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Does team communication represent a one-size-fits-all approach?: A meta-analysis of team communication and performance

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ABSTRACT

Although it is consistently identified as a critical component of team performance, team communication is often conceptualized in a variety of manners. The present meta-analysis addresses this inconsistency by examining the moderating influence of communication characteristics, as well as other salient team and task characteristics, on the relationship between team communication and performance. The findings revealed several fundamental insights. First, communication quality had a significantly stronger relationship with team performance than communication frequency. Second, further distinguishing between different communication types, classifying communication into the eight most commonly measured communication forms (e.g., knowledge sharing, information elaboration), has further value; information elaboration has the strongest relationship with performance while self-report frequency and objective frequency have the weakest relationships. Third, familiar and face-to-face teams exhibited a stronger relationship between communication and performance. These results indicate the necessity of distinguishing between different communication types in both practical and theoretical applications of team science.

1. Introduction

The modern workforce faces numerous challenges associated with recent changes prompted by globalization, advancing technology, and a shifting economy (Ilgen, 1994). To contend with these dynamic conditions, organizations are increasingly opting to utilize teams (Lawler, Mohrman, & Benson, 2001), as such entities are argued to be more suited to contending with complex tasks than individuals and offer organizations a host of advantages (Campbell, 1988; Sundstrom, De Meuse, & Futrell, 1990). Mirroring this trend, research has correspondingly expanded (Mathieu, Hollenbeck, van Knippenberg, & Ilgen, 2017), with empirical work examining factors that contribute to the effectiveness of teams burgeoning (e.g., Hu & Liden, 2011; Wang, Waldman, & Zhang, 2014). A prevalent finding within the teams literature is the necessity of team communication for effective team performance (Marks, Zaccaro, & Mathieu, 2000; Warkentin & Beranek, 1999).

Relatedly, Mesmer-Magnus and colleagues conducted two meta-analyses on information sharing and performance, examining unique information sharing (i.e., the extent to which teams share information that is uniquely held by certain members of the team) and openness of information sharing (i.e., the extent to which teams share information, regardless of the distribution of commonly held information) (Mesmer-Magnus & DeChurch, 2009; Mesmer-Magnus, DeChurch, Jimenez-Rodriguez, Wildman, & Shuffler, 2011); both forms of information sharing were found to significantly, positively relate to performance. However, complicating present understanding about the relationship between team communication and performance, team communication has been defined and evaluated in a variety of manners that do not necessarily align with the construct of information sharing (MacMillan, Entin, & Serfaty, 2004). For example, a distinguishable aspect of high-performing expert teams is their ability to perform well without overtly communicating; that is, information is not necessarily shared, yet team members still exhibit high levels of performance (Burke, Salas, Wilson-Donnelly, & Priest, 2004). In accordance with this difficulty, Stout, Salas, and Carson (1994) suggested that the relationship between team communication and performance has been inconsistent in previous studies because of the varying ways in which communication has been evaluated.

Illustrating this trend, knowledge sharing (e.g., “old members give

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advice to new members"; Henttonen, Janhonen, & Johanson, 2013, p. 623), information elaboration (e.g., "the group members contributed a lot of information during the group task"; Homan et al., 2008, p. 1212), and openness of communication ("team members have an open and honest communication during the meetings"; Puck, Rygl, & Kittler, 2006, pp. 231–232) all represent different types of team communication measures. Although it is likely that there is some overlap between these measures, it is unclear whether they represent distinct facets of communication and relate to performance in unique manners. Moreover, despite clear agreement on the importance of team communication, the degree to which communication is required for achieving high levels of performance under different conditions (e.g., varying task types) is relatively unexplored on a systematic level. This is in spite of the evidence suggesting communication may be more or less important, given differing circumstances (e.g., Bowers, Jentsch, Salas, & Braun, 1998).

Consequently, the aim of the present meta-analysis is to advance present understanding regarding the extent to which team communication is related to team performance under varying conditions. To accomplish this aim, and expand upon the work of Mesmer-Magnus and DeChurch (2009), Mesmer-Magnus et al. (2011), we incorporate additional types of communication, beyond information sharing, into our meta-analytic effect size estimating the relationship between team communication and performance. This provides insight into the overarching strength of this relationship which, to our knowledge, has yet to be meta-analytically assessed. We further contribute to the literature by examining the influence of theoretically relevant moderators on this relationship. In particular, we explore three broad categories that consistently emerge as influential to teams across studies: team characteristics, task characteristics, and aspects of team communication operationalization.

The team characteristics we examine include team familiarity, virtuality, and leadership structure. Team familiarity has been found to enhance a variety of team processes and team performance (e.g., Gruenfeld, Mannix, Williams, & Neale, 1996; Harrison, Mohammed, McGrath, Florey, & Vanderstoep, 2003; Littlepage, Robison, & Reddington, 1997), highlighting the importance of examining whether this positive influence generalizes to the relationship between overall communication and performance. The influence of virtuality has similarly been emphasized within the literature as critical to shaping team functioning but especially so in the case of communication (e.g., Lu, Watson-Manheim, Chudoba, & Wynn, 2006). Although the effect of virtuality has been meta-analytically examined within the context of information sharing (Mesmer-Magnus et al., 2011), it has yet to be systematically assessed in regard to overall communication despite the numerous theoretical arguments emphasizing its potentially negative impact (e.g., Gibson & Cohen, 2003). Finally, leadership structure represents another salient team characteristic that may differ across teams in organizations (e.g., hierarchical, shared; Pearce & Manz, 2005). Understanding whether the necessity of communication to effective performance changes as a function of leadership represents a substantial contribution to the literature; although leadership is often emphasized as influencing teamwork (Zaccaro, Rittman, & Marks, 2001), to our knowledge it has yet to be meta-analytically tested.

Task characteristics represent another condition argued by researchers to have a strong effect on team functioning (Saavedra, Earley, & Van Dyne, 1993; Shea & Guzzo, 1987; Sundstrom et al., 1990). Communication needs, and the influence of communication on performance, may be altered dramatically by the nature of the task type and interdependence (i.e., the level of interaction required among team members by the task; Shea & Guzzo, 1987). Yet, there are few studies examining how the relationship between communication and performance may differ due to the influence of task features and, of these studies, many center primarily on virtual teams (e.g., Rico & Cohen, 2005). There is not enough evidence to conclusively determine whether this relationship is significantly changed by task characteristics. Synthesizing this literature, and examining the moderating influence of task interdependence and task type across studies, represents another substantial contribution of the present meta-analysis.

Finally, we suggest that the largest contribution of our effort stems from our examination of the influence of different features of team communication. We examine theoretical arguments set forth in the literature, including the distinction between task-oriented and relational communication content (Keyton, 1997) and the distinction between communication quality and frequency (Marks et al., 2000). Although these theoretical frameworks offer strong rationale for distinguishing between these different facets of communication, these aspects of communication have yet to be empirically compared to determine if they have unique relationships with performance. Addressing this gap will provide empirical support for these theoretical frameworks. Finally, we investigate the distinct relationships with performance associated with additional communication types, beyond unique and open information sharing, to clarify whether they significantly differ. Although a variety of team communication measures have been utilized, whether they relate to performance in different ways has yet to be acknowledged or tested. By addressing these gaps in this science, we expand our understanding of the relationship between team communication and performance and incrementally contribute to related theory.

2. Team communication and team performance

Team communication can be defined as an exchange of information, occurring through both verbal and nonverbal (e.g., email) channels, between two or more team members (Adams, 2007; Mesmer-Magnus & DeChurch, 2009). Measures of team communication generally capture the degree to which team members feel the information received from team members was clear (e.g., Hoch & Kozlowski, 2014), the frequency with which they interacted with other team members (e.g., Bunderson & Sutcliffe, 2003), the extent to which knowledge was shared (e.g., Kessel, Kratzer, & Schultz, 2012), or some combination of these components. Team communication is conceptualized as integral to a majority of team processes or the interdependent team behaviors that lead to outcomes such as performance (Marks, Mathieu, & Zaccaro, 2001). Specifically, communication is posited to enhance team performance via facilitating and improving critical team processes, such as coordination and strategy formulation (Marks et al., 2001). For instance, it serves the primary purpose of clarifying misunderstandings among team members (Fletcher & Major, 2006), but also functions as a conduit through which team members can distribute crucial information to other team members.

Further, communication enables team members to receive information pertaining to the environment and situational factors which could impact the nature and demands of the team tasks (MacMillan et al., 2004). In addition to this, researchers posit that communication assists in the development of team emergent states (e.g., team cognition; Salas, Cannon-Bowers, & Johnston, 1997), which are, in turn, posited to foster high performance (e.g., He, Butler, & King, 2007). Communication is also argued to directly relate to team performance because it distributes critical, task-relevant information to team members (Salas, Sims, & Burke, 2005). Indeed, one common thread across studies of team effectiveness is the ability of high performing teams, relative to low performing teams, to effectively communicate (Entin, Serfaty, & Deckert, 1994). Illustrating the importance of this process, communication deficiencies within teams have been linked to poor, even catastrophic, outcomes in both routine and high-stakes environments (Foushee, 1984; Lingard et al., 2004; Moorman, 2007; Sasou & Reason, 1999; Sutcliffe, Lewton, & Rosenthal, 2004). For example, analyses of aviation accidents have indicated that pilot error can often be attributed to a lack of effective communication among crew members (Sexton & Helmreich, 2000). Consequently, we hypothesize:

Hypothesis 1. Communication is positively related to team performance.

3. The influence of team, task, and communication characteristics: a framework

Theory and evidence alike indicate that numerous characteristics affect the relationship between communication and performance. In particular, we suggest that the most theoretically relevant characteristics can be argued to be subsumed under three overarching categories: task characteristics, team characteristics, and characteristics of the team communication itself.

3.1. Team characteristics

3.1.1. Familiarity

Team familiarity is the level of knowledge team members hold about one another (Goodman & Garber, 1988; Littlepage et al., 1997). Although this characteristic may sound similar to average team tenure, it is different in that it reflects how well team members know one another rather than how long they have worked within the organization. Moreover, there is robust evidence that familiar teams outperform unfamiliar teams on a variety of tasks (e.g., Harrison et al., 2003). Researchers have suggested that this difference arises as a function of shared knowledge and more effective team processes that familiar teams have cultivated over time (Katz, 1982; Littlepage et al., 1997). In regards to communication, we posit that the same notion holds true. Specifically, we suggest that communication will be more integral for performance in familiar teams because they engage in more effective communication patterns. As team familiarity increases, team members become more adept at locating expertise among team members, reducing the frequency by which team members communicate and increasing efficiency (Espinosa, Slaughter, Kraut, & Herbsleb, 2007).

