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Information Sharing and Team Performance: A Meta-Analysis

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Information sharing is a central process through which team members collectively utilize their available informational resources. The authors used meta-analysis to synthesize extant research on team information sharing. Meta-analytic results from 72 independent studies (total groups = 4,795; total N = 17,279) demonstrate the importance of information sharing to team performance, cohesion, decision satisfaction, and knowledge integration. Although moderators were identified, information sharing positively predicted team performance across all levels of moderators. The information sharing–team performance relationship was moderated by the representation of information sharing (as uniqueness or openness), performance criteria, task type, and discussion structure by uniqueness (a 3-way interaction). Three factors affecting team information processing were found to enhance team information sharing: task demonstrability, discussion structure, and cooperation. Three factors representing decreasing degrees of member redundancy were found to detract from team information sharing: information distribution, informational interdependence, and member heterogeneity.

Keywords: group, information sharing, information sampling bias, hidden profile, information processing

Organizations are increasingly assigning complex decision-making tasks to teams rather than to lone individuals. Personnel selection decisions usually require input from a selection committee rather than a single hiring manager; homicide investigations are typically conducted by a group of detectives rather than by a single officer; the assignment of guilt or innocence to an accused criminal is the responsibility of a jury rather than a judge. A primary advantage of using small groups and teams in these situations is to expand the pool of available information, thereby enabling groups to reach higher quality solutions than could be reached by any one individual. Still, superior solutions to complex decision tasks require members to effectively integrate unique, relevant, and often diverse informational sets.

Despite the intuitive importance of effective information sharing (IS) for team decision-making (e.g., Bunderson & Sutcliffe, 2002; Jehn & Shah, 1997), past research has shown teams often deviate from the optimal utilization of information when making decisions; discussion often serves to strengthen individual prediscussion preferences rather than as a venue to share new information (i.e., biased information sampling model; Stasser & Titus, 1985). These results raise a number of questions of significant importance to the research and practice of teams. We used meta-analysis to cumulate empirical findings culled from studies examining various task domains and discussion structures as well as different aspects of IS and performance criteria to address the following questions: First, to what extent does IS impact team performance? Second, what role do moderators play in this relationship (i.e., definition of IS, operationalization of performance criteria, discussion structure, and team task type)? Third, which factors promote (e.g., cooperation) and suppress (e.g., information distribution) IS? Figure 1 summarizes the relationships examined in the current study.

Information Sharing Uniqueness and Openness

Differing theoretical and operational definitions of IS in teams may partially explain discrepant findings reported in the extant literature regarding the role of IS in performance. Most prior work on IS originates with Stasser and Titus's (1985, 1987) biased information sampling model, which demonstrates that groups spend more time discussing *shared information* (information already known by all group members) than *unshared information* (information uniquely held by one group member; Stasser & Titus, 1985, 1987). Empirical studies examining biased information sampling have essentially examined what Hinsz, Tindale, and Vollrath (1997) described as the *commonality–uniqueness dimension* of IS, or "variability in how many group members have access to a piece of information" (p. 54). We refer to these studies as investigations of the *uniqueness* of IS. A second subset of studies relevant to team information processing has examined aspects of information exchange more broadly, encompassing team communication related to goals, progress, coordination, and the like, independent of the initial distribution pattern of information among team members (Henry, 1995; Jehn & Shah, 1997). We refer to these studies as investigations of the *openness* of IS. Table 1 presents examples of

