems (Nunamaker et al., 1996; Pinsonneault & Heppel, 1997)—points at the feeling of disinhibition enabled by anonymity. This research demonstrates that anonymity reduces perceived pressure to conform to the group (Pinsonneault & Heppel, 1997) and reduces (or even eliminates) perceived status differences among group members—creating an effect referred to as the *equalization phenomenon* (Dubrovsky et al., 1991; Flanagin et al., 2002). The equalization phenomenon perspective posits that self- and other-anonymity can eliminate several types of social cues (e.g., facial expressions, vocal intonation), which in turn decreases the impact of social constraints and social norms and creates a feeling of disinhibition. Furthermore, research shows that anonymity can reduce fear of evaluation (Hayne & Rice, 1997; Pinsonneault & Heppel, 1997), fear of criticism, and fear of retribution from team members and supervisors (Nunamaker et al., 1996), all of which are associated with feelings of inhibition.

Taken together, the disinhibiting effects produced by anonymity overlap significantly with the effect produced by team psychological safety, although they are entirely distinct constructs. As such, it is plausible that a team member may *perceive* team psychological safety even if it is merely due to anonymity-fueled disinhibition. Thus, it stands to reason that greater amounts of perceived anonymity would be associated positively with perceived team psychological safety. Thus, I hypothesized the following:

Hypothesis 5: Team-aggregated anonymity will be positively related to team psychological safety.

Hypothesis 6: Team virtuality will have an indirect effect on team psychological safety via team-aggregated anonymity.

**Team Psychological Safety and Team Performance**

Team psychological safety has been empirically demonstrated to directly and indirectly relate to several individual- and group-level processes including engagement, voice behavior, information sharing, learning-behavior, trust, and conflict, all of which have been shown to have an effect on team performance (Edmondson & Lei, 2014; Frazier et al., 2017; Newman et al., 2017). For example, greater levels of psychological safety allow members to fully engage in their tasks as well as to engage in learning-behaviors and information sharing; in this way, psychological safety has a positive effect on team performance (Edmondson & Lei, 2014). In an effort to add to the body of empirical evidence demonstrating the effect of team psychological safety on team performance, I hypothesized the following:

Hypothesis 7: Team psychological safety will be positively related to team performance.

# CHAPTER FOUR: METHODS

Preregistered plans, data, and analysis scripts can be accessed at the project's Open Science Framework page: https://osf.io/nbztr/?view_only=ce7f8808c08144f6b2fb13b4ea2d74c7.

## Sample

An a priori power analysis, with error probability $\alpha = .05$ and power $(1 - \beta) = .80$, was computed using the G*Power software (version 3.1.9.6; Faul et al., 2007) for each portion of the hypothesized model, using (1) estimated corrected correlations from Frazier et al.'s (2017, p. 131) group-level meta-analysis, and (2) estimates for effect sizes in the absence of available empirical data. For the indirect effects, I consulted Fritz and MacKinnon's (2007, p. 237) simulated recommendations for sample size. The results of these a priori power analyses collectively indicated a sample size of 78 teams should have been sufficient to obtain statistically significant results. However, due to resource limitations, only 74 teams were ultimately recruited, of which 71 were included in the analyses (for reasons explained below).

In total, 222 adults were recruited via the Prolific online platform. 56% self-reported as female, 41% as male, and 3% as other genders. The median age band of participants was 25 to 34 years . The median level of education was a Bachelor's degree. Sixty-six percent of participants  self-reported as being only White, 10% as only Black, 5% as only Asian, 5% as White and Spanish/Hispanic/Latinx, and 14% as other race/ethnicities. Participants self-reported via their Prolific profile as being residents of the United States at the time of data collection and being fluent in written and spoken English. Participants were also screened via their Prolific profile and a screener questionnaire to ensure they had a laptop or desktop computer (tablets and mobile phones were prohibited due to limitations and inconsistencies in how they allow users to download and view PDF files while on a Zoom™ call), a microphone, a webcam, and an audio

output speaker. Participants were randomly assigned to teams of three members. One team was dropped from the analyses because one of their team members had to leave the experiment session early. Two other teams failed to submit their team performance data. Therefore, the final sample consisted of 213 individuals on 71 three-person teams.

**Procedure**

Participants scheduled themselves for an experiment session, listed on the Prolific online platform for compensation of $9.80 into the participant's Prolific account. A session only occurred when three participants signed up for it (i.e., a complete team of three members). During the sessions, a study facilitator provided instructions and participants completed a single 30-minute iteration of the TINSEL TOWN task (described in the following section) followed by an online questionnaire for the self-reported measures. Participants were reminded of how much time remained in the TINSEL TOWN task via a message that appeared on the participants' computer display for 10 seconds every 5 minutes, and with 3 minutes remaining, and one minute remaining. In total, the duration of participation was approximately 45 minutes for each participant. Upon completion of the session, participants received their compensation.

Teams were randomly assigned, yet evenly distributed, to one of three conditions in order of decreasing team virtuality: (1) the text-chat condition, (2) the audio-call condition, and (3) the video-call condition. Differences in the degree of virtuality across the conditions are defined by virtue of the different levels of media richness each ICT transmits, and do not imply any absolute levels of virtuality (e.g., the text-chat condition has the highest degree of virtuality relative to the other two conditions, but it does not necessarily represent a *high* degree of virtuality in absolute terms). Text-chat teams were only permitted to use online instant messaging (i.e., text-chat

within the Zoom™ software)—communications via audio and/or video were prohibited. Audio-call teams were only permitted to use synchronous audio communication (i.e., an audio-only Zoom™ call without video nor text-chat). Video-call teams were only permitted to use synchronous audio-video calling (i.e., Zoom™ without the text-chat feature). Although modern teams in reality make simultaneous use of various types of ICT, the present experiment design only allowed one ICT tool per experiment condition for the sake of experimental control.

**Team Task**

Each team was tasked with completing the TINSEL TOWN activity developed by Devine et al. (2004). This activity was chosen because (1) it is challenging enough such that team performance can benefit from team psychological safety, and (2) it approximates the complexity of the work performed by modern teams that operate virtually. TINSEL TOWN is a distributed expertise activity that places participants in the role of a top management team of a fictional movie-production company in which participants must work interdependently to determine the optimal set of choices that maximize the company's profits (see Devine et al., 2004, for full details). Each participant is assigned to a distinct role (i.e., *Developer*, *Marketer*, or *Researcher*), corresponding to possessing a unique set of information that is necessary to complete the task. The information for performing the activity was provided to participants via digital documents in Portable Document Format (i.e., PDF), and participants were prohibited from sharing documents. All participants were required to adopt a code name corresponding to their assigned role. The nature of the task is complex in the sense that it involves many steps that combine information from several documents, such that no single team member can accomplish the task alone because each member is provided a unique set of necessary information.

## Measures

All questionnaire items are presented in Appendix A.

### *Peer Support*

Team-level perceived peer support was computed by aggregating individual perceptions of peer support, using an additive composition model (Chan, 1998) and the arithmetic mean of within-team responses to Ducharme and Martin's (2000) ten-item scale. Their scale was developed with two factors: (1) affective support, and (2) instrumental support (each factor corresponding to five items). The items have been adapted slightly in the present study by (1) putting them in the first-person point of view, (2) replacing *coworker* with *team member*, and (3) replacing "while you're absent" with "if you were absent"[d] in one item. Items were scored on a seven-point agreement scale from 1 "Strongly disagree," to 7 "Strongly agree." A sample item is "My team members are helpful in getting the job done." In the present study, Cronbach's α was .92.