Similarly, familiar teams may engage in more unique information sharing because of their increased interactions with one another, allowing more time to identify one another's strengths, weaknesses, expertise, and other critical information. According to Mesmer-Magnus and DeChurch (2009), information sharing uniqueness holds greater predictive validity of performance than openness; as such, this may contribute to the stronger relationship between communication and performance within familiar teams. In other words, the communication patterns within less familiar teams may have greater breadth, but less uniqueness as compared to more familiar teams, leading to greater team performance in familiar teams. In support of this, Jarvenpaa, Shaw, and Staples (2004) found that communication measured at a later time in a team's life cycle was more strongly related to performance than communication measured at an earlier time. Thus, we hypothesize:

Hypothesis 2. Team familiarity moderates the relationship between communication and team performance such that this relationship is stronger in familiar teams than in unfamiliar teams.

3.1.2. Virtuality

Virtuality represents an increasingly common team characteristic across organizations today (Society for Human Resource Management, 2012). Highly virtual teams are defined as primarily coordinating and communicating via electronic tools, such as e-mail, to accomplish tasks (Gibson & Cohen, 2003). The absence of nonverbal cues associated with most virtual communication has been argued to impair communication processes within teams (Cramton, 2001; Gibson & Cohen, 2003; Hertel, Geister, & Konradt, 2005). The understanding of information imparted by team members is often confirmed or denied via nonverbal gestures such as a head nod (Kraut, Lewis, & Swezey, 1982; Yngve, 1970). Without these gestures, it may be difficult to discern whether messages are understood. Confirmation of both the receipt and content of information exchanged is argued to be critical in ensuring that communication distributes the information that is required for effective performance (McIntyre & Salas, 1995). For example, Nurmi (2011) found that global virtual team members perceived their communication as low in clarity, which was associated with several negative outcomes. Relatedly, Schweitzer and Duxbury (2010) note that virtuality may include communication delays; this may further weaken the relationship between communication and performance because time delays may result in team members completing aspects of the task without receiving pertinent information in time. Yet another potential difficulty includes the possibility that team members may misinterpret the tone of written text, perceiving conflict when none was intended (Joinson, 2002). Consistent with these arguments, we hypothesize:

Hypothesis 3. Team virtuality moderates the relationship between communication and team performance such that this relationship is stronger in face-to-face teams than in more virtual teams.

3.1.3. Leadership

According to research and theory, leadership influences team dynamics to a great extent as is evidenced by the research within this domain (Lord, Day, Zaccaro, Avolio, & Eagly, 2017). We argue that a team's underlying leadership structure will moderate the relationship between communication and team performance such that the relationship will be stronger for teams with a shared leadership configuration as compared to those with a hierarchical leadership structure. The latter denotes one in which there is a formally designated individual holding more power and influence over the remaining team members (i.e., a traditional leader), while the former reflects distributed and dynamic leadership (Pearce & Sims, 2000). Further, shared leadership implies that a team leader (or set of leaders) will emerge organically, sharing leadership roles (e.g., monitoring progress, identifying team goals; Morgeson, DeRue, & Karam, 2010), influence, and responsibilities. A main distinction between these leadership structures is that shared leadership represents a team-level phenomenon, while hierarchical leadership is at the individual-level (Wang et al., 2014). As a result, communication may be more important for shared leadership because the team represents a source of collective action, while hierarchical leadership relies on a single-source of action (Van Ameijde, Nelson, Billsberry, & Van Meurs, 2009; Resick et al., 2012).

Although communication between a designated leader and other team members is still necessary for effective team functioning (e.g., creating a shared vision, establishing leader-member exchange), there is evidence supporting the notion that it may be more important for shared leadership structures. If multiple leaders emerge, leadership functions and responsibilities are distributed, requiring a heightened degree of communication to ensure efforts are not duplicated. Moreover, team members engage in team decision-making, rather than relying on one individual to make leadership-related decisions (Hoch, 2014), increasing the necessity of communication between team members. Shared leadership structures also engender a mutual influence process, whereby team members lead one another towards goal attainment and task completion (Barnett & Weidenfeller, 2016; Day, Gronn, & Salas, 2004). In contrast, hierarchical leadership relies on a top-down influence process. In teams with shared leadership structures, team members may also need to communicate with one another to denote when leadership responsibilities transfer (Bergman, Small, Bergman, & Bowling, 2014). Research also suggests that communication is a partial mediator of the relationship between shared leadership and desired outcomes (Hoch, 2014; Lee, Lee, & Seo, 2015; Resick et al., 2012), further bolstering the aforementioned argument. It is for these reasons that we hypothesize the following:

Hypothesis 4. Leadership structure moderates the relationship between communication and team performance such that this relationship is stronger in teams with shared leadership than in teams with a hierarchical leader.

3.2. Task characteristics

3.2.1. Interdependence

Interdependence can be defined as the degree to which the task requires interaction among team members or the extent to which team

outcomes are contingent upon the actions of other team members (Shea & Guzzo, 1987; Wageman, 1995; Wildman et al., 2012). For example, performing a surgery represents a highly interdependent task: the actions of one team member impact the actions of another team member and the primary performance outcome is collective (Gully, Incalcaterra, Joshi, & Beaubien, 2002). As highly interdependent tasks entail a higher degree of coordination (Shea & Guzzo, 1987), we suggest that teams working on such tasks will require a greater degree of effective communication than teams that are working on tasks requiring lower levels of interdependence. For example, communication during highly interdependent tasks may ensure team members do not duplicate efforts. Communication may also allow individuals to update team members about actions they have taken that will directly impact the efforts towards task completion that are subsequently required. In the case of tasks with low interdependence, such communication is not necessary as efforts towards task completion have low impact on other team members' action. Therefore, we hypothesize:

Hypothesis 5. Task interdependence moderates the relationship between communication and team performance such that this relationship is stronger when tasks are more interdependent than less interdependent.

3.2.2. Task type

We also investigate the effect of task type, as various tasks have vastly different demands which may necessitate different patterns of action among team members (Wildman et al., 2012). Although there are numerous categorizations and approaches to evaluating task type, we investigate the broad categories of cognitive-based and action-based, based on previous approaches to categorizing task types. Sundstrom, McIntyre, Halfhill, and Richards (2000) described action and performing groups as those consisting of "individual experts and support staff who conduct complex, time-limited performance events involving audiences, adversaries, or challenging environments, such as surgery teams or search and rescue teams" (p. 47). We adopt this definition to apply to action groups, but also include those such as Sundstrom et al.'s (2000) production groups (e.g., producing tangible output) and Wildman et al.'s (2012) task type of psychomotor action. We conceptualize additional task types (e.g., problem-solving, human service) as primarily cognitive in nature, as they necessitate more cognitive activities than physical action. We suggest that these groups will exhibit a stronger relationship between communication and performance, in comparison to action groups, because communication serves as the mechanism through which team members may pool cognitive resources to perform the task. In contrast, the performance of action-based groups may rely more on effective, individual-based psychomotor action rather than collective action. Therefore, we hypothesize:

Hypothesis 6. Task types moderates the relationship between communication and team performance such that this relationship is stronger when tasks are cognitive-based than when they are action-based.

3.3. Communication characteristics

3.3.1. Operationalization

According to Marks et al. (2000), communication quality is more integral to team performance than communication frequency. As previously noted, a variety of communication types exist; however, this framework represents a more general approach by classifying communication into two main categories, including *quality* (i.e., the extent to which communication, both of a verbal and nonverbal nature, adequately distributes pertinent information among team members as needed) and *frequency* (i.e., the volume of communication, both of a verbal and nonverbal nature, which occurs among team members) (e.g., Bowers, Urban, & Morgan, 1992; González-Romá & Hernández, 2014; Urban, Bowers, Monday, & Morgan, 1995). Consequently, we categorized each of the communication forms we examine into these two communication operationalizations to determine how this distinction influences performance.

A high volume of communication will inevitably impart some useful information, but it may also include irrelevant information that may distract from the more important details. In line with the literature on information overload (e.g., Edmunds & Morris, 2000), we suggest that a high frequency of communication may contain distracting, irrelevant information that may interfere with the ability of individuals to set priorities appropriately. Further, based on cognitive load theory (Van Merrienboer & Sweller, 2005), a large volume of communication may lead to difficulties in accurately remembering and comprehending more relevant, previously received information.[1] Conversely, measures of communication quality typically assess components of communication such as the clarity of information exchanged among team members (e.g., Hirst & Mann, 2004), which we argue will have more of an impact on performance for several reasons. High-quality communication may clarify information related to the task, ensure team members are on the same page, and mitigate any overlap in efforts geared towards task completion. High-quality communication enables team members to clarify who is doing what. In accordance with these ideas, many researchers have measured the quality of team communication as opposed to the frequency of communication (e.g., González-Romá & Hernández, 2014; Hirst & Mann, 2004). Therefore, we hypothesize:

Hypothesis 7. The operationalization of communication moderates the relationship between communication and team performance such that the quality of communication is more strongly related to team performance than the frequency of communication.

3.3.2. Content

Keyton (1997) suggests that communication content can generally be categorized as either relational or task-oriented. Keyton (1997) defines relational communication as encompassing interpersonal interactions, or communication more related to building relationships within the team. In contrast, task-oriented communication centers on details pertinent to task completion. As task-oriented communication is more likely to impart task details necessary for successful performance, we suggest it is more critical for effective performance than relational communication. Relational communication does not directly relate to the task or directly convey information regarding how to achieve targeted task goals whereas this is the purpose of task-oriented communication. Therefore, we hypothesize:

Hypothesis 8. The content of communication will moderate the relationship between communication and performance such that task-oriented communication is more strongly related to team performance than interpersonal communication.

[1] Future research should investigate whether the relationship between communication frequency and team performance is curvilinear. Although the current literature suggests this to be true in certain cases (e.g., Patrashkova-Volzdoska, McComb, Green, & Compton, 2003), we did not test this relationship due to the nature of the primary study data. Few studies assessing communication frequency provided information about scores on the independent variable (e.g., communication frequency mean), preventing us from calculating or recording a score for communication frequency, that the effect size from each study could be regressed onto (e.g., Byron, Khazanchi, & Nazarian, 2010). Moreover, various response scales were implemented across the primary studies investigating communication frequency (e.g., "communication frequencies were measured by the self-reported single-item instruments asking students for the number of meetings, calls, and e-mails that their teams had conducted during the prior week": He, Butler, & King, 2007, p. 275 versus "we asked team members to assess the frequency of team meetings [1 = less than once a month, 2 = once a month, 3 = 2–3 times a month, 4 = once a week, 5 = more than once a week]": Peltokorpi & Hasu, 2014, p. 267), preventing us from using a common metric for communication frequency.

3.3.3. Additional communication types

As previously discussed, there are numerous types of communication within the literature. Although we explore the distinction between quality and frequency, we also note the prevalence of distinct types of communication (e.g., communication openness, Puck et al., 2006). In particular, the following types of team communication emerged as commonly measured: unique or common information sharing, general information sharing, knowledge sharing, openness of communication, content analysis coded communication, information elaboration, self-report measures of communication frequency, and objective measures of communication frequency.