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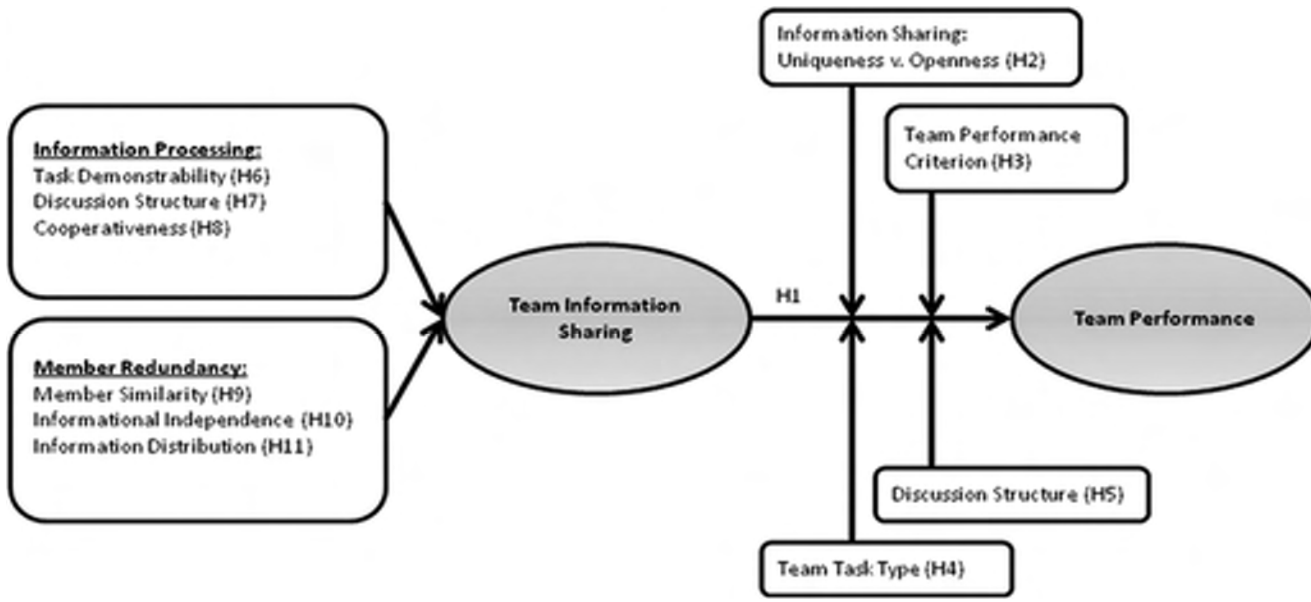

Figure 1. Organizing framework for understanding team information sharing. H = hypothesis.

conceptual and operational definitions adopted in primary studies of uniqueness and openness.

Empirical studies conducted within either domain demonstrate the importance of effective IS to team performance (Greenhalgh & Chapman, 1998; Schittekatte & Van Hiel, 1996). Conceptually, these two aspects of IS parallel the two basic aspects of teamwork: task and socio-emotional functioning (Hackman, 1987). Uniqueness captures the extent to which teams are utilizing members' distinctive knowledge sets for the team's benefit. Increasing uniqueness means teams are expanding the pool of knowledge available for processing and therefore ought to increase team task performance. Although greater openness does not necessarily imply an increase in the team's available knowledge stock, there are several ways openness could indirectly enhance performance (e.g., by enhancing team socio-emotional functioning, the depth of team information processing, and/or the opportunity for unique information to be shared). Overtly sharing information with teammates promotes positive climactic states (e.g., trust, cohesion), which ought to improve team socio-emotional outcomes and, in turn, team task performance (Beal, Cohen, Burke, & McLendon, 2003).

Both operationalizations of IS ought to relate to team performance, but because of its direct link to team task functioning, uniqueness ought to be more strongly related to performance than openness. In addition to these construct-based reasons, there are also methodological differences within these streams of research that may yield differential relationships to performance (e.g., reliance upon manipulations vs. self-report measures, ad hoc vs. intact teams, objective vs. subjective performance criteria). Therefore, we expect the following:

> *Hypotheses 1–2:* IS will positively predict team performance (H1), whereas IS uniqueness will more strongly predict team performance than will IS openness (H2).

Differential Prediction of Team Performance Criteria

Differing performance criteria may also partially explain discrepant findings. Past investigations link IS to three broad classes of performance criteria, which differ in terms of both their contamination and deficiency: decision effectiveness, objective measures, and subjective measures (Campbell, McCloy, Oppler, & Sager, 1992). Objective measures are least contaminated with performance-irrelevant content (e.g., rater bias) but are deficient in representing the full domain of team performance. Subjective measures are less deficient in representing the team performance domain but are typically more contaminated with rater biases and other non-performance-relevant sources of variance. Decision effectiveness measures are intermediate in terms of contamination and deficiency; by specifying multiple dimensions along which a decision is evaluated, they capture more of the relevant performance domain than do objective measures, and they also suffer from less contamination than do subjective measures. We expect contamination will inflate relationships with subjective criteria and that deficiency will suppress relations to objective criteria. Thus, IS ought to exhibit differential validity with team performance criteria descending as follows: subjective measures, decision effectiveness, and objective measures.