An additive composition model was used because perceived peer support is defined in the present study as the other-to-self peer support the individual members perceived they received as individuals; it is not defined in terms of a shared consensus of how much peer support was received across the team. Whereas other constructs are defined by shared consensus among team members (e.g., team climate and culture are defined as shared perceptions; there is arguably no team-level culture if all team members disagree on what the team's culture is) and are measured

[d] This latter change was made to avoid phrasing that implies the participant was ever absent during our session.

using consensus-based aggregation models, peer support (and anonymity) are constructs that can exist in the absence of team-level consensus (e.g., one team member may experience much more peer support than other members). Although researchers may be interested in investigating within-group consensus on peer support (and anonymity), the present study proposed that team virtuality would have an impact on peer support (and anonymity) without necessarily creating within-team consensus on perceived levels of peer support (nor anonymity), due to a variety of individual-level factors such as individual tasks, personality, and familiarity with computer technology that would cause differential effects of virtuality on the perceived receipt of peer support. Moreover, I theorized that team-average levels of peer support would have an impact on team psychological safety, regardless of whether there was within-team consensus on peer support, because members would pick up on resultant behaviors such as complaining and changes in information-sharing (i.e., members may withdraw and become quieter when they are frustrated), which would have an effect on perceptions of team psychological safety. Therefore, I computed the team-level arithmetic average of individual perceptions of peer support, regardless of the presence or absence of consensus on this measure. This additive composition model is reflected in the wording of the peer support items, which focuses on the individual respondent's experience, rather than the team as whole.

### *Anonymity*

Team-level perceived anonymity was computed by aggregating individual-level perceived anonymity, using an additive composition model (Chan, 1998) and the arithmetic mean of within-team responses to a measure that is similar to the approach used by Rains et al. (2007). Participants were asked three items: one item to capture the extent to which *they* felt

anonymous throughout the team task, and two items to capture the extent to which they felt each of their two *teammates* were anonymous. A sample item is "I feel that I was anonymous throughout the team task." Items were scored on a seven-point agreement scale from 1 "Strongly disagree," to 7 "Strongly agree." Cronbach's $\alpha$ in the present study was .94.

Similar to the rationale for using an additive composition model for perceived peer support, an additive composition model was also used for perceived anonymity because it is defined in the present study in terms of the self- and other-anonymity the individual members perceive; it is not defined in terms of a shared consensus among the group members about how anonymous the team members are as a collective whole. I theorized that a variety of individual-level factors such as familiarity with computer technology, general propensity to trust others, and personality (e.g., extraversion and openness to experiences) would cause differential effects of team virtuality on perceived anonymity. Further, I theorized that team-averaged anonymity would have an impact on team psychological safety, regardless of shared consensus on anonymity, due to resultant behaviors such as information-sharing (e.g., members may interpret quiet members as being afraid to speak their mind). Therefore, I computed the team-level arithmetic average of individual perceptions of anonymity, regardless of the presence or absence of consensus on this measure.

### *Team Psychological Safety*

Team psychological safety was assessed using Edmondson's (1999) seven-item scale. The scale demonstrates strong psychometric properties across studies (Newman et al., 2017), including concurrent criterion-related evidence of validity, discriminant evidence of construct-related validity against related constructs, moderate inter-item correlations, and a Cronbach's $\alpha$

of .82 in Edmondson's original sample (1999)—comparable to $\alpha = .78$ in the present study. Given that team psychological safety is defined as a shared belief about the team as a whole, it is computed by aggregating individual perceptions of team psychological safety with a referent-shift consensus composition model (Chan, 1998) using the arithmetic mean of within-team perceptions. Aggregation indices for the present study are summarized in Table 3 and discussed in the corresponding subsection of Results. Sample items include "It is safe to take a risk in this team" and "Members of this team are able to bring up problems and tough issues." The items were on a seven-point agreement scale from 1 "Strongly disagree," to 7 "Strongly agree."

### *Team Performance*

Team performance was operationalized as the numerical profit that the team achieves in the TINSEL TOWN task, expressed as a percentage of the maximum possible profit. Teams that did not abide by the budgetary constraints established in the task received a performance score of zero. Given that the performance score corresponds to the entire team, this measure is purely at the team level of analysis and does not involve any aggregation from individual-level data.

### *Controls*

In general, one's familiarity with computer technology may influence their experience in a virtual team (e.g., predisposing them to feeling comfortable with ICT). As such, I controlled for intrateam averages of (1) technological self-efficacy, (2) prior use of ICT similar to those employed in the present study, and (3) age. These averages were computed as the arithmetic mean within the team, which corresponds to an additive composition model. The additive composition model is most appropriate given that these controls are not defined as shared team-

level properties that hinge on consensus; rather, they reflect individual-level properties that may be unique to each member.

**Technological Self-Efficacy.** Technological self-efficacy refers to one's confidence in one's skills to successfully complete "high-tech" tasks. This was measured via an adaptation of McDonald and Siegall's (1992) 5-item measure, on a seven-point agreement scale from 1 "Strongly disagree," to 7 "Strongly agree." The adaptations to the measure consisted of (1) adding "or my friends or peers" after "my work group", to help contextualize the item for participants who may not have a work group, and (2) removing items 4 and 5 because they specifically focus on making evaluations with regard to a particular software that was the target of McDonald and Siegall's (1992) study. A sample item is "When I have to learn a new task that is high-tech, my first reaction is that I'm sure I can do it." The measure demonstrated high internal reliability in the present study, with a Cronbach's $\alpha$ of .81.

**Prior use of similar ICT**. Two items asked the respondent to report the frequency with which they typically use (1) group text-chat software such as Discord®, Slack®, or Microsoft Teams®, and (2) video-call software such as Zoom™, Skype®, or FaceTime®. These items are on a five-point frequency scale from 1 = "Never or almost never," to 5 = "Daily."