Unique or common information sharing measures generally collect information about the number of times team members discuss commonly or uniquely held pieces of information (e.g., Stasser & Stewart, 1992). These studies typically stem from investigations of Stasser and Titus' (1985, 1987) biased information sampling model, which posits that groups are more likely to discuss information already known by all group members rather than discussing information uniquely held by one group member. In contrast, general information sharing measures (e.g., Bunderson & Sutcliffe, 2002) encompass the overall level of information exchanged within the team, without targeting specific types of information shared. Knowledge sharing measures focus on the degree to which individuals share their expertise with fellow team members (e.g., Song, Park, & Kang, 2015). We suggest that knowledge sharing measures may demonstrate a particularly strong relationship with team performance, as they focus specifically on expertise relevant to performance.

Openness of communication measures, instead of focusing on types or level of information shared, assess how comfortable individuals feel talking openly with other members of the team (O'Reilly & Roberts, 1977). We suggest that this type of communication will be important to performance, as it contains elements of quality. Moreover, content analysis coded communication involves the use of raters; these raters read transcripts of team communication and classify all pieces of communication into different categories that emerge from the analyzed communication (e.g., responses to requests for information; Minionis, 1995). As all types of information shared are included within this measure, it may exhibit a weaker relationship with performance than the measures capturing aspects of communication more relevant to communication quality. For example, information elaboration encompasses more elements of communication quality; these measures assess the degree to which information is shared and elaborated on with team members (e.g., Homan, Van Knippenberg, Van Kleef, & De Dreu, 2007). In other words, these metrics examine whether shared information is both understood and utilized by team members to further task performance.

Finally, there are two primary measures of communication frequency: self-report assessments of the frequency of communication within the team (e.g., Boerner, Schaffner, & Gebert, 2012) and objective measures of communication frequency that sum a unit assessing overall communication volume, such as total number of emails exchanged (e.g., Jarvenpaa et al., 2004). In accordance with our arguments focusing on the distinction between communication frequency and quality, we expect these measures to show weaker relationships with performance than the other measures due to the lack of focus on relevant or specific types of communication exchanged. Table 1 summarizes information about each of these communication types in more detail. There is insufficient theory regarding the unique impact of these varying types of team communication and there is potential conceptual overlap in the content captured by each measure. Thus, we do not propose formal hypotheses but examine the unique relationships between these communication measures with performance in exploratory moderator analyses. This research question, to our knowledge, has yet to be addressed within the literature.

4. Methods

4.1. Literature search and inclusion criteria

Studies were collected through a computerized search of PsychInfo and the Business Source Premiere databases from the available start date to the end of 2016 utilizing the following keywords: "*communication*", "*information sharing*", "*information exchange*", "*knowledge sharing*", "*knowledge exchange*", "*information elaboration*", "*voice*", "*assertiveness*", *paired* with "*performance*", and "*team*". We included published and unpublished studies to reduce the potential for publication bias; we searched for unpublished studies using the same set of keywords in ProQuest Dissertations and Theses over the same time frame. As a supplementary search, we reviewed the reference list from relevant meta-analyses (e.g., Mesmer-Magnus & DeChurch, 2009; Mesmer-Magnus et al., 2011). From our searches, we identified 475 articles as potentially being relevant.

Studies were included if they met the following criteria: were in English, were empirical, reported sufficient information to calculate an effect size (i.e., Pearson correlation) between team communication and team performance, were at the team level of analysis, and included an adult sample (i.e., all participants were over the age of 18). Additionally, we excluded certain studies from our analyses for not utilizing measures corresponding to our conceptualization of team communication. Specifically, measures of voice which were not aggregated to the team level were excluded, as this captured an individual-level behavior (e.g., the extent to which individuals "raise suggestions to improve procedures of one's job"; Yao & Wang, 2008, p. 249). We also excluded studies measuring assertiveness, which was captured at the individual-level. Knowledge sharing measures which included items pertaining to sharing physical items, rather than sharing team expertise via communication, such as "I will always provide my manuals, methodologies, and models for members of my organization" (Liu, Keller, & Shih, 2011, p. 287) were also excluded. The types of communication measures which were included are summarized in Table 1. 142 articles were identified as meeting inclusion criteria. As some articles included multiple independent studies, we ultimately included 150 studies (total teams = 9,702) within our analyses.

4.2. Coding procedure and intercoder agreement

Each study included in analysis was coded independently, in pairs, by three of the authors. The coders met for consensus and all discrepancies were resolved through discussion. The inter-rater agreement was 94%. Information extracted from each study is located in Appendix A. Studies were coded for sample size, reliability (i.e., Cronbach's alpha) for communication and performance measures, and effect size. Correlations were extracted or the statistical information needed to compute a correlation (e.g., *t*-values) was recorded. When performance measures were collected in such a manner that high scores represented low performance (e.g., total errors), the correlation sign was reversed. Means were recorded for continuous moderators. The following definitions were referenced when coding for categorical moderators. Note that we include a number of methodological moderators in addition to the theoretically driven moderators.

4.2.1. Communication

Consistent with previous definitions, communication was defined as the exchange of information among team members (Adams, 2007). Team communication variables were further categorized as (1) *frequency of communication* or (2) *quality of communication*. Frequency of communication was defined as the volume of communication exchanged between team members over all communication modes, including face-to-face and virtual modes (Marks et al., 2000). Quality of communication was defined as the extent to which communication among team members is effective and clear (González-Romá & Hernández, 2014). Measures which included both aspects of frequency and quality were included in overall communication analyses but not within this moderator analysis. We also coded communication content, which was identified as being (1) *task-oriented* (i.e., the communication measure assesses task-relevant communication), (2) *relational* (i.e., the communication measure assesses relational communication,

Table 1
Type of communication measures that emerged from the literature.

Communication type	Description	Example measure	Operationalization[a]
Information Sharing: Unique or Common or Critical Pieces of Information	These measures typically assess the amount of times team members discussed commonly or uniquely known or critical pieces of information. Or they assess some ratio of one of these types of information to the total information discussed	"We divided the number of times that a group mentioned critical clues by the total number of times that all types (critical, noncritical, and details) of information were mentioned," with critical clues representing those which enabled a correct decision," (Stasser & Stewart, 1992, p. 431)	Overall Communication
General Information Sharing	These measures of information sharing are more general and focus on general information exchange within the team	"We measured information sharing by asking each team member to evaluate the extent to which (1) information used to make key decisions was freely shared among the members of the team, (2) team members worked hard to keep one another up to date on their activities, and (3) team members were kept 'in the loop' about key issues affecting the business unit," (Bunderson & Sutcliffe, 2002, pp. 885–886)	Quality
Openness of Communication	This is a common self-report measure of communication that assesses the degree to which team members openly share information with others, created by O'Reilly & Roberts (1977). Some measures included within our analysis adapted this measure or included additional items	Examples of the items assessing communication openness include: "(1) It is easy to talk openly to all members of this group, and (2) It is easy to ask advice from any member of this group," (O'Reilly & Roberts, 1977)	Quality
Content Analysis Coded Communication	These measures of communication entail analyzing communication within the team for content and then coding all pieces of communication into emerging categories (e.g., requests for information). The categories are, in turn, correlated with performance	"All communication during the performance period was time tagged and recorded. These tapes were then coded based on a frequency count of the seven communication categories (operational planning, contingency planning, execution, group regulation, feedback, information exchange, and task irrelevant information). In lieu of time and workload, five minute segments were randomly selected from each quarter, instead of coding the whole performance hour," (Minionis, 1995, p. 55)	Frequency
Self-Report Frequency Measures	These self-report measures focus on frequency in some manner, such as the number of times team members met face-to-face or how frequently they felt they interacted	"To measure the frequency of team meetings, the following item was used: 'On average, how often do meetings take place that are attended by all team members?' The response format ranged from 'at least every 3 months' (1), 'at least once a month' (2), 'at least every 2 weeks' (3), and 'at least once a week' (4), to 'every day' (5)," (Boerner et al., 2012, p. 260)	Frequency
Knowledge Sharing	These measures assess the extent to which team members share their knowledge or expertise with other team members	"We used the four-item scale proposed by Faraj and Sproull (2015) to measure individual perceptions of the extent of knowledge sharing by team members. Sample items are 'People in our team share their special knowledge and expertise with one another,' and 'More knowledgeable team members freely provide other members with hard-to-find knowledge or specialized skills,'" (Song et al., 2015, p. 1753)	Quality
Information Elaboration	These measures typically focus on the degree to which individuals thoroughly elaborate on information they share with team members	"The items were 'The group members contributed a lot of information during the group task,' 'The group members contributed unique information during the group task,' and "During the task, we tried to use all available information,'" (Homan et al., 2008, p. 1212)	Quality
Objective Communication Frequency	These measures sum a unit assessing overall communication volume, such as the total number of emails exchanged	"Communication level is the number of e-mail messages sent through the listserv by an individual's teammates over a specific period of time," (Jarvenpaa et al., 2004, p. 257)	Frequency

[a] *Note.* We coded frequency and quality on a case by case basis. Although most of the communication types were coded similarly and are coded with the operationalizations listed in this column, some measures included elements of frequency or quality that we felt necessitated a different label.

or communication that involves content outside of work), or (3) *mixed* (i.e., includes aspects of both task and relational communication).

We also coded for the type of communication measure, using a coding scheme based on the most common, reoccurring types of communication which emerged from the articles. Utilizing this approach, we were able to classify communication using the categories described in Table 1. There were additional types of communication which were unable to be categorized using this scheme, as they were based on measures created exclusively for the study or measures which were not utilized in additional studies, and did not map onto the previously described categories (e.g., reflective communication; Sinha, Janardhanan, Greer, Conlon, & Edwards, 2016) . However, these communication measures were still included in the overall communication analyses.

4.2.2. Performance

Performance was conceptualized as the evaluation of the outcomes of team processes relative to some set of predetermined standards (Hackman, 1987). We categorized the type of performance as (1) *creative performance* (e.g., novelty of product produced), (2) *decision-making performance* (e.g., accuracy of decision of team as compared to expert solution), and (3) *generic task performance* (e.g., score on simulation).

4.2.3. Team characteristics

The following team characteristics were coded: familiarity, virtuality, tenure, and leadership structure. Virtuality was coded as: (1) *none* (i.e., no virtual tools used at all, face-to-face meetings were the only method of communication), (2) *hybrid* (i.e., both virtual tools and

face-to-face meetings were used), or (3) *full* (i.e., virtual tools were the only method of communication, no face-to-face meetings were used). Familiarity was coded as the number of years the team had been working together. In our sample, this ranged from 0 to 7.1 years (M = 0.82, SD = 1.70). In the case of newly formed teams, they were given a value of zero. Leadership structure was coded as (1) *shared* (i.e., distributed leadership responsibilities among more than one member of the team, or (2) *hierarchical* (i.e., where one individual, either internal or external to the team, is designated as the leader).