> *Hypothesis 3:* IS will differentially predict performance criteria such that IS will most strongly predict subjective measures, then decision effectiveness and objective measures.

Moderating Role of Task Type

A recurring concern surrounding IS research has been the extent to which IS effects are applicable to task domains other than intellective, hidden profile tasks (i.e., external validity; Mohammed & Dumville, 2001; Winquist & Larson, 1998; Wittenbaum,

Table 1
Definitions and Operationalizations of Information Sharing

Author (year)	Conceptual definition	Operational definition
	Uniqueness of information sharing	
Devine (1999)	"Effectively incorporating the specialized information provided by individual experts." (p. 613)	Measured common and unique information sharing via observer ratings of videotaped group discussions. Represented as the "sum . . . of information cues of each type mentioned aloud during discussion." (p. 619)
Johnson et al. (2006)	"The degree to which team members share information with each other." (p. 106)	Measured as the number of times team members sent information they acquired while doing their task to their teammates. The information being sent was known by only one team member.
Stasser & Titus (1987)	The prediscussion distribution of shared and unshared information is "the way the information is distributed among group members before discussion." (p. 82)	Manipulated the proportion of unshared information available to team members before discussion as either 33% or 66%.
	Openness of information sharing	
Bunderson & Sutcliffe (2002)	"Conscious and deliberate attempts on the part of team members to exchange work-related information, keep one another apprised of activities, and inform one another of key developments." (p. 881)	Measured using a 3-item self report scale: (a) Information used to make key decisions was freely shared among the members of the team, (b) team members worked hard to keep one another up to date on their activities, and (c) team members were kept "in the loop" about key issues affecting the business unit.
Jehn & Shah (1997)	"Making statements to other group members about the task." (p. 777)	Measured using 3 techniques: (a) Raters content-analyzed audio tapes for the percentage of discussion that consisted of sharing information, (b) the experimenter rated the quality of information sharing in the group based on a videotape, and (c) group members responded to a self-report measure; a sample item was "This group engaged in very open communication."
Miranda & Saunders (2003)	"Refers to oral and written discussion of information among group members." (p. 90)	Measured the breadth and depth of information sharing. "Breadth . . . was a count of the number of distinct discussion sequences initiated during a session. Depth . . . was the average number of comments or threads in the discussion sequences." (p. 94)

Hollingshead, & Botero, 2004). An *intellective task* is high on task demonstrability because, on the basis of available information and commonly accepted criteria, a correct answer exists; at the other end of the demonstrability continuum are *judgmental tasks*, which require groups to come to a consensus (Laughlin, 1980). A *hidden profile task* is one where the optimal decision choice differs from each team member's initial decision preference and where relevant information is distributed among team members in such a way that only by incorporating the unique knowledge of each member can the team realize the optimal decision (Stasser & Titus, 1985).

The presence or absence of a hidden profile and the level of task demonstrability distinguish four basic task types (i.e., intellective hidden profile, judgmental hidden profile, intellective nonhidden profile, and judgmental nonhidden profile), which differ in terms of the information processing demands required for goal accomplishment. In particular, either the presence of a hidden profile or the demonstrability of a correct solution increases the information processing required to make a high-quality decision. Hidden profile tasks require members to incorporate information that conflicts with their prediscussion preferences in order to make a nonintuitive group choice. Similarly, in addition to requiring teams to reach consensus, intellective tasks have the added processing demands of requiring sufficient information, incorrect members capable of recognizing the correct response if proposed, and correct members with the ability, motivation, and time to demonstrate the correct response to incorrect members (Laughlin, 1996). Therefore, owing to differential information processing requirements, we expect the following:

> *Hypothesis 4:* IS will predict team performance more positively when a hidden profile is present than when there is no hidden profile (H4A) and on intellective as opposed to judgmental tasks (H4B).