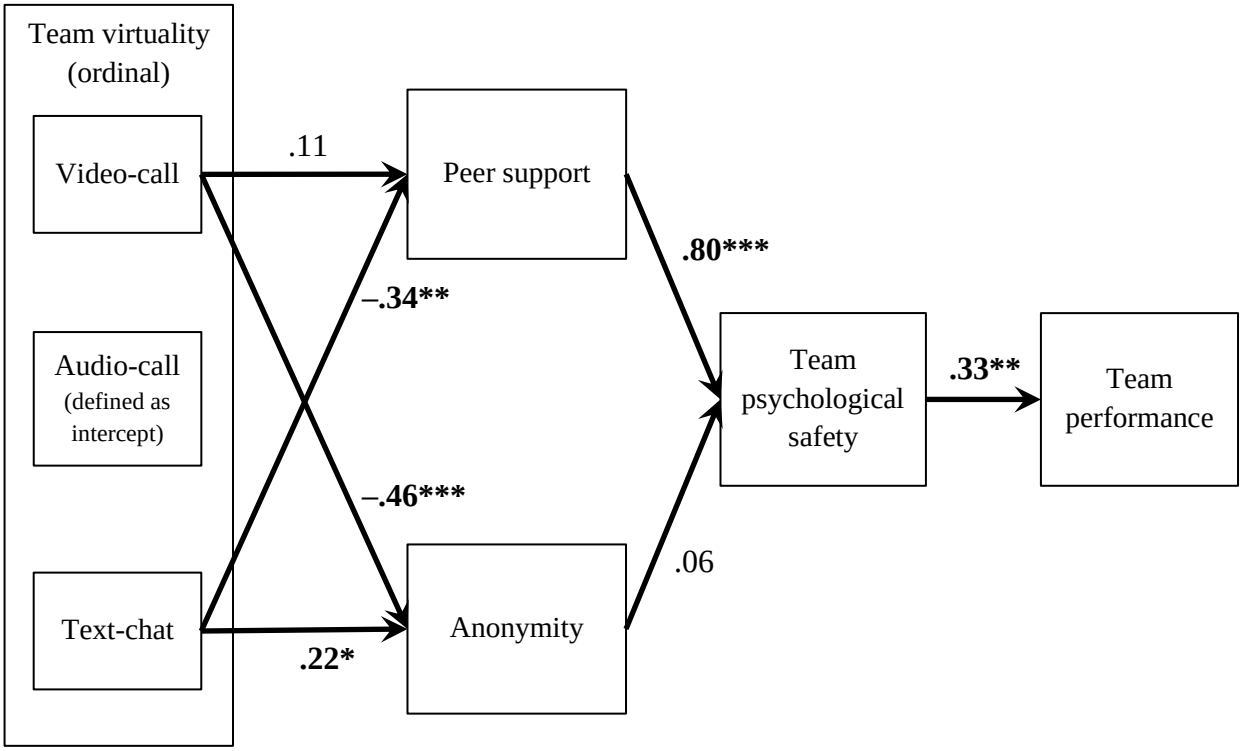
## Analyses

All hypotheses were tested using path analysis with the lavaan package (version 0.6-9) within R version 4.1.1. Because the virtuality condition is an ordinal predictor in the hypothesized model, I dummy coded it into the regression equations in two ways for ease of interpretation. Specifically, in one iteration I designated the text-chat condition as the "reference group" (i.e., the intercept) because that makes it easier to interpret the resulting effects as the

degree of virtuality increases/decreases. In the other iteration, I designated the audio-call condition as the reference group because it represents the “middle” condition along our ordinal dimension of virtuality, which aids in the interpretation of the regression coefficients from the other two conditions with respect to this “middle” condition. The respondent questionnaire was designed such that a response was required for all items, therefore there was no missing data on the individual-level data. However, team-level performance data was missing for two teams which were therefore omitted from the analysis, thus dropping the sample size from 74 teams to 71 teams.

## CHAPTER FIVE: RESULTS

Table 1 summarizes the descriptive statistics, inter-measure correlations, and Cronbach's $\alpha$ for each variable. Table 2 summarizes the means and standard deviations for each variable per each virtuality condition. Figure 2 represents the empirically supported model.




*Note*. The entire model is at the team level of analysis. Standardized coefficients are shown. The audio-call condition is defined as the intercept for the regression analysis with dummy codes for the video-call and text-chat conditions. $N$ = 71 teams.

**Figure 2.** *Empirically Supported Model*

### Aggregation to the Team Level of Analysis

In the present study, team psychological safety was the only construct that was conceptualized with a consensus-based composition model (Chan, 1998). As expected, the

measure of team psychological safety displayed sufficient statistical justification for aggregation to the team level of analysis. Using a format encouraged by Biemann et al. (2012), Table 3 summarizes the aggregation indices for team psychological safety and, for informational purposes, peer support and anonymity. Medians, .25, and .75 quantiles—rather than means—are reported for $r_{WG(J)}$ due to the skewed-negative distribution of $r_{WG(J)}$ across teams. In addition to the standard practice of reporting $r_{WG(J)}$ with respect to the uniform null distribution of error (i.e., $r_{WG(J).uniform}$), $r_{WG(J)}$ was also computed with respect to a slightly skewed null distribution of error (i.e., $r_{WG(J).measure\text{-}specific}$), given the expectation of a leniency bias whereby respondents may have judged their teammates favorably due to politeness. LeBreton and Senter's (2008) value for the variance of a slightly skewed null distribution of error for a measure with 7 response options (i.e., 2.90) was used for this computation. The median[e] $r_{WG(J).uniform}$ was .92, and median $r_{WG(J).measure\text{-}specific}$ was .86, both of which are greater than .70, suggesting strong within-team agreement (LeBreton & Senter, 2008).

ICC(1) and ICC(2) values for team psychological safety provide further evidence in support of aggregation to the team level of analysis. Specifically, an ICC(1) value of 0.17 represents a medium-large effect (LeBreton & Senter, 2008). ICC(2) is interpreted similarly to other measures of reliability. However, ICC(2) is affected by group size, such that larger groups will have larger ICC(2) values, all other things being equal (Klein & Kozlowski, 2000), and high ICC(2) values are known to be difficult to achieve when there are less than a handful of members per group (Schneider et al., 2013). Given that the teams in the present study had only three members, it is not surprising that the ICC(2) for team psychological safety was only 0.39,

[e] The median, rather than the mean, was used because the distribution of $r_{WG(J)}$ across teams was skewed negative.

although this value is not necessarily low either. Thus, given the relatively high ICC(1), the conditionally acceptable ICC(2), and the high average $r_{WG(J)}$, team psychological safety was determined to demonstrate sufficient statistical justification for aggregation to the team level of analysis for all teams. The Post Hoc Sensitivity Analyses section reports the Null Hypothesis Significance Testing results when teams with $r_{WG(J)} < .50$ are dropped from the analyses.

**Model Fit and Alternative Models**

The hypothesized model displayed good fit to the data (CFI = 1.00, TLI = 1.042, RMSEA = 0.00, SRMR = .041), and it demonstrated better fit in comparison to an a priori alternative model in which a direct effect was added between team virtuality (along with the control variables) and team psychological safety, $\chi^2_{\text{difference}}(5, N = 71) = 3.20$, $p = .669$. Other alternative models were not considered theoretically defensible a priori.

The results of the path analysis on the hypothesized model indicated that the relationship of each of the three control variables (i.e., technological self-efficacy, prior use of similar ICT, and age) with peer support and anonymity were not statistically significant (*p*-values available in Table 4). Removing these control variables resulted in a better-fitting model as determined by a $\chi^2$ difference test, $\chi^2_{\text{difference}}(6, N = 71) = 4.67$, $p = .586$, CFI = 1.00, TLI = 1.018, RMSEA = 0.00, SRMR = .048. Therefore, the hypothesized model without control variables was used to test the a priori hypotheses.

**Hypothesis Testing**

Results of the path analyses are summarized in Figure 2 and Table 5. The team virtuality condition was negatively related to team-aggregated peer support, $R^2_{\text{adjusted}}$ = .15, $F(2,68) = 7.00$, $p$ = .002, such that video-call teams reported greater peer support than text-chat teams. However, there was no statistically significant difference between the audio-call teams versus video-call teams in this regard. Still, these results support Hypothesis 1. Secondly, team-aggregated peer support was positively related to team psychological safety, $R^2_{\text{adjusted}}$ = .60, $F(2,68) = 53.3$, $p$ <.0001, thus supporting Hypothesis 2. Thirdly, team virtuality condition had an indirect effect on team psychological safety via team-aggregated peer support, specifically when comparing the video-call teams versus the text-chat teams. Similar to the results for Hypothesis 1, there was no statistically significant difference in this indirect effect among audio-call teams versus video-call teams. Together, these results support Hypothesis 3.

Team virtuality condition was positively related to team-aggregated anonymity, $R^2_{\text{adjusted}}$ = .35, $F(2,68) = 19.9$, $p < .0001$, such that the average level of anonymity reported was different between each of the three virtuality conditions, thus supporting Hypothesis 4. However, no statistically significant relationship between anonymity and team psychological safety was found, thus failing to support Hypothesis 5. Furthermore, there was no statistically significant indirect relationship between team virtuality condition and team psychological safety via anonymity, thus failing to support Hypothesis 6.

Team psychological safety was positively related to team performance, $R^2_{\text{adjusted}}$ = .10, $F(1,69) = 8.37$, $p$ = .005, thus supporting Hypothesis 7.