4.2.4. Task characteristics

We coded for task characteristics, which included interdependence and task type. The task type was characterized as either: (1) *cognitive-based* or (2) *action-based*. The cognitive tasks included teams working in fields such as management, sales, and research and development. Action-based teams included teams such as surgical teams, search and rescue teams, and even simulated war games, in line with the definition described by Sundstrom et al. (2000). Due to the simplistic nature of this approach, we further examined task type using the taxonomy described by Wildman et al. (2012). This categorizes tasks as: (1) *managing others* (i.e., supervising others in an authoritative role), (2) *advising others* (i.e., consulting work defined by the advisor's lack of authority over the advisee), (3) *human service* (i.e., providing a good or service to another party), (4) *negotiation* (i.e., two or more parties seeking a agreement), (5) *psychomotor activity* (i.e., motor functioning requiring psychological processing, such as machine operation), (6) *defined problem solving* (i.e., where a correct answer exists) or (7) *ill-defined problem solving* (i.e., where there is no conclusive solution). Interdependence of the task was further coded as (1) *high* (in which a team member's actions are based on the other member's actions and team members must interact to complete the task) or (2) *low* (where the team members do not need to interact to complete the task), in line with definitions from the literature (e.g., Shea & Guzzo, 1987).

4.2.5. Study and sample characteristics

Several characteristics of the study were coded, including sample type, study setting, team size, and publication year. Sample type was classified as: (1) *student* (e.g., undergraduate population) and (2) *employee* (e.g., research and development teams). Study type was categorized as (1) *field* (i.e., data was collected from a sample without experimental manipulation, during part of the team's regularly occurring work) or (2) *lab* (i.e., experimental manipulation was implemented). Team size reflected the average of individuals per team, which ranged from 2 to 12.78 people (M = 5.09, SD = 2.54); team organizational tenure was calculated as the average amount of time team members had worked for the company, which ranged from 0 to 14.67 years (M = 7.06, SD = 3.98); team age represented the average age of team members, which ranged from 18.93 to 49 years (M = 30.46, SD = 8.84). We also noted the percentage of men and women comprising the sample.

Measurement source was coded based on who rated the team's communication and performance. Specifically, source was classified as (1) *self-report* (i.e., team members rate their team), (2) *observer* (i.e., an independent observer who is not a part of the team rates the team), (3) *supervisor* (i.e., the team's superior rates the team), (4) *subordinate* (i.e., individuals who work under the team provide ratings), (5) *automated* (i.e., the team's rating is objectively calculated by a simulation, game, or another automated source), or (6) *a combination of sources* (i.e., scores gathered from different rating sources were averaged for the team's final rating).

4.3. Analyses

The meta-analytic procedures outlined by Schmidt and Hunter (2014) for a random effects meta-analysis were utilized to assess overall relationships and examine categorical moderators. When a single sample was associated with multiple effect sizes (e.g., two measures of communication quality were collected) and the inter-correlations among the variables were provided, a composite correlation was calculated, using Schmidt and Hunter's (2014) formula. If inter-correlations were not provided, an average correlation was calculated to maintain independence (Schmidt & Hunter, 2014). A sample weighted mean correlation was calculated and corrected for sampling error and measurement unreliability in both the independent (i.e., communication) and dependent (i.e., performance) variables using an artifact distribution ($\alpha_{\text{team communication}}$ = 0.84 and $\alpha_{\text{team performance}}$ = 0.86). If multiple reliabilities were reported for one type of variable (e.g., two communication measures were used) from one independent sample, we used Spearman-Brown's (1910, 1910) prediction formula to combine them into one reliability. To examine continuous moderators weighted least squares (WLS) multiple regression, as described by Hedges and Olkin (1985), was used (Steel & Kammeyer-Mueller, 2002).

5. Results

Results of the meta-analysis examining the relationship between team communication and team performance are summarized in Tables 2 and 3 and illustrated in Fig. 1. Effect sizes were interpreted using the 95% confidence intervals (CIs); effect sizes are interpreted as identifying relationship significance if they exclude zero. Credibility intervals are interpreted as estimating variability within the individual correlations among the primary studies and confidence intervals are interpreted as estimating variability in the mean correlation. Note that we do not report or interpret analyses with less than five studies, as the correlation coefficients are likely to be unstable (Borenstein, Hedges, Higgins, & Rothstein, 2009).

A subgroup moderator analysis for publication status (i.e., published versus unpublished independent studies) was performed to assess for a potential file-drawer effect (i.e., significant studies are more likely to be published) (Rosenthal, 1979). These results are in Table 2, and indicate that publication status is not a significant moderator as signified by the overlapping 95% confidence intervals. We also conducted a fail-safe k analysis (Rosenthal, 1979) which suggested that an additional 7,084 studies would be required to find non-significant results. Moreover, we conducted Egger's test of the intercept (Egger, Smith, Schneider, & Minder, 1997) and the intercepts were nonsignificant when the standardized effect size was regressed onto the inverse of the standard error (β_0 = 0.18, $p > 0.05$), suggesting no publication bias.

One of the main goals of the current study was to investigate the meta-analytic relationship between team communication and performance. In support of Hypothesis 1, communication was positively and significantly related to team performance (ρ = 0.31, 95% CI [0.23, 0.30]). In addition to identifying the relationships between communication and performance, the current meta-analysis also investigated moderators of this relationship. Hypothesis 2 was supported as there was a significant, positive effect of familiarity on the relationship between communication and performance (β = 0.30, SE = 0.01, t = 3.06, p = 0). In regard to Hypothesis 3, which stated that face-to-face teams (ρ = 0.32, 95% CI [0.21, 0.34]) would have a stronger relationship than hybrid teams (ρ = 0.29, 95% CI [0.19, 0.32]) and fully virtual teams (ρ = 0.10, 95% CI [0.02, 0.19]), there was a significant difference between fully virtual teams and face-to-face teams. However, the difference between hybrid teams and face-to-face teams was not significant. Hypothesis 4 predicted that shared leadership teams would have a stronger relationship between communication and performance than those with hierarchical leadership. This hypothesis was not supported, as teams with shared leadership exhibited a similar relationship (ρ = 0.27, 95% CI [0.18, 0.28]) as teams with hierarchical leadership (ρ = 0.33, 95% CI [0.24, 0.34]).

Hypothesis 5 predicted that more interdependent tasks would be associated with a stronger relationship between communication and performance. However, the relationship between communication and

Table 2
Meta-analytic subgroup analyses.

Meta-analysis	k	N	r	ρ	SD_ρ	95% CI		80% CR		% SEV	% *AV*
						LL	UL	LL	UL		
Overall	150	9,702	0.27	0.31	0.22	0.23	0.30	0.03	0.59	0.28	0.01
Publication type											
Published	129	7,872	0.28	0.32	0.20	0.24	0.31	0.07	0.57	0.33	0.01
Unpublished	21	1,831	0.23	0.27	0.29	0.12	0.35	−0.10	0.64	0.14	0.00
Sample type											
Student	75	4,589	0.23	0.27	0.21	0.18	0.28	−0.00	0.55	0.31	0.00
Employees	72	5,005	0.31	0.36	0.20	0.26	0.36	0.10	0.61	0.29	0.02
Study type											
Field	84	6,070	0.28	0.33	0.22	0.23	0.33	0.05	0.60	0.26	0.01
Lab	66	3,633	0.25	0.29	0.22	0.19	0.30	0.01	0.57	0.32	0.00
Interdependence											
High	91	5,094	0.23	0.27	0.23	0.19	0.28	−0.02	0.57	0.30	0.00
Low	10	746	0.33	0.39	0	0.28	0.39	0.39	0.39	1.36	0.13
Task type											
Cognitive-based	98	6,670	0.26	0.30	0.20	0.22	0.30	0.05	0.55	0.32	0.01
Action-based	36	1,716	0.22	0.26	0.21	0.15	0.30	−0.01	0.54	0.37	0.00
Wildman tasks											
Management	9	514	0.28	0.31	0.04	0.19	0.36	0.26	0.36	0.89	0.05
Advisory	5	330	0.26	0.32	0.04	0.16	0.37	0.27	0.37	0.89	0.04
Human service	12	672	0.33	0.38	0	0.27	0.38	0.38	0.38	1.56	0.07
Negotiation	–	–	–	–	–	–	–	–	–	–	–
Psychomotor	–	–	–	–	–	–	–	–	–	–	–
Defined problem-solving	27	1,550	0.27	0.32	0.24	0.18	0.36	0.01	0.63	0.27	0.00
Ill defined problem-solving	45	3,333	0.25	0.29	0.20	0.19	0.31	0.04	0.55	0.29	0.01
Leadership structure											
Hierarchical	59	4,227	0.29	0.33	0.19	0.24	0.34	0.09	0.57	0.31	0.02
Shared	75	4,379	0.23	0.27	0.23	0.18	0.28	−0.02	0.56	0.29	0.00
Virtuality											
Face-to-face	48	2,526	0.27	0.32	0.21	0.21	0.34	0.05	0.59	0.34	0.00
Hybrid	18	886	0.25	0.29	0.03	0.19	0.32	0.25	0.34	0.94	0.02
Virtual	14	1,013	0.08	0.10	0.19	−0.02	0.19	−0.15	0.35	0.34	0.00
Communication operationalization											
Quality	78	4,662	0.31	0.36	0.14	0.27	0.35	0.19	0.54	0.48	0.03
Frequency	51	3,349	0.16	0.19	0.25	0.09	0.23	−0.13	0.51	0.25	0.00
Communication source											
Self	94	6,779	0.27	0.32	0.21	0.23	0.32	0.06	0.58	0.28	0.01
Observer	43	2,242	0.25	0.29	0.27	0.17	0.32	−0.05	0.63	0.25	0.00
Supervisor	–	–	–	–	–	–	–	–	–	–	–
Subordinate	–	–	–	–	–	–	–	–	–	–	–
Automated	6	273	0.20	0.23	0	0.09	0.30	0.23	0.23	1.26	0.01
Consensus	–	–	–	–	–	–	–	–	–	–	–
Mixed	6	337	0.28	0.33	0.11	0.16	0.40	0.19	0.46	0.66	0.00
Content											
Task	103	6,479	0.31	0.36	0.20	0.27	0.35	0.11	0.62	0.31	0.01
Interpersonal	–	–	–	–	–	–	–	–	–	–	–
Both	6	558	0.19	0.22	0.18	0.05	0.34	−0.01	0.45	0.30	0.01
Performance source											
Self	32	2,159	0.30	0.35	0.20	0.23	0.37	0.09	0.61	0.29	0.02
Observer	24	1,586	0.20	0.24	0.22	0.11	0.29	−0.03	0.52	0.30	0.00
Supervisor	13	870	0.25	0.29	0.13	0.16	0.34	0.12	0.46	0.50	0.02
Subordinate	–	–	–	–	–	–	–	–	–	–	–
Automated	53	3,064	0.23	0.27	0.21	0.17	0.29	0.01	0.53	0.34	0.00
Consensus	–	–	–	–	–	–	–	–	–	–	–
Mixed	21	1,688	0.33	0.38	0.26	0.23	0.43	0.04	0.71	0.17	0.01
Type of performance											
Creative	8	637	0.20	0.23	0.25	0.04	0.36	−0.09	0.54	0.21	0.00
Decision-making	18	979	0.31	0.37	0.27	0.19	0.43	0.02	0.71	0.23	0.00
Generic	119	7,802	0.27	0.32	0.21	0.23	0.31	0.05	0.59	0.29	0.01
Communication measure											
Information sharing	15	714	0.19	0.23	0.23	0.07	0.31	−0.07	0.52	0.34	0.00
General Information sharing	14	889	0.26	0.30	0.16	0.16	0.36	0.09	0.51	0.41	0.03
Openness of communication	7	380	0.27	0.31	0	0.23	0.31	0.31	0.31	4.88	0.06
Content analysis	13	724	0.17	0.20	0.34	−0.00	0.34	−0.23	0.63	0.17	0.00
Self-report frequency	21	1,727	0.13	0.16	0.24	0.03	0.23	−0.15	0.47	0.22	0.00
Knowledge sharing	12	897	0.37	0.44	0.13	0.29	0.46	0.28	0.60	0.44	0.06