**Post Hoc Sensitivity Analyses**

Rather than using the average $r_{WG(J)}$ across all teams to determine whether TPS can be aggregated to the team level of analysis, one can also omit from subsequent analyses the teams whose $r_{WG(J)}$ is lower than a cut-off score. LeBreton and Senter (2008) provide a rubric for evaluating a range of $r_{WG(J)}$ scores; specifically, scores from .00 to .30 represent a lack of consensus, .31 to .50 is weak consensus, .51 to .70 is moderate consensus, .71 to .90 is strong consensus, and .91 to 1.00 is very strong consensus. Thus, a post hoc subsample was created by omitting all 13 teams whose $r_{WG(J)}$ on team psychological safety was less than or equal to .50[f], therefore only keeping teams with at least moderate agreement on team psychological safety. This post hoc subsample ($N$ = 58 teams) retained a fairly equal number of teams across virtuality conditions, with 19 teams in the text-chat condition, 21 in the audio-call condition, and 18 in the video-call condition.

An ANOVA on team psychological safety's $r_{WG(J)}$ demonstrated no difference between the three virtuality conditions when the full sample ($N$ = 71 teams) was used, $F(2, 68) = 0.414$, $p = .663$. However, the post hoc subsample did demonstrate a difference in $r_{WG(J)}$, $F(2, 55) = 3.49$, $p = .037$. Tukey's post hoc "Honest Significant Difference" test specified that a difference was only detected between the audio-call and video-call conditions. However, the size of this difference was so small as to be practically insignificant (difference in $M$ = 0.08, 95% CI[0.004, 0.16], Cohen's $d$ = 0.26).

Results of the path analyses on the post hoc sub-sample are summarized in Table 6, which closely replicate the findings from the full sample such that the parameter estimates and

[f] A stricter cut-off score of .70 would have only resulted in the removal of an additional 6 teams.

their corresponding *p*-values were nearly identical in the full sample versus the post hoc sub-sample. Thus, the results from the full sample are robust with regard to this sensitivity analysis.

**Post Hoc Direct and Indirect Effects**

Additionally, although I did not hypothesize *a priori* a measurable indirect effect of peer support (nor anonymity) on team performance through team psychological safety, these indirect effects were implied in the theoretical and therefore they were taken into consideration post hoc. The indirect effect of peer support on team performance was computed with percentile-based confidence intervals from 1,000 bootstrapped iterations, yielding a statistically significant indirect effect, $\beta$ = 0.26, 95% CI[0.09, 0.43], *SE* = 0.09, *p* = .002. The indirect effect of anonymity on team performance was not computed because the relationship between anonymity and psychological safety was already determined via Null Hypothesis Significance Testing as not statistically significant.

Similarly, a measurable two-step indirect effect of the team virtuality conditions on team performance, through team psychological safety and either peer support or anonymity was not formally hypothesized. This is because the indirect effect of the virtuality conditions was considered to be too far removed from team performance to yield a measurable effect. Still, we computed post hoc the indirect effect through the two-step path of peer support followed by psychological safety. When comparing the text-chat versus the audio-call condition (with the audio-call condition set as the regression intercept), their difference in this indirect effect approached significance, $\beta$ = -0.09, 95% CI[-0.18, 0.00], *SE* = 0.05, *p* = .051, suggesting that audio-call teams performed slightly better than text-chat teams. The difference between the text-chat versus the video-call condition (with the text-chat condition as the regression intercept) was statistically significant, $\beta$ = 0.12, 95% CI[0.02, 0.22], *SE* = 0.05, *p* = .014, indicating that video-

call teams performed better than text-chat teams. However, the difference in performance between the video-call versus the audio-call condition (with the audio-call condition as the regression intercept) was not statistically significant, $\beta$ = .03, 95% CI[-0.03, 0.09], *SE* = 0.03, *p* = .328. On the whole, these results show that the indirect effect of team virtuality on team performance became more positive as virtuality decreased (i.e., as the virtuality condition better approximated a traditional co-located experience).

Additionally, although direct paths were not hypothesized to team performance from peer support nor from anonymity, these paths were explored post hoc. When adding both direct paths simultaneously into the hypothesized model (without control variables), the $\chi^2$ test of model fit favored the hypothesized model, $\chi^2_{\text{difference}}(2, N = 71) = 0.830$, $p = .660$. Further, neither direct path was statistically significant; for the path from peer support to team performance: $\beta$ = -0.08, 95% CI[-0.43, 0.28], *SE* = 0.18, *p* = .677; for the path from anonymity to team performance: $\beta$ = -0.11, 95% CI[-0.33, 0.12], *SE* = 0.11, *p* = .341.

Lastly, a direct relationship between team virtuality condition and team performance was taken into consideration post hoc. However, this relationship was not statistically significant among any of the virtuality conditions, $p > .40$.

# CHAPTER SIX: DISCUSSION

The present results supported a majority of the hypotheses, except for the relationship between anonymity and team psychological safety (i.e., Hypotheses 5 and 6). The relation between peer support and team psychological safety, as well as the relation between team psychological safety and team performance, matched recent meta-analytic results (Frazier et al., 2017). That is, peer support was related positively to psychological safety, which was related positively to team performance. Further, the different levels of team virtuality (distinguished by the level of media richness in each condition) did have an impact on perceived peer support and anonymity. Specifically, greater media richness was associated with higher levels of perceived peer support, and lower levels of anonymity, as hypothesized. Anonymity was not related to team psychological safety, suggesting that the theoretical rationale for this association may have been incorrect or that another variable may have moderated this relationship.

## Theoretical Contributions

The present study makes contributions to theory in two primary areas: (1) the literature on team virtuality and media richness, and (2) the literature on psychological safety. With regard to media richness and team virtuality, the present study offers an explanation for why less peer support was reported in the text-chat condition versus the audio-call and video-call conditions, whereas there was no statistically significant difference between the audio-call condition compared to the video-call condition. Specifically, these results suggest that (1) the effect of hearing one's teammates' voices in real time has a significant impact on feeling peer support, compared to not hearing the voices at all, and (2) the effect of seeing one's teammates' faces in real time does not result in elevated levels of perceived peer support beyond what can be

expected in an audio-only call, all else being equal. Because the measure of peer support was composed of both affective and instrumental peer support, a post hoc path analysis was conducted to determine whether different results would be obtained after separating peer support into the two constituent factors. This post hoc analysis replicated the pattern of results originally obtained with peer support, suggesting that affective support and instrumental support were not differentially perceived between the audio-call and video-call conditions. These results suggest that, in the context of computer-mediated communication, peer support is perceived more strongly via auditory cues rather than facial or body-language cues.

Of course, the virtuality conditions in the present study solely manipulated the ICT media richness facet of virtuality, which is merely one facet of team virtuality. Therefore, we cannot rule out the possibility that other facets of team virtuality (e.g., the amount or proportion of time that teammates spend interacting while co-located) may influence the present results. For example, it is possible that perceived peer support would differ as a function of the average amount of time the team members spend on a phone or video call with each other. In this case, a team that spends 10 hours per week on group *video* calls may perceive significantly greater levels of peer support than a team that spends 1 hour per week on group *audio* calls (without video), all other factors being equal. Future research is needed to investigate these various facets of virtuality.

Regarding the levels of perceived anonymity among the virtuality conditions, the present study offers a perspective for finding that there was much less perceived anonymity reported among the video-call teams than in the audio-call teams, whereas the difference between the text-chat versus the audio-call teams was not as large. Specifically, these results suggest that seeing one's teammates' faces and having one's face seen (in real time) has a greater impact on

feeling anonymous than does being able to hear each other's voices, all other factors being equal. In terms of the different types of signals that are transmitted by different levels of media richness, it is likely that visual signals that are of a personal nature (e.g., one's face, body, or bedroom) have a greater impact on perceived anonymity, than does auditory signals about oneself (i.e., one's voice). Additionally, it is possible this effect may be related to the general understanding that most people know how to take a still image (i.e., a screenshot) of a video-call and post it publicly on the Internet, whereas the same is not true for an audio-call. Thus, participants may have felt that a video-call was riskier in this regard.

With regard to psychological safety, the present results demonstrated a direct relationship between team psychological safety and team performance, with psychological safety accounting for at least 10% of the variance on team performance. Whereas many other models specify the mediating variables by which team psychological safety has an indirect effect on team performance (e.g., engagement and learning-behaviors), the present study supports a strong direct relationship between team psychological safety and team performance, at least in the context of performing knowledge work. We don't necessarily have a reason to believe that team psychological safety wouldn't have similar effects on team performance for tasks that aren't characterized as knowledge work, such as physical work (Frazier et al., 2017). This strong relationship adds credibility to claims of the importance of team psychological safety, in order to enhance team performance.

Furthermore, the present findings replicate meta-analytic data and provide further evidence on the relationship between peer support and psychological safety even though the team members were interacting purely via computer-mediated communication, thus showing that

virtual teams are still subject to the dynamics of peer support and psychological safety despite diminished social cues.

The lack of a statistically significant relationship between anonymity and team psychological safety suggests either (1) a true lack of a strong association between anonymity and team psychological safety, rather than a Type II error, or (2) the existence of a moderating third variable. Given the theoretical basis of the relationship between anonymity and team psychological safety (e.g., the equalization phenomenon and disinhibition) proposed in the introduction section, it is more likely that there is a moderating variable. For example, it is possible that some participants are better able to discriminate between disinhibited behavior that results from anonymity rather than from team psychological safety. This would suggest individual differences in propensities for committing a fundamental attribution error (Langdridge & Butt, 2004), i.e., attributing team interpersonal dynamics to team psychological safety, rather than to anonymity-fueled disinhibition. There is some evidence of individual differences in the relation between one's propensity to make social attribution errors and (1) one's own personality (Block & Funder, 1986), and (2) social explanatory styles (Gill & Andreychik, 2014), but more specific theories are needed before a specific moderating third variable for the present study can be confidently proposed.

**Practical Implications**

The results of the present study suggest that teams should carefully consider the ICT they use for their work. Firstly, rather than communicating solely via text-based mediums (e.g., text-chat, emails, etc.), teams may perceive greater levels of peer support from their team members just by communicating via synchronous audio calls (e.g., using audio calls in Microsoft Teams®,

Discord®, or Zoom™) without necessarily having to turn on their video cameras. This latter detail is particularly encouraging for members working from home, who may not want to turn on their cameras, due to children or other distractions that may enter into the visual field of the camera. The resultant higher levels of perceived peer support are likely to have an indirect on team performance, through increased psychological safety (this indirect effect was shown to be statistically significant in the post hoc analysis section).

Secondly, although the present study found no relationship between anonymity and psychological safety, there was a relationship between media richness and anonymity. As such, teams may still wish to implement technology with levels of media richness that induce anonymity on an as-needed basis, e.g., in a Group Support System designed to leverage the benefits of anonymity to enhance the quality of group decision-making (Nunamaker et al., 1996; Valacich et al., 1992).

More broadly speaking, while text-based communications may be particularly convenient for some purposes, an overreliance on them may not be as helpful for teams to achieve a positive sense of peer support and psychological safety. Thus, it may be reasonable for a team to adopt a habit of meeting in-person or at least face-to-face via a video-call with some routine frequency. While such face-to-face interactions may be more costly in terms of time and efficiency in some respects, they may effectively "pay for themselves" in the long run by fostering desirable within-team sociopsychological dynamics (e.g., emergent states such as cohesion and trust) that have empirically been found to have a positive relationship with team performance, team commitment, and team satisfaction (Frazier et al., 2017).

**Limitations and Future Directions**

A number of limitations are identified in the present study, which can be addressed in future studies. Firstly, although the three anonymity items displayed high internal consistency (Cronbach's $\alpha$ = .94) and the self-anonymity item (i.e., "I feel that I was anonymous throughout the team task") correlated strongly with the mean of the two other-anonymity items (i.e., "I feel that [team member title] was anonymous throughout the team task"), $r(219) = .83$, $p < .0001$, it is possible the anonymity items were too broad and therefore interpreted in different ways among the respondents. For example, it's possible that some respondents may have interpreted "anonymity" as referring to specific facets of their identity such as their gender, race-ethnicity, or age. This may have introduced measurement error which further led to the lack of a statistically significant relationship between anonymity and team psychological safety. Thus, future research can seek to employ measures of anonymity that target specific facets of identity (e.g., name, gender, race/ethnicity, age), in addition to a general measure of anonymity (like what was used in this study). Results can then be compared between the general measure versus the facet-specific measures.

Secondly, there may have been unintended variance in the participants' awareness of time during the team task. Periodic reminders of how much time remained for the task-portion of the experiment were only briefly displayed on the participants' Zoom™ window on their computer display for 10 seconds per reminder. When the reminders were sent, text-chat teams engaged in more discussion of the remaining time compared to the other virtuality conditions. One possible reason for this may have been that the text-chat teams needed to view the Zoom™ window almost constantly to send and read messages in their team. In contrast, the audio-call and video-call teams may not have had their Zoom™ windows visible on their computer displays

as often, especially after they got into a rhythm with the task and spent more time looking at the documents, rather than the Zoom™ window. As a result, they may have missed some of those periodic reminders of remaining time, which in turn may have affected the teams' performance. Although a one-way ANOVA revealed no difference in performance between the virtuality conditions in the full sample, $F(2, 68) = 0.95$, $p = .392$, nor in the post hoc sub-sample, $F(2, 55) = 1.12$, $p = .335$, we cannot rule out the possibility that missing out on the timely reminders of remaining time may have impacted the within-team dynamics in some way that could have indirectly affected team performance. Future studies can remedy this by using reminders that are simultaneously auditory and visual.

Thirdly, future research can seek to further explore the nomological network surrounding the relationship between team virtuality and team psychological safety. Examples of potentially important variables include (1) the frequency of within-team meetings and interactions; (2) the number and proportion of team members who interact virtually with the team; (3) the proportion of time spent interacting virtually; (4) team compositional and structural features such as member diversity, member churn, faultlines, shared leadership, and task complexity; (5) individual member characteristics such as personality and hostile attribution biases; and (6) mediating mechanisms such as task conflict, relationship conflict, and psychological distance (Trope & Liberman, 2010).

Lastly, because the present study represents a first attempt at empirically determining the relationship between team virtuality and team psychological safety, a laboratory experiment seemed most appropriate to exercise precise control over the virtuality conditions. However, given the present results that confirmed the majority of the hypotheses, future research can seek to test these findings in real teams within existing organizations. Of course, care will need to be

taken to ensure that a field sample contains sufficient variability in virtuality conditions such that differential effects on constructs of interest can be detected. This may require improved measures of team virtuality, particularly because (1) the existing literature lacks consensus on the definition of virtuality, and (2) team virtuality is undoubtedly a multi-faceted construct in the real world (as briefly mentioned earlier) which further complicates its measurement.