(continued on next page)

Table 2 *(continued)*

Meta-analysis	k	N	r	ρ	$SD_ρ$	95% CI		80% CR		% SEV	% *AV*
						LL	UL	LL	UL		
Information elaboration	11	747	0.43	0.52	0.10	0.36	0.51	0.40	0.64	0.57	0.05
Objective frequency	10	449	0.13	0.15	0	0.05	0.21	0.15	0.15	1.24	0.00

Notes. k = number of effect sizes in the meta-analysis; r = sample-size weighted mean correlation; ρ = correlation corrected for unreliability in both measures; $SD_ρ$ = standard deviation of ρ; CI = confidence interval for ρ; LL = lower limit of confidence interval; UL = upper limit of confidence interval; CR = credibility interval around ρ; LL = lower limit of credibility interval; UL = upper limit of credibility interval; % SEV = percent of variance accounted for by sampling error; % AV = percent of variance due to all corrected artifacts.

Table 3
Continuous moderator analyses.

Analysis	*k*	*β*	*SE*	*t*-value	*p*-value	R^2
Publication year	150	0.06	0.00	0.77	0.45	0.00
Team size	137	−0.08	0.01	−0.92	0.36	0.01
Tenure	26	0.24	0.01	1.23	0.23	0.06
Familiarity	95	0.30	0.01	3.06	0.00	0.09
Average team age	68	0.11	0.00	0.86	0.39	0.01
Ratio of women to men	95	0.02	0.00	0.18	0.86	0.00

Notes. k = number of independent studies; β = standardized estimate; SE = standard error; R^2 = variance explained.

performance was similar for teams engaging in highly independent tasks (ρ = 0.27, 95% CI [0.19, 0.28]) and tasks with low interdependence (ρ = 0.39, 95% CI [0.28, 0.39]). Hypothesis 6 stated that the relationship between communication and performance would be moderated by the task type, such that a stronger relationship would be found in teams that completed cognitive-based tasks compared to teams that completed action-based tasks. This hypothesis was not supported; teams completing cognitive-based tasks (ρ = 0.30, 95% CI [0.22, 0.30]) demonstrated a similar relationship as teams completing action-based tasks (ρ = 0.26, 95% CI [0.15, 0.30]).

Hypothesis 7, which predicted that the relationship between communication quality and performance (ρ = 0.36, 95% CI [0.27, 0.35]) would be stronger than the relationship between communication frequency and performance (ρ = 0.19, 95% CI [0.09, 0.23]), was supported. To further compare the strength of the relationship between communication quality and performance to the relationship between communication frequency and performance, we used Fisher's *r*-to-*z* transformation (Rosenthal, 1991) on the uncorrected meta-analytic correlation association with each type of communication (quality r = 0.31, N = 4,662; quantity r = 0.16, N = 3,349, respectively). This resulted in a *z*-score of 7.01, $p < 0.01$, further indicating that these relationships are significantly different in the expected direction.

Hypothesis 8, which predicted a stronger relationship between task-related communication and performance than interpersonal communication and performance, was not supported. There were no studies that solely measured interpersonal communication, and the studies that measured both interpersonal and task performance did not have a significantly different relationship (ρ = 0.22, 95% CI [0.05, 0.34]) as compared to studies that measured only task-related communication (ρ = 0.36, 95% CI [0.27, 0.35]).

5.1. Exploratory moderators

We ran a series of exploratory analyses to identify whether certain methodological (i.e., publication year, performance source,

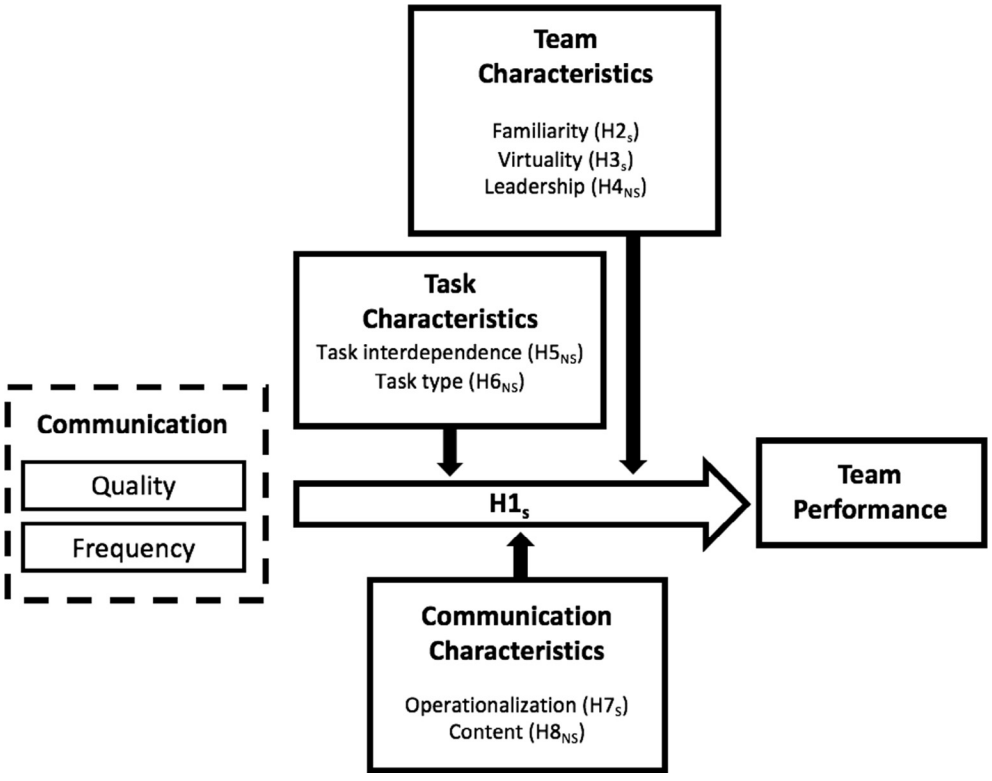

Fig. 1. A model of the relationship between team communication and performance. This figure illustrates the relationships hypothesized and tested, with respective findings. *Notes.* S = hypothesis was supported by the current findings; NS = hypothesis was not supported by the current findings.

communication source, performance type, and study type) and sample (i.e., sample type, average team size, average team organizational tenure, average team age, and gender composition) factors influenced the strength of the relationship between communication and performance. However, our results indicate that gender composition, publication year, sample type, study type, performance source, communication source, team size, team age, organizational tenure, and type of performance did not impact the strength of the relationship (see Tables 2 and 3).

Finally, we also examined the type of communication to determine if that further influenced the strength of the relationship between communication and performance. When the type of communication was information elaboration (ρ = 0.52, 95% CI [0.36, 0.51]), communication had a significantly stronger relationship with performance than all other measures except knowledge sharing (ρ = 0.44, 95% CI [0.29, 0.46]) and general information sharing (ρ = 0.30, 95% CI [0.16, 0.36]). Also, objective communication frequency (ρ = 0.15, 95% CI [0.05, 0.21]) and self-report frequency (ρ = 0.16, 95% CI [0.03, 0.23]), were all associated with significantly weaker relationships than knowledge sharing. Further, measures of openness of communication (ρ = 0.31, 95% CI [0.23, 0.31]) were associated with a significantly stronger relationship than that of objective communication frequency.

6. Discussion

This meta-analysis of communication and performance contributes to the literature in three primary ways. First, our results provide empirical evidence that distinguishing between communication quality and frequency, as suggested by Marks et al. (2000), has utility. Although this is a prevalent theoretical argument in the literature, a robust, empirical test of this assertion has yet to be completed. Illustrating this trend, we found few studies which measured communication frequency and quality in conjunction. We address this gap and find that there is value in conceptualizing communication frequency and quality as separate facets of communication. Quality was found to have a significantly stronger relationship with performance than frequency, providing support to the idea that too much communication may impart unnecessary noise that mitigates, rather than enhances, performance. Conversely, we suggest communication quality demonstrates a stronger relationship with performance because it enables team members to gather pertinent information necessary to task completion while minimizing confusion.

Second, we found that the importance of communication largely generalizes across conditions. Although we tested numerous methodological and sample moderators, we found that few significantly moderated the relationship between team communication and performance. This suggests that, as previous researchers have emphasized, team communication plays a critical role in furthering team performance (e.g., Marks et al., 2001). Regardless of sample and task characteristics, team communication is critical. However, our results suggest that, as familiarity increases, team communication becomes even more strongly related to team performance. Similarly, face-to-face teams exhibited a stronger relationship between communication and performance than virtual teams, indicating that communication plays a more critical role in shaping performance in these teams, perhaps due to the communication limitations associated with virtual tools (e.g., Cramton, 2001).

Finally, we believe the most important contribution to the literature is the finding that the type of communication measured matters. Some forms of communication have a significantly stronger relationship with performance than others. For example, information elaboration demonstrated a stronger relationship than all other communication measures. Knowledge sharing also exhibited a stronger relationship than several other types of communication. The two most common approaches to measuring frequency (i.e., self-report frequency and objective frequency), in accordance with the distinction between communication quality and frequency, were found to be associated with the weakest relationships. Although different communication measures are often implemented without reference to others, the implications of our findings are clear: these types of communication are not interchangeable and should not be treated as such.

6.1. Theoretical implications

We sought to determine if the importance of communication to performance varies depending upon context. To begin, our results suggest there to be meaningful differences in the strength of the relationship between communication and team performance depending on several team characteristics, namely team familiarity and virtuality. In contrast, we did not find support for leadership structure as a moderator of this relationship. Our findings reinforce the notion that familiarity matters; specifically, the relationship between communication and team performance increases as the degree of team familiarity grows. This is in accordance with the idea that familiar teams outperform unfamiliar teams on numerous tasks (e.g., Harrison et al., 2003) because they have fostered more effective team processes. Due to this development, they may possess a greater degree of team-related shared knowledge (Katz, 1982; Littlepage et al., 1997). and may have established more efficient communication practices.