## CHAPTER SEVEN: CONCLUSION

Team virtuality and psychological safety are relatively newer topics—especially at their intersection. The present study takes an initial step to examine the relationship between team virtuality and psychological safety. The findings provide important theoretical and empirical contributions to the literature on the intersection of team virtuality and team psychological safety. Results indicate that different levels of team virtuality (specifically with respect to media richness) differentially affect perceived peer support and anonymity. Although we found no relationship between anonymity and team psychological safety, we did confirm a strong relationship between peer support and team psychological safety, which in turn is related to team performance. As work and society at large increasingly operate in a virtual capacity, researchers in the social, behavioral, and organizational fields will need to meet the world where it's at, to have a meaningful impact that truly enhances wellbeing and other desired outcomes.

# APPENDIX A:

# QUESTIONNAIRE ITEMS

Questionnaire items about the team were grouped together in the questionnaire and were contextualized with this instruction: "Think about your team ***from today's task*** as you answer these questions."

These are the scale anchors for the seven-point agreement scale:

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Neither agree nor disagree
5. Somewhat agree
6. Agree
7. Strongly agree

**Peer Support**

***Affective support from peers:***

1. My team members really care about me.
2. I feel close to my team members.
3. My team members take a personal interest in me.
4. I feel appreciated by my team members.
5. My team members are friendly to me.

***Instrumental support from peers:***

1. My team members would fill in if I were absent.
2. My team members are helpful in getting the job done.
3. My team members give useful advice on job problems.
4. My team members assist with unusual work problems.
5. My team members will pitch in and help.

**Anonymity**

On a seven-point agreement-scale from 1 = *Strongly Disagree*, 7 = *Strongly Agree*.

1. I feel that I was anonymous throughout the team task.
2. I feel that [team member 1] was anonymous throughout the team task.
3. I feel that [team member 2] was anonymous throughout the team task.

**Team Psychological Safety**

On a seven-point agreement-scale from 1 = *Strongly Disagree*, 7 = *Strongly Agree*.

1. If you make a mistake in this team, it is often held against you.
2. Members of this team are able to bring up problems and tough issues.
3. People in this team sometimes reject others for being different.
4. It is safe to take a risk in this team.
5. It is difficult to ask other members of this team for help.
6. No one on this team would deliberately act in a way that undermines my efforts.
7. Working with members of this team, my unique skills and talents are valued and utilized.

**Technological Self-Efficacy**

Adaptation of McDonald and Siegall's (1992) measure on a seven-point agreement-scale from 1 = *Strongly Disagree*, to 7 = *Strongly Agree*.

For the following items, please think about your ***general life experiences***.

1. When I have to learn a new task that is high-tech, my first reaction is that I'm sure I can do it.
2. In terms of my ability to learn new tasks that are high-tech, I would describe myself as one of the best in my work group [or my friends or peers].
3. In the past, I have had a great amount of experience (either on or off the job) working on high-tech tasks.

The following two items were not included in the present study, due to their specific focus on a particular software that was the target of McDonald and Siegall's (1992) study.

4. I am extremely confident that I can learn to use CAT on my job
5. CAT will allow me to perform my job better and more efficiently.

**Frequency of use of video-call or group text-chat software**

Measured on the following five-point frequency scale: 1 = *Never or almost never*, 2 = *A few times per year*, 3 = *A few times per month*, 4 = *A few times per week*, 5 = *Daily*.

How often do you ***use*** any of the following types of apps or software?

1. Group text-chat software such as Discord®, Slack®, or Microsoft Teams®?
2. Video-call software such as Zoom™, Skype®, or FaceTime®?

**Age**

What is your age?

18–24
25–34
35–44
45–54
55–64
65–74
75 years or older

**Gender**

What is your gender?

1. Male
2. Female
3. Non-binary / third gender
4. Prefer not to say

**Education**

What is the highest level of education you have ***completed***?

1. Did not graduate high school
2. High school diploma or GED
3. Some college, but no degree
4. Associate's degree (two-year college degree)
5. Bachelor's degree (four-year college degree)
6. Master's degree
7. Doctoral degree

**Race/Ethnicity**

What is your race or ethnicity? Select ***ALL*** that apply.

1. White

2. Black or African American
3. Spanish, Hispanic, or Latinx
4. Native American
5. Pacific Islander
6. Asian
7. Other: [text box]

# APPENDIX B:

# TABLES

**Table 1**

*Team-level Descriptive Statistics, Correlations, and Cronbach's α*

| Measure | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Perceived peer support | 5.26 | 0.74 | .92 | | | | | | |
| 2. Perceived anonymity | 5.25 | 1.00 | **-.37**** | .94 | | | | | |
| 3. Team psychological safety | 5.64 | 0.60 | **.78***** | **-.24*** | .78 | | | | |
| 4. Team performance | 42.09 | 32.31 | **.25*** | -.17 | **.33**** | - | | | |
| 5. Technological self-efficacy | 5.08 | 0.72 | .17 | -.02 | .19 | .14 | .81 | | |
| 6. Prior frequency of use of similar ICT | 3.61 | 0.58 | .04 | -.03 | -.04 | -.10 | **.25*** | .63 | |
| 7. Age band[a] | 2.36 | 0.73 | -.08 | -.06 | -.03 | -.09 | .08 | -.01 | - |

*Note*. ICT = Information and communication technology. *Cronbach's α* are listed along the diagonal.

[a]Age band is measured at an approximately interval level of measurement, such that 1 = 18–24, 2 = 25–34, 3 = 35–44, …, 7 = 75 years or older.

*$p < .05$, **$p < .01$, ***$p < .001$.

**Table 2**

*Team-level Means and Standard Deviations, Per Each Virtuality Condition*

| | Text-chat | | Audio-call | | Video-call | |
|---|---|---|---|---|---|---|
| Measure | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| 1. Perceived peer support | 4.85 | 0.76 | 5.38 | 0.54 | 5.55 | 0.71 |
| 2. Perceived anonymity | 5.89 | 0.78 | 5.42 | 0.67 | 4.45 | 0.93 |
| 3. Team psychological safety | 5.43 | 0.67 | 5.66 | 0.44 | 5.83 | 0.61 |
| 4. Team performance | 34.84 | 34.30 | 47.11 | 34.75 | 44.55 | 27.58 |
| 5. Technological self-efficacy | 5.08 | 0.57 | 5.03 | 0.89 | 5.14 | 0.71 |
| 6. Prior frequency of use of similar ICT | 3.66 | 0.60 | 3.52 | 0.56 | 3.65 | 0.59 |
| 7. Age band[a] | 2.15 | 0.44 | 2.39 | 0.72 | 2.53 | 0.93 |

*Note*. ICT = Information and communication technology. Coefficient $\alpha$ are listed along the diagonal.

[a]Age band is measured at an approximately interval level of measurement, such that 1 = 18–24, 2 = 25–34, 3 = 35–44, …, 7 = 75 years or older.

**Table 3**

*Aggregation Statistics for Team Psychological Safety, and for Other Aggregated Variables*

| | $r_{WG(J).uniform}$ | | | $r_{WG(J).measure\text{-}specific}$ | | | | | Other Indices | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measure | Med. | .25 quantile | .75 quantile | Shape | $\sigma_E^2$ | Med. | .25 quantile | .75 quantile | *F* ratio | ICC(1) | ICC(2) |
| Team psychological safety (7)[a] | 0.919 | 0.853 | 0.965 | slight skew | 2.90 | 0.863 | 0.694 | 0.948 | 1.64* | 0.176 | 0.390 |
| Perceived peer support (7)[a] | 0.949 | 0.906 | 0.973 | slight skew | 2.90 | 0.915 | 0.810 | 0.959 | 2.019** | 0.254 | 0.505 |
| Perceived anonymity (7)[a] | 0.682 | 0.000 | 0.900 | triangular | 2.10 | 0.000 | 0.000 | 0.767 | 1.077 | 0.025 | 0.071 |

*Note*. Although peer support and anonymity were aggregated according to an additive composition model, aggregation statistics for these two variables are provided here for informational purposes. Shape = the shape of the alternative null distribution of error; a skewed shape corresponds to respondents' leniency bias, and a triangular shape corresponds to respondents' central tendency bias; $\sigma_E^2$ = variance of the alternative null distribution of error. Expected variances for the measure-specific null distributions were taken from LeBreton and Senter (2008, p. 832).

[a]Denotes a 7-point response scale.

*$p < .01$, **$p < .001$.

**Table 4**

*Team-level Path Analysis with Control Variables*

| Direct Effects | *B* | *p* | *SE* | $B_{95\%\ CI_{lower}}$ | $B_{95\%\ CI_{upper}}$ | $R^2$ |
|---|---|---|---|---|---|---|
| **Predicting Peer Support** | | | | | | .23 |
| Intercept (Text-chat condition) | 4.29*** | .0000 | .69 | 2.93 | 5.65 | |
| Audio-call condition | .59** | .0018 | .19 | .22 | .96 | |
| Video-call condition | .77*** | .0000 | .19 | .40 | 1.14 | |
| Computer Self Efficacy | .18 | .0970 | .11 | -.03 | .40 | |
| Frequency of use of similar software | .01 | .9171 | .14 | -.25 | .28 | |
| Age band[a] | -.19 | .0709 | .11 | -.41 | .02 | |
| | | | | | | |
| **Predicting Anonymity** | | | | | | .37 |
| Intercept (Text-chat condition) | 5.79*** | .0000 | .85 | 4.12 | 7.46 | |
| Audio-call condition | -.49* | .0330 | .23 | -.95 | -.04 | |
| Video-call condition | -1.47*** | .0000 | .23 | -1.92 | -1.02 | |
| Computer Self Efficacy | .01 | .9119 | .13 | -.25 | .28 | |
| Frequency of use of similar software | -.05 | .7876 | .17 | -.37 | .28 | |
| Age band[a] | .09 | .5097 | .13 | -.17 | .35 | |

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

[a]Age band is measured at an approximately interval level of measurement, such that 1 = 18–24, 2 = 25–34, 3 = 35–44, …, 7 = 75 years or older.

**Table 5**

*Team-level Path Analysis Results*

| Direct Effects | *B* | *p* | *SE* | $B_{95\%\ CI_{lower}}$ | $B_{95\%\ CI_{upper}}$ | $\beta$ | *p* | *SE* | $\beta_{95\%\ CI_{lower}}$ | $\beta_{95\%\ CI_{upper}}$ | $R^2_{adjusted}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Predicting Peer Support** | | | | | | | | | | | .15 |
| *With Text-chat condition as the intercept:* | | | | | | | | | | | |
| Intercept (Text-chat condition) | 4.85*** | .0000 | .14 | 4.58 | 5.11 | 6.64 | .0000 | .65 | 5.36 | 7.91 | |
| Audio-call condition | .53** | .0062 | .19 | .15 | .91 | .34 | .0035 | .12 | .11 | .57 | |
| Video-call condition | .71*** | .0002 | .19 | .33 | 1.08 | .46 | .0000 | .11 | .24 | .67 | |
| *With Audio-call condition as the intercept:* | | | | | | | | | | | |
| Intercept (Audio-call condition) | 5.38*** | .0000 | .14 | 5.11 | 5.65 | 7.36 | .0000 | .62 | 6.16 | 8.57 | |
| Text-chat condition | -.53** | .0062 | .19 | -.91 | -.15 | -.34 | .0035 | .12 | -.57 | -.11 | |
| Video-call condition | .17 | .3685 | .19 | -.21 | .55 | .11 | .3653 | .12 | -.13 | .36 | |
| **Predicting Anonymity** | | | | | | | | | | | .35 |
| *With Text-chat condition as the intercept:* | | | | | | | | | | | |
| Intercept (Text-chat condition) | 5.89*** | .0000 | .16 | 5.57 | 6.20 | 5.95 | .0000 | .42 | 5.13 | 6.76 | |
| Audio-call condition | -.47* | .0413 | .23 | -.92 | -.02 | -.22 | .0364 | .11 | -.43 | -.01 | |
| Video-call condition | -1.44*** | .0000 | .23 | -1.88 | -.99 | -.69 | .0000 | .08 | -.84 | -.53 | |
| *With Audio-call condition as the intercept:* | | | | | | | | | | | |
| Intercept (Audio-call condition) | 5.42*** | .0000 | .16 | 5.10 | 5.74 | 5.47 | .0000 | .44 | 4.61 | 6.33 | |
| Text-chat condition | .47* | .0413 | .23 | .02 | .92 | .22 | .0364 | .11 | .01 | .43 | |
| Video-call condition | -.97*** | .0000 | .23 | -1.42 | -.52 | -.46 | .0000 | .10 | -.65 | -.27 | |
| **Predicting Team Psychological Safety** | | | | | | | | | | | .60 |
| Intercept | 2.01*** | .0000 | .45 | 1.13 | 2.89 | 3.35 | .0003 | .92 | 1.53 | 5.16 | |
| Peer Support | .66*** | .0000 | .06 | .53 | .78 | .80 | .0000 | .05 | .70 | .89 | |
| Anonymity | .03 | .4470 | .05 | -.05 | .12 | .06 | .4473 | .08 | -.09 | .21 | |
| **Predicting Team Performance** | | | | | | | | | | | .10 |
| Intercept | -57.53 | .0898 | 33.91 | -123.99 | 8.93 | -1.79 | .07296 | 1.00 | -3.75 | .17 | |
| Team Psychological Safety | 17.67** | .0031 | 5.98 | 5.95 | 29.38 | .33 | .00174 | .11 | .12 | .54 | |

| Indirect Effects | *B* | *p* | *SE*† | $B_{95\%\ CI_{lower}}$ | $B_{95\%\ CI_{upper}}$ | $\beta$ | *p* | *SE*† | $\beta_{95\%\ CI_{lower}}$ | $\beta_{95\%\ CI_{upper}}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **Predicting Team Psychological Safety** | | | | | | | | | | |
| *With Text-chat condition as the intercept:* | | | | | | | | | | |
| Audio-call condition → Peer Support | .35** | .0047 | .12 | .11 | .59 | .27 | .0030 | .09 | .09 | .45 |
| Video-call condition → Peer Support | .46** | .0010 | .14 | .18 | .74 | .36 | .0006 | .11 | .16 | .57 |
| Audio-call condition → Anonymity | -.02 | .5430 | .03 | -.08 | .03 | -.01 | .5128 | .02 | -.05 | .03 |
| Video-call condition → Anonymity | -.05 | .4910 | .07 | -.19 | .10 | -.04 | .4844 | .06 | -.15 | .07 |
| *With Audio-call condition as the intercept:* | | | | | | | | | | |
| Text-chat condition → Peer Support | -.35** | .0047 | .12 | -.59 | -.11 | -.27 | .0030 | .09 | -.45 | -.09 |
| Video-call condition → Peer Support | .11 | .3599 | .12 | -.12 | .36 | .09 | .3526 | .10 | -.10 | .28 |
| Text-chat condition → Anonymity | .02 | .5430 | .03 | -.03 | .08 | .01 | .5128 | .02 | -.03 | .05 |
| Video-call condition → Anonymity | -.03 | .4968 | .05 | -.13 | .07 | -.03 | .4814 | .04 | -.10 | .05 |

*Note*. Direction of indirect paths are indicated with →.

†Standard errors of indirect effects are estimated via percentile bootstrapping (1,000 iterations), which did not substantially differ from the Sobel test estimates.

*$p$ < .05, **$p$ < .01, ***$p$ < .001.