The current results also suggest that a team's level of virtuality influences the strength of the relationship between communication and performance, such that it is stronger in face-to-face teams than in entirely virtual teams. These findings contribute incrementally to our understanding of the effect of team virtuality on the underlying mechanisms of teamwork as they extend related research conducted by Mesmer-Magnus et al. (2011). In this work, the authors investigated the relationship between information sharing, a type of communication, and team performance. Our results mirror their findings and suggest that face-to-face teams exhibit a stronger link between all communication processes and team performance. Highly virtual teams utilize virtual communication tools that may impair certain communication elements (e.g., lack of nonverbal communication; Cramton, 2001; Gibson & Cohen, 2003); it thus may be necessary for virtual team members to compensate with different teamwork processes. In opposition to our hypothesis, hybrid teams displayed a similar relationship between communication and performance to that of face-to-face teams. Perhaps this is due to their ability to meet both face-to-face and work virtually; as such, team members can utilize virtual tools for convenience, but meet face-to-face if problems associated with virtual tools (e.g., ambiguous tone) arise.

We also investigated whether the relationship between communication and team performance varies across team leadership structures. Although numerous studies have indicated that shared leadership results in the same level, if not an increased level, of team performance as compared to hierarchical leadership (e.g., Hoch & Kozlowski, 2014), relatively few studies have investigated the underpinnings of team processes and their relationship across leadership structures. Our research provides insight into this area by suggesting that certain processes (i.e., team communication) are critical for team performance, regardless of whether leadership is shared or hierarchical. It could be the case, however, that the *purpose* of communication differs across these teams. Future research might explore this possibility.

We also assessed the influence of different task types and task

interdependence, components that are emphasized as significant aspects of the task (e.g., Shea & Guzzo, 1987). Although interdependence is argued to strengthen the need for communication in order to achieve effective levels of performance (Gully et al., 2002), we found no evidence for this idea. It may be due to the fact that the majority of teams in our sample had a high level of interdependence (k = 91). Indeed, some definitions stipulate that a group of individuals cannot be considered a team unless they have some degree of interdependence (e.g., Salas, Dickinson, Converse, & Tannenbaum, 1992). Based on our findings, it appears that few researchers choose to study teams with little to no interdependence. Of the teams we classified as low in interdependence, these teams still had *some* level of interdependence. We thus interpret our results with caution and are hesitant to claim that interdependence does not moderate the relationship between communication and performance.

We further found no evidence that task type influences the relationship between communication and performance. We examined the difference between cognitive-based and action-based tasks, but we also applied an additional coding scheme to examine more granular task distinctions (i.e., the scheme developed by Wildman et al., 2012). Yet, again, we found no evidence for moderation. We suggest that more action-based tasks may still necessitate coordination that requires a high degree of effective communication. Although the task inputs may be largely individual, the team may still need to communication such that the individual inputs are orchestrated in a fashion that coordinates with those of fellow team members. Another aspect influencing these findings is the difficulty of imposing task categories on field studies. Teams working on real-world tasks may be argued to mostly fall under one category; however, it is likely that such teams complete multiple types of tasks throughout their daily work (e.g., research and development teams).

In addition to task and team characteristics, we also assessed different aspects of communication. To begin, we were unable to fully examine the impact of communication content, regarding whether it was relational or task-related, because we were unable to find any measures solely capturing relational communication. We suggest that future research might explore whether there is value in distinguishing between types of communication content. However, communication operationalization was found to be a significant moderator of communication and performance. This suggests that, in line with the theoretical distinction described by Marks et al. (2000), communication quality and frequency should be distinguished from one another. Moreover, we found that different types of communication had significantly different relationships with performance. In particular, information elaboration emerged as a very strong predictor of performance, in comparison to other communication types. Information elaboration measures typically evaluate not just whether information is shared within the team but whether it is acknowledged or utilized in some fashion (e.g., Homan et al., 2007). Consequently, these measures tend to move beyond general measures of communication, suggesting there is utility in taking this additional step.

Knowledge sharing similarly exhibited a strong relationship. As these measures focus on communication about knowledge and expertise pertinent to the task (e.g., Jin & Sun, 2010), it is unsurprising that this form of communication demonstrated a similar relationship with performance as information elaboration. General information sharing measures also exhibited a similar relationship with performance, indicating the necessity of effective information exchange among team members for performance. Finally, both self-report and objective measures of frequency led to weaker relationships between communication and performance than knowledge sharing and information elaboration. Similarly, openness of communication was more strongly related to performance than objective communication frequency. This aligns with the distinction between frequency and quality (Marks et al., 2000). There appears to be less value, in terms of predicting performance, in focusing on frequency of communication in any form. Openness of communication encompasses aspects of communication that can be likened to quality of communication, as it entails whether team members can easily communicate with other team members (O'Reilly & Roberts, 1977).

Finally, content analysis coded communication showed similar relationships as openness of communication and both forms of information sharing. As this form of communication is focused on specific, task-related pieces of communication (e.g., Kennedy & McComb, 2014), it aligns with the rest of our findings. Our results indicate that ensuring understanding and utilizing provided information is most important in terms of performance, followed by knowledge-focused communication and general information sharing. On the whole, these findings suggest that theories of team communication should be modified to account for additional communication types beyond quality and frequency.

6.2. Practical implications

The present results suggest that the volume of information may be less important to team performance than the quality of the exchange. Thus, organizations attempting to improve team performance with interventions targeting team processes, among which communication is frequently included (e.g., TeamSTEPPS, Crew Resource Management) (Clancy & Tornberg, 2007; Helmreich, Merritt, & Wilhelm, 1999), should continually focus on improving the quality of the communication exchange rather than targeting communication volume alone. Different types of communication also appear to matter more in regard to performance. Effective information elaboration and knowledge exchange should be emphasized, in particular, if the goal is to improve performance.

Our results also suggest that, in a majority of cases, communication influences performance. Across task and sample types, communication is significantly and similarly related to performance. Organizations should thus ensure that teams understand the importance of effective communication to performance. Our results further suggest that in the case of less familiar teams, communication is less strongly related to performance. This may be because such teams have failed to develop effective patterns of communication. Although we argue communication should be fostered in all teams, it may be that these teams require additional attention to develop effective team communication. Simply setting aside time for the team to talk with one another and clarify any misunderstandings or discuss any communication issues may be one effective step towards improving communication. Offering an intervention designed to facilitate team communication may also allow effective communication patterns to be developed. Our results indicate that, consistent with previous research (e.g., Martins, Gilson, & Maynard, 2004), enabling teams that primarily communicate via virtual tools to meet face-to-face occasionally or in the beginning of team formation may similarly facilitate improved performance.

6.3. Limitations and future research

Despite the contributions of the current meta-analysis, there are several limitations. We were unable to gather information on each moderator from every study, limiting the sample within each of our moderator analyses. For example, although we were interested in the effect of ethnic composition, we were unable to examine this moderator due to a low number of samples reporting full information on the ethnic

composition of their sample. Similarly, we were unable to extract information for each moderator from every study due to a lack of detail within primary studies. As such, not all studies could be included within every moderator analysis. We suggest that, when possible, researchers should strive to report all salient method and sample details such that future meta-analyses can test these moderators more thoroughly.

Although these results suggest that communication quality has a stronger relationship with performance than frequency, we note that these communication types may also interact to predict performance. Varying levels of frequency, associated with varying levels of quality (e.g., high quality, low frequency or high frequency, low quality) may be associated with different or comparable levels of performance. However, we were unable to assess this possibility as few studies measured both quality and frequency in conjunction. It seems that, for the vast majority of studies, researchers choose one form of communication to measure without reference to the other. Our findings suggest these two relationships are not comparable, and we suggest that future researchers measure communication quality and frequency in conjunction such that an interaction effect can be assessed. We also suggest that researchers should further distinguish between different types of communication, beyond quality and frequency (Marks et al., 2000) although this initial distinction has clear value.

Researchers might also consider examining different types of communication to determine if they similarly exhibit distinct relationships with different team processes or influence performance uniquely, as a function of time. Our results suggest current theories encompassing communication should be revised to account for the influence of different communication types. For example, Marks et al. (2001) suggests that teams have transition processes (e.g., planning), action processes (e.g., coordination), and interpersonal processes (e.g., conflict management). It might be the case that different types of communication are more important for performance depending upon the phase the team is experiencing. As an example, perhaps knowledge sharing is more important during action processes, when the team is completing the task, and information elaboration is more important during transition processes, before the task begins (Marks et al., 2001).

Moreover, it may be the case that some of our moderators have direct relationships with communication. In particular, there is rationale to suggest familiarity and virtuality may directly relate to communication. However, we were unable to meta-analytically explore this idea as correlations between familiarity and communication were rarely reported in our sample of studies. Similarly, researchers did not assess or report the relationship between virtuality and communication in our sample. Thus, we encourage future research to examine these relationships to provide more insight into how these variables influence communication and if they do so outside of the relationship between communication and performance.

In regard to virtuality, we suggest there are several directions for future work. Gilson, Maynard, Young, Vartiainen, and Hakonen (2015) noted that as technology has advanced, additional virtual tools have become available to teams. However, they found that the bulk of research continues to focus on traditional virtual tools such as email and chat, which have been studied extensively over the past decade. Similarly, we found that the majority of primary studies included within the present meta-analysis focused on evaluating these traditional tools. Although, we were able to determine which type of tools were used, we were rarely able to determine, in the case of field studies, which tools were definitively *not* used. Moreover, there are few laboratory studies examining the impact of these newer tools on team communication although they may be implemented within highly virtual teams more than the traditionally studied communication mediums (Koutsabasis, Vosinakis, Malisova, & Paparounas, 2012). Such tools may provide additional advantages to face-to-face communication. Thus, studies isolating the specific effect of these tools on the relationship between communication and performance would help increase our understanding of this relationship in hybrid and virtual teams.

Another avenue for future research is to explore the effect of individual differences on the relationship between team communication and performance in teams that have some degree of virtuality. For example, Venkatesh and Morris (2000) found that individuals from the millennial generation have been found to have a more positive attitude towards communicating via virtual tools than individuals from previous generations. Variables such as these (e.g., age, comfort with technology) may influence the relationship between team communication and performance and the impact of virtuality. Highly virtual teams comprised of individuals that have a high degree of comfort with technology may begin with higher quality team communication than teams comprised of individuals that prefer face-to-face contact. We were unable to examine these relationships due to a lack of detail in primary studies. Examining the impact of these individual characteristics may shed light on why some teams more effectively or more quickly master team communication across virtual mediums than others and how this, in turn, influences performance.

7. Conclusions

The measurement of team communication varies widely across studies, as different definitions and operationalizations are currently utilized, which may lead to inconsistent findings. To determine if differences exist in the relationship between performance and communication type, the current meta-analysis examined the difference between communication frequency and quality in regard to team performance. We also examined the relationship between additional communication types and performance. Our results indicate that communication quality has a significantly stronger relationship with performance than communication frequency, and that different types of communication demonstrated significantly different relationships with performance. We further found that face-to-face and familiar teams have a significantly stronger relationship between communication and performance. These findings have practical implications for how communication should be both conceptualized and measured within organizations and research studies. Our results also have significant theoretical implications, suggesting that progressing beyond the distinction between communication frequency and quality (Marks et al., 2000) may provide additional value in understanding how communication affects performance in teams.

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Appendix A. Study description table

Study	N	Familiarity (in years)	Interdependence	Task type	Communication content	Leadership structure	Virtuality	α_{xx}	α_{yy}	Communication operationalization	Communication type	r
Alge, Wiethoff, and Klein (2003)	66			Cognitive, Defined problem Solving	Task	Shared				Overall	Information Sharing: Unique, etc.	−0.04
Ariel (2001)	82			Cognitive, Ill-Defined Problem Solving				0.87	0.91	Quality		0.63
Armon (2015)	290	0	High	Cognitive, Ill-Defined Problem Solving		Shared	Full		0.90	Frequency	Self-Report Frequency	−0.16
Aube, Brunelle, and Rousseau (2014)	85	0	High	Cognitive, Ill-Defined Problem Solving	Task	Shared	None	0.81		Quality	General Information Sharing	0.18
Auh, Spyropoulou, Menguc, and Uslu (2014)	86	5.4	Low	Cognitive, Human Service	Task	Hierarchical		0.88	0.87	Quality	General Information Sharing	0.31
Bang, Fuglesang, Ovesen, and Eilertsen (2010)	8		High	Cognitive, Managing others	Task		None	0.93		Quality		0.05
Barelka (2007)	72	0	High	Action	Mixed (frequency)	Hierarchical		0.93_q		Quality, Frequency	Objective Frequency	0.33 (r_q) 0.11 (r_f) 0.22 (r_o)
Barrick, Bradley, Kristof-Brown, and Colbert (2007)	94	7.1		Cognitive, Managing others	Task	Hierarchical		0.97	0.81	Quality		0.24
Barrick, Stewart, Neubert, and Mount (1998)	51	3.6	High	Action	Task		None	0.87	0.83	Quality	Openness to Communication	0.26
Boerner et al. (2012)	55		High	Cognitive, Advising others		Hierarchical			0.73	Frequency	Self-Report Frequency	0.19
Boies et al. (2015)	44	0	High	Cognitive, Ill-Defined Problem Solving		Hierarchical	None			Frequency	Objective Frequency	0.25
Bowers et al. (1992)	24	0	High	Action		Shared	None			Overall		0.44
Bradley, Baur, Banford, and Postlethwaite (2013)	107	0	High	Cognitive, Defined problem solving	Task	Shared		0.74	0.80	Quality		0.25
Brannick, Roach, and Salas (1993)	52	0	High	Action	Mixed	Shared	None			Frequency	Content Analysis	−0.26

Bunderson and Sutcliffe (2002)	44			Cognitive, Managing others	Task	Hierarchical	Hybrid	0.89	Quality	General Information Sharing	0.40
Bunderson and Sutcliffe (2003)	44	3.1		Cognitive, Managing Others		Hierarchical	Hybrid	0.66	Frequency	Self-Report Frequency	0.05
Burchfield (1997)	72	0	High	Action, Psychomotor		Shared	None		Quality	Openness to Communication	0.28
Burke (2000)	83	0	High	Action	Task	Hierarchical			Quality		0.28
Burke (2007)	25		High	Action, Psychomotor	Interpersonal (frequency)	Shared			Quality, Frequency		0.19 (r_q) 0.38 (r_f) 0.26 (r_o)
Caya (2008)	102				Task	Hierarchical	Full		Quality		0.12
Chalos and Poon (2000)	55		Low	Cognitive	Task	Hierarchical		0.68	0.93 Quality	General Information Sharing	0.50
Chapelain, Morineau, and Gautier (2015)	26	0	High	Action, Human Service	Task	Shared	None		Frequency	Content Analysis	0.45
Chiocchio (2007)	34	0	High	Cognitive, Ill-defined problem solving	Task	Shared	Hybrid		Frequency	Content Analysis	0.15
Choi (2008)	106	0	High	Cognitive, Ill-defined problem solving	Task	Shared		0.89	Quality	General Information Sharing	0.15
Chun and Choi (2014)	145	2.7			Task	Hierarchical		0.9	0.9 Quality	Openness to Communication	0.22
Colquitt, Hollenbeck, Ilgen, LePine, and Sheppard (2002)	45	0	High	Action	Task	Shared		0.96	Quality		0.41
Coopman (2001)	7		High	Action, Human Service		Shared	Hybrid		0.77 Quality		0.55
Cropanzano, Li, and Benson (2011)	170	0	High	Cognitive, Defined problem solving	Mixed	Shared		0.89	Overall		0.12
Cummings (2004)/Cummings and Cross (2003)	182			Cognitive, Ill-defined problem solving		Hierarchical			Overall, Frequency	Knowledge Sharing and Self-Report Frequency	.32 (r_o) 0.36 (r_f)
Day et al. (2005) Sample A	58	0	High	Action	Task	Shared	None	0.71	Quality		0.21
Day et al. (2005) Sample B	31	0	High	Action	Task	Shared	None	0.71	Quality		0.11
Day et al. (2005) Sample C	31	0	High	Action	Task	Shared	None	0.71	Quality		0.45

Day et al. (2005) Sample D	50	0	High	Action	Task	Shared	None	0.71		Quality		−0.09
Dayan and Di Benedetto (2008)	117			Cognitive, Ill-defined problem solving	Mixed			0.78	0.83	Overall		0.23
De Dreu (2007)	46		High	Cognitive	Task	Hierarchical		0.66	0.69	Quality	General Information Sharing	−0.08
Devine (1999)	50	0	High	Cognitive, Defined problem solving	Task	Shared				Overall	Information Sharing: Unique, etc.	0.06
Dominick, Reilly, and Mcgourty (1997)	15	0	High	Cognitive, Defined problem solving	Task	Shared	None			Quality		0.89
Druskat and Pescosolido (2006)	16			Action, Psychomotor	Task	Shared		0.86		Quality	Openness to Communication	0.40
Earley and Mosakowski (2000) Sample A	23	0	High	Cognitive, Managing others		Shared	None	0.85		Quality		0.34
Earley and Mosakowski (2000) Sample B	24	0		Cognitive	Task	Shared		0.89		Quality		0.52
Espinosa, Cummings, and Pickering (2012)	123			Cognitive		Hierarchical		0.87	0.81	Frequency	Self-Report Frequency	0.03
Finholt, Sproull, and Kiesler (1990)	7	0	High	Cognitive, Ill-defined problem solving		Hierarchical	Hybrid			Frequency	Self-Report Frequency and Objective Frequency	0.60
Fletcher and Major (2006)	54	0	High	Cognitive, Defined problem solving	Task	Shared		0.87		Quality		0.39
Fulmer (2014)	35		High	Action	Task	Hierarchical		0.86	0.85	Quality	Openness to Communication	0.25
Gajendran (2009)	168		High	Cognitive		Shared	Hybrid	0.91		Frequency	Self-Report Frequency	0.22
Galinsky and Kray (2004) Sample A	30	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.37
Galinsky and Kray (2004) Sample B	21	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.39

Gardner, Gino, and Staats (2012)	79			Cognitive, Advising others	Task			0.95_q	0.76	Quality, Frequency	Self-Report Frequency	0.34 (r_q) 0.11 (r_f) 0.32 (r_o)
Gong, Kim, Lee, and Zhu (2013)	100		High	Cognitive, Ill-defined problem solving	Task	Hierarchical		0.90	0.82	Quality	General Information Sharing	0.29
González-Romá and Hernández (2014)	115		Low	Cognitive, Human Service	Task	Hierarchical		0.95	0.86	Quality		0.27
Gorman and Cooke (2011)	39	0	High	Action	Task	Shared	Full			Quality, Frequency	Objective Frequency	0.57 (r_q) −0.19 (r_f) 0.12 (r_o)
Greer, Homan, Hoogh, Annebel, and Den Hartog (2012)	100		Low	Action, Human Service	Task	Hierarchical	None	0.77		Quality		0.35
Gautam (2009)	54			Cognitive	Task	Hierarchical		0.78	0.91	Quality	Knowledge Sharing	0.04
He et al. (2007)	51	0	High	Cognitive, Ill-defined problem solving		Shared	Hybrid			Frequency	Self-Report Frequency	0.38
Henningsen, Henningsen, Jakobsen, and Borton (2004)	47	0	High	Cognitive, Defined problem solving	Task	Hierarchical	None			Overall	Information Sharing: Unique, etc.	−0.36
Henttonen et al. (2013)	76	4			Task			0.69	0.82	Overall	Knowledge Sharing	0.64
Hewitt (2008)	63		High	Cognitive, Ill-defined problem solving	Task	Hierarchical		0.84	0.88	Quality	Knowledge Sharing	0.41
Hinds and Mortensen (2005)	43			Cognitive, Ill-defined problem solving	Mixed	Hierarchical			0.84	Frequency		0.13
Hirst (2009)	41	3.3	Low	Cognitive, Ill-defined problem solving	Task	Hierarchical	Hybrid	0.90		Quality	Openness to Communication	0.39

Hirst and Mann (2004)	37		High	Cognitive, Ill-defined problem solving	Task	Hierarchical	Hybrid		0.97	Quality		0.25
Hoch (2014)	46				Task			0.75	0.82	Quality	General Information Sharing	−0.19
Hoch and Kozlowski (2014)	101			Cognitive, Ill-defined problem solving	Task	Hierarchical	Full	0.79	0.79	Quality		0.19
Homan et al. (2008)	58	0	High	Action	Task	Shared		0.85		Quality	Information Elaboration	0.44
Hsu, Shih, Chiang, and Liu (2012)	31	1.4		Cognitive, Ill-defined problem solving	Mixed	Hierarchical		0.73	0.88	Overall		0.50
Hyung-Jin Park, Lim, and Birnbaum-More (2009)	62	2.0		Cognitive, Ill-defined problem solving	Task	Hierarchical				Overall	General Information Sharing	0.21
Ishikawa (2012)	122	1.9		Cognitive, Ill-defined problem solving		Hierarchical		0.80	0.84	Frequency	Self-Report Frequency	0.37
Jackson (2007)	29				Task			0.91	0.85	Quality	General Information Sharing	0.76
Jarvenpaa et al. (2004)	16	0	High	Cognitive, Ill-defined problem solving		Shared	Full			Frequency	Objective Frequency	0.34
Jehn and Shah (1997)	53	0	High	Action, Psychomotor		Shared	None	0.86		Quality		0.08
Jin and Sun (2010)	77			Cognitive, Ill-defined problem solving	Task	Hierarchical		0.81	0.93	Quality	Knowledge Sharing	0.30
Johnson et al. (2006)	80	0	High	Action	Task	Shared	None			Frequency	Objective Frequency	0.05
Johnston (1966)	35	0	High	Action	Task	Shared				Frequency	Content Analysis	−0.59
Kanawattanachai and Yoo (2007)	38	0	High	Cognitive, Ill-defined problem solving	Task	Shared	Full			Frequency	Content Analysis	0.27
Katz (1982)	50	3.4		Cognitive, Ill-defined problem solving	Task		Hybrid			Overall		0.11