**Table 6**

*Team-level Path Analysis Results, After Dropping Teams Whose* $\boldsymbol{r}_{\text{WG(J).measure-specific}}$ *for Team Psychological Safety is < .50*

| Direct Effects | *B* | *p* | *SE* | $B_{95\%\ \text{CI}_{\text{lower}}}$ | $B_{95\%\ \text{CI}_{\text{upper}}}$ | $\beta$ | *p* | *SE* | $\beta_{95\%\ \text{CI}_{\text{lower}}}$ | $\beta_{95\%\ \text{CI}_{\text{upper}}}$ | $R^2_{\text{adjusted}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Predicting Peer Support** | | | | | | | | | | | .23 |
| *With Text-chat condition as the intercept:* | | | | | | | | | | | |
| Intercept (Text-chat condition) | 4.97*** | .0000 | .11 | 4.76 | 5.18 | 9.23 | .0000 | .95 | 7.38 | 11.09 | |
| Audio-call condition | .51*** | .0006 | .15 | .22 | .79 | .45 | .0001 | .12 | .22 | .68 | |
| Video-call condition | .64*** | .0000 | .15 | .34 | .94 | .55 | .0000 | .11 | .33 | .76 | |
| *With Audio-call condition as the intercept:* | | | | | | | | | | | |
| Intercept (Audio-call condition) | 5.48*** | .0000 | .10 | 5.28 | 5.68 | 10.17 | .0000 | .90 | 8.41 | 11.94 | |
| Text-chat condition | -.51*** | .0006 | .15 | -.79 | -.22 | -.44 | .0001 | .11 | -.66 | -.22 | |
| Video-call condition | .13 | .3710 | .15 | -.16 | .43 | .11 | .3676 | .13 | -.13 | .36 | |
| **Predicting Anonymity** | | | | | | | | | | | .32 |
| *With Text-chat condition as the intercept:* | | | | | | | | | | | |
| Intercept (Text-chat condition) | 5.84*** | .0000 | .19 | 5.48 | 6.21 | 5.82 | .0000 | .46 | 4.92 | 6.71 | |
| Audio-call condition | -.48 | .0601 | .26 | -.99 | .02 | -.23 | .0534 | .12 | -.47 | .00 | |
| Video-call condition | -1.46*** | .0000 | .27 | -1.98 | -.94 | -.67 | .0000 | .09 | -.85 | -.49 | |
| *With Audio-call condition as the intercept:* | | | | | | | | | | | |
| Intercept (Audio-call condition) | 5.36*** | .0000 | .18 | 5.01 | 5.71 | 5.34 | .0000 | .48 | 4.40 | 6.28 | |
| Text-chat condition | .48 | .0601 | .26 | -.02 | .99 | .23 | .0534 | .12 | .00 | .45 | |
| Video-call condition | -.98*** | .0002 | .26 | -1.49 | -.47 | -.45 | .0000 | .11 | -.66 | -.24 | |
| **Predicting Team Psychological Safety** | | | | | | | | | | | .48 |
| Intercept | 2.14*** | .0001 | .56 | 1.04 | 3.24 | 4.50 | .0022 | 1.47 | 1.62 | 7.38 | |
| Peer Support | .64*** | .0000 | .08 | .47 | .81 | .73 | .0000 | .07 | .59 | .86 | |
| Anonymity | .03 | .4482 | .05 | -.05 | .12 | .07 | .4481 | .10 | -.11 | .26 | |
| **Predicting Team Performance** | | | | | | | | | | | .09 |
| Intercept | -88.91 | .0716 | 49.35 | -185.63 | 7.82 | -2.71 | .0548 | 1.41 | -5.47 | .06 | |
| Team Psychological Safety | 22.95** | .0073 | 8.56 | 6.18 | 39.72 | .33 | .0044 | .12 | .10 | .56 | |

| Indirect Effects | *B* | *p* | *SE*† | $B_{95\%\ \text{CI}_{\text{lower}}}$ | $B_{95\%\ \text{CI}_{\text{upper}}}$ | $\beta$ | *p* | *SE*† | $\beta_{95\%\ \text{CI}_{\text{lower}}}$ | $\beta_{95\%\ \text{CI}_{\text{upper}}}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **Predicting Team Psychological Safety** | | | | | | | | | | |
| *With Text-chat condition as the intercept:* | | | | | | | | | | |
| Audio-call condition → Peer Support | .32** | .0017 | .10 | .13 | .54 | .33 | .0001 | .09 | .16 | .50 |
| Video-call condition → Peer Support | .41** | .0015 | .13 | .17 | .69 | .40 | .0001 | .10 | .20 | .60 |
| Audio-call condition → Anonymity | -.02 | .5372 | .03 | -.09 | .02 | -.02 | .4989 | .02 | -.07 | .03 |
| Video-call condition → Anonymity | -.05 | .4638 | .07 | -.20 | .08 | -.05 | .4484 | .06 | -.17 | .08 |
| *With Audio-call condition as the intercept:* | | | | | | | | | | |
| Text-chat condition → Peer Support | -.32** | .0017 | .10 | -.54 | -.13 | -.32 | .0001 | .08 | -.48 | -.16 |
| Video-call condition → Peer Support | .09 | .3590 | .09 | -.08 | .28 | .08 | .3510 | .09 | -.09 | .26 |
| Text-chat condition → Anonymity | .02 | .5372 | .03 | -.02 | .09 | .02 | .4989 | .02 | -.03 | .06 |
| Video-call condition → Anonymity | -.03 | .4626 | .05 | -.13 | .06 | -.03 | .4365 | .04 | -.11 | .05 |

*Note*. Direction of indirect paths are indicated with →.

†Standard errors of indirect effects are estimated via percentile bootstrapping (1,000 iterations), which did not substantially differ from the Sobel test estimates.

*$p$ < .05, **$p$ < .01, ***$p$ < .001.

## APPENDIX C:

## IRB DETERMINATION OF EXEMPTION FROM REGULATION

UNIVERSITY OF CENTRAL FLORIDA

**Institutional Review Board**
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

June 17, 2021

Dear Moses Rivera:
On 6/17/2021, the IRB determined the following submission to be human subjects research that is exempt from regulation:

| | |
|---|---|
| Type of Review: | Initial Study, Initial Study |
| Title: | Team Virtuality and Psychological Safety: An Experiment |
| Investigator: | Moses Rivera |
| IRB ID: | STUDY00002979 |
| Funding: | Name: Society for Industrial and Organization |
| Grant ID: | |
| Documents Reviewed: | • HRP-251, Category: Faculty Research Approval;<br>• Developer ~ packet, Category: Other;<br>• End-of-session questionnaire, Category: Test Instruments;<br>• Experimenter script, Category: Other;<br>• Final Recommendations ~ Year One ~ Marketing, Category: Other;<br>• Final Recommendations ~ Year Two ~ Marketing, Category: Other;<br>• General Memo, Category: Other;<br>• HRP-254, Category: Consent Form;<br>• HRP-255, Category: IRB Protocol;<br>• Marketer ~ Year One ~ packet, Category: Other;<br>• Marketer ~ Year Two ~ packet, Category: Other;<br>• Profit scoring, Category: Other;<br>• Recruitment on MTurk, Category: Recruitment Materials;<br>• Researcher ~ Year One ~ packet, Category: Other;<br>• Researcher ~ Year Two ~ packet, Category: Other;<br>• Screener questionnaire, Category: Survey / Questionnaire;<br>• Screenplay Profiles ~ Year One, Category: Other;<br>• Screenplay Profiles ~ Year Two, Category: Other |

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.
If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Katie Kilgore
Designated Reviewer

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