Kearney and Gerbert (2009)	62	2.3	High	Cognitive, Ill-defined problem solving	Task	Hierarchical			0.86	Quality	Information Elaboration	0.44
Kearney, Gerbert, and Voelpel (2009)	83	1	High		Task	Hierarchical		0.86	0.86	Quality	Information Elaboration	0.54
Keller (2001)	93	0.4		Cognitive, Ill-defined problem solving	Task	Hierarchical				Frequency		0.25
Kennedy and McComb (2014)	60	0	High	Cognitive, Managing others	Task	Shared	None			Frequency	Content Analysis	0.12
Kessel et al. (2012)	73	6.6	High	Action, Human Service	Task		None		0.93	Frequency	Knowledge Sharing	0.31
Kim (2003)	89	0	High	Cognitive, Defined problem solving	Task	Shared	None			Frequency	Content Analysis	0.61
Kooij-De Bode, van Knippenberg, and van Ginkel (2008)	64	0	High	Cognitive, Ill-defined problem solving	Task	Shared	None			Quality	Information Elaboration	0.53
Kratzer, Leenders, and Van Engelen (2004)/Leenders, Van Engelen, and Kratzer (2007)	44			Cognitive, Ill-defined problem solving		Hierarchical				Frequency	Self-Report Frequency	−0.54
Lechler (2001)	159				Task		None	0.86	0.94	Overall		0.40
Leicher and Mulder (2016)	30	4.2	High	Action, Human Service	Task	Hierarchical		0.87		Quality	Knowledge Sharing	0.47
Lee, Park, and Lee (2015)	115			Cognitive	Task			0.91	0.94	Overall		0.56
Lee, Gillespie, Mann, and Wearing (2010)	34	3	High	Cognitive, Ill-defined problem solving	Task	Hierarchical		0.96	0.90	Quality	Knowledge Sharing	0.77
Lee and Chen (2007)	133			Cognitive, Ill-defined problem solving	Task	Hierarchical			0.90	Quality		0.17
Lewis (2004)	64		High	Cognitive, Advising others		Shared	Hybrid		0.90	Frequency	Self-Report Frequency	0.05
Liu (2006)	312	4.6			Task	Hierarchical			0.91	Overall		0.62
Lu, Xiang, Wang, and Wang (2011)	25			Cognitive, Ill-defined problem solving	Task	Hierarchical		0.75	0.83	Quality		0.36

Lurey and Raisinghani (2001)	12					Hierarchical	Hybrid		0.82	Frequency	Self-Report Frequency	−0.06
Madrid, Totterdell, Niven, and Barros (2016) Sample A	87				Task	Hierarchical		0.93	0.85	Quality	General Information Sharing	0.29
Madrid et al. (2016) Sample B	69				Task	Hierarchical		0.93	0.91	Quality	General Information Sharing	0.40
Malhotra and Majchrzak (2014)	54					Hierarchical	Full			Frequency	Self-Report Frequency	−0.15
Marks et al. (2000)	59	0	High	Action	Task	Hierarchical	Full	0.84		Quality		0.25
Mell, van Knippenberg, and van Ginkel (2014)	112	0	High	Cognitive, Advising others	Task	Shared	None			Quality	Information Elaboration	0.38
Minionis (1995)	120		High	Action		Shared	Full			Frequency	Content Analysis	0.10
Moye and Langfred (2004)	38	0		Cognitive, Ill-defined problem solving	Task	Shared		0.85		Quality	General Information Sharing	0.28
Murthy and Kerr (2004)	35	0	High	Cognitive, Defined problem solving	Task	Shared				Overall	Information Sharing: Unique, etc.	0.24
Nederveen Pieterse, Van Knippenberg, and van Ginkel (2011)	44	0	High	Cognitive, Defined problem solving	Task	Shared	None			Quality	Information Elaboration	0.58
Nederveen Pieterse, Van Knippenberg, and Van Dierendonck (2013)	109	0	High	Cognitive, Ill-defined problem solving	Task	Shared		0.7		Quality	Information Elaboration	0.3
Nonose, Kanno, and Furuta (2015)	13	0	High	Action	Task	Shared	None			Frequency		0.03 (r_f) 0.25 (r_o)
Palanski, Kahai, and Yammarino (2011) Sample A	35	0	High	Cognitive, Ill-defined problem solving	Task	Hierarchical	Hybrid	0.83	0.84	Quality		0.20
Palanski et al. (2011) Sample B	16		High	Action, Human Service	Task	Hierarchical	Hybrid	0.96	0.85	Quality		0.64
Park and Lee (2014)	135			Cognitive, Ill-defined problem solving		Hierarchical	Hybrid	0.79	0.91	Frequency	Self-Report Frequency	0.34
Patrashkova-Volzdoska et al. (2003)	60					Hierarchical	Hybrid		0.91	Frequency	Self-Report Frequency	0.43
Pavitt, High, Tressler, and	97	0	Low	Cognitive,	Task	Shared	None			Frequency	Content Analysis	0.36

Winslow (2007)				Defined problem solving							
Pearsall, Christian, and Ellis (2010)	90	0	High	Action	Task	Shared			Frequency		0.46
Pearsall, Ellis, and Bell (2010)	60	0	High	Action	Task	Shared			Frequency		0.38
Peltokorpi and Hasu (2014)	124	5		Cognitive, Ill-defined problem solving		Hierarchical			Frequency	Self-Report Frequency	0.24
Peters (2004)	33			Cognitive					Frequency	Self-Report Frequency	0.05
Phillips, Mannix, Neale, and Gruenfeld (2004)	34		High	Cognitive, Defined problem solving	Task	Shared	None		Overall	Information Sharing: Unique, etc.	0.39
Puck et al. (2006)	20	6.1	High	Cognitive, Advising others	Task	Hierarchical	None	0.77	Quality	Openness to Communication	0.29
Quigley, Tesluk, Locke, and Bartol (2007)	60	0	Low	Cognitive, Managing others	Task	Shared			Frequency	Knowledge Sharing	0.37
Rajivan (2014)	30		High	Cognitive, Ill-defined problem solving	Task	Shared	None		Overall	Information Sharing: Unique, etc.	0.02
Rentsch et al. (1998)	29	0	High	Cognitive, Ill-defined problem solving	Task	Shared	None		Quality		0.03 0.33
Resick, Murase, Randall, and DeChurch (2014)	68	0	Low	Cognitive, Ill-defined problem solving	Task (quality)	Shared	None		Quality, Frequency	Information Elaboration	0.31 (r_q) −0.10 (r_f) 0.12 (r_o)
Rico, Sánchez-Manzanares, Antino, and Lau (2012)	72	0	High	Cognitive, Defined problem solving	Task	Shared	None		Quality	Information Elaboration	0.55
Robert, Dennis, and Ahuja (2008)	46	0	High	Cognitive, Defined problem solving	Task	Shared	None		Overall	Information Sharing: Unique, etc.	0.59
Rosen (2011)	69	0	High	Cognitive, Ill-defined problem solving	Task	Shared	Hybrid		Frequency	Objective Frequency and Content Analysis	0.20
Rutkowski, Saunders, Vogel, and	13	0	High	Cognitive, Ill-		Shared	Virtual	0.82	Frequency	Self-Report	0.91

Van Genuchten (2007)				defined problem solving							Frequency	
Schmutz, Hoffmann, Heimberg, and Manser (2015)	68		High	Action, Human Service	Task	Hierarchical	None			Frequency	Content Analysis	0.14
Scholten, van Knippenberg, Nijstad, and De Dreu (2007)	49	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.05
Sinha et al. (2016)	38				Task	Hierarchical		0.76	0.84	Quality		0.49
Song et al. (2015)	67		Low	Cognitive, Human Service	Task	Hierarchical		0.93		Quality	Knowledge Sharing	0.32
Srivastava, Bartol, and Locke (2006)	102			Cognitive, Managing others	Task	Hierarchical		0.94		Quality	Knowledge Sharing	0.25
Stachowski, Kaplan, and Waller (2009)	14	2.4	High	Action	Task	Hierarchical	None			Frequency	Content Analysis	−0.09
Stasser and Stewart (1992)	83	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.06
Stewart and Stasser (1998)	88	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.18
Stewart, Billings, and Stasser (1998)	81	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.47
Stewart and Gosain (2006)	67			Cognitive, Ill-defined problem solving	Task		Full	0.90		Quality		0.33
Straus (1996) Sample A	28	0	High	Cognitive, Defined problem solving	Task	Shared	Full			Overall	Information Sharing: Unique, etc.	0.38
Straus (1996) Sample B	26	0	High	Cognitive, Defined problem solving	Task	Shared	None			Overall	Information Sharing: Unique, etc.	0.46
Stringfellow (1998)	33	1.1						0.91	0.95	Quality		−0.22
Swaab, Phillips, and Schaerer (2016)	50	0	High	Cognitive, Defined problem solving		Shared	Full			Frequency	Objective Frequency	0.12

Taggar and Brown (2001)	94		High	Cognitive, Ill-defined problem solving		Shared			0.87	Quality		0.48
Wei, Jeon, and Choo (2016)	55	0	High	Cognitive, Defined problem solving		Shared	None	0.89		Frequency	Self-Report Frequency	−0.03
Tung and Chang (2011)	79			Cognitive, Managing Others	Task			0.94	0.93	Quality	Knowledge Sharing	0.47
Urban et al. (1995)	24	0	High	Action	Task	Shared				Frequency	Content Analysis	−0.57
Valls, González-Romá, and Tomás (2016)	57	3.6	Low	Cognitive, Human Service	Task	Hierarchical		0.89	0.78	Quality		0.42
Van der Kleij, Lijkwan, Rasker, and De Dreu (2009)	36	0	High	Cognitive, Ill-defined problem solving	Task	Shared		0.70		Quality	General Information Sharing	0.39
van Ginkel and van Knippenberg (2008)	28	0	High	Cognitive, Defined problem solving	Task	Shared	None			Quality	Information Elaboration	0.79
Villado and Arthur (2013)	47	0	High	Action	Task	Shared	None	0.73		Quality		0.36
Wakefield, Leidner, and Garrison (2008)	12					Hierarchical	Hybrid		0.88	Frequency	Self-Report Frequency	0.35
Wang (2015)	47	0	High	Cognitive, Defined problem solving	Task	Shared	None			Quality	Information Elaboration	0.20
Wang, Chen, Lin, and Hsu (2010)	27		High	Action, Human Service		Hierarchical	None	0.94	0.92	Quality		0.30
Werner and Lester (2001)	107	0		Cognitive, Ill-defined problem solving	Task	Shared		0.82		Quality		0.22
Williges, Johnston, and Briggs (1966)	32	0	High	Action	Task	Shared				Frequency	Content Analysis	0.55
Yoo and Kanawattanachai (2001)	38	0	High	Cognitive, Defined problem solving		Shared	Full			Frequency	Objective Frequency	0.22

Note: r_q = Correlation of the effect size for communication quality; r_f = correlation of the effect size for communication frequency; r_o = correlation of the effect size for overall communication

Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.obhdp.2017.08.001.

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