Moderating Role of Discussion Structure

Team discussions range in their degree of structure from free-form to highly focused. Past research has examined the impact of a variety of discussion structures on the pooling of information in teams (Wittenbaum & Bowman, 2004). Structured discussion procedures (Stasser, Taylor, & Hanna, 1989), judge–advisor systems (Savadori, Van Swol, & Sniezek, 2001), and dialectical inquiry methods (Devine, 1999) have been investigated as means of improving the amount of information used in decision-making, the logic being that more focused, structured discussions organize the group's retrieval and combination of information, which likely enhances the impact of IS on performance. Thus, we expect the following:

> *Hypothesis 5:* IS will more positively predict team performance when discussion structure is high than when discussion structure is low.

Information Processing

Past research has examined three information processing factors that tend to promote IS: task demonstrability, discussion structure, and cooperation. Highly demonstrable tasks (intellective; Laughlin, 1980; Stasser & Stewart, 1992), structured group discussions (Larson, Christensen, Franz, & Abbott, 1998; Mennecke, 1997; Okhuysen & Eisenhardt, 2002; Stasser, Stewart, & Wittenbaum, 1995), and cooperative group discussions (Greenhalgh & Chapman, 1998; Henningsen & Henningsen, 2003) have been found to increase members' in-depth processing and elaboration of information. Thus, we expect the following:

> *Hypotheses 6–8:* Task demonstrability (H6), discussion structure (H7), and cooperation (H8) will positively predict team IS.

Member Redundancy

Past research has examined three factors that tend to undermine IS in groups: member heterogeneity, informational interdependence, and information distribution (Stasser & Titus, 1985, 1987). These three factors reflect some variant of the extent to which team members are redundant in their informational contributions to the team.[1] To the extent that members are nonredundant, team performance could be enhanced through the effective sharing of information. However, prior research suggests that (a) group members are less willing to share information with individuals they perceive to be different from themselves (Devine, 1999; Miranda & Saunders, 2003; Stasser et al., 1995), (b) teams with more initially correct and therefore informationally independent members tend to share more information (Hollingshead, 1996b; Stasser & Stewart, 1992), and (c) teams spend less time discussing initially distributed (unshared) information than shared information (Stasser & Titus, 1985). Thus, we expect teams high in member redundancy will share more information than teams low in member redundancy.

> *Hypotheses 9–11:* Group member homogeneity (H9), informational independence (H10), and information distribution (H11) will positively predict team IS.

Method

Database

Seventy-two independent studies reported in 71 manuscripts (total number of groups = 4,795; total N = approximately 17,279) examining information sharing (IS) in teams were included in this meta-analysis. To ensure a comprehensive search, studies were located using the following strategies: (a) searching the PsycINFO, ABI Inform, and ERIC databases using appropriate keywords and phrases,[2] (b) searching for articles that cited Stasser, Stewart, and/or Titus's work on information sampling in teams, (c) checking references cited in studies included in this meta-analysis, and (d) requesting related manuscripts presented at annual conferences.[3] Studies were omitted from the meta-analytic database if sufficient information to compute a correlation between IS and a relevant correlate was not reported. Forty-seven of the 72 studies did not report correlations between IS and a relevant correlate but did provide sufficient information to compute a point-biserial correlation (e.g., means and standard deviations for experimental and control groups, t statistics).[4] In six cases, authors reported multiple estimates of the same relationship from the same sample (i.e., two methods of measuring the same conceptualization of IS were examined in relation to relevant correlates). In these cases, a mean correlation was computed to maintain independence (Hunter & Schmidt, 1994, 2004).[5]

Coding Procedure and Intercoder Agreement

Each study was coded for (a) sample size, (b) number of teams, (c) IS uniqueness versus openness, (d) task type, (e) discussion structure, (f) team performance criterion, (g) correlations between IS and relevant correlates and outcomes, (h) reliability estimates for IS, correlates, and outcomes, and (i) the proportion of discussion that was focused on shared versus unshared information. To ensure coding consistency and construct validity, we jointly developed a coding scheme based upon the conceptual and operational definitions for relevant constructs within the primary studies. We each undertook an independent effort to code the 72 studies that met criteria for inclusion in this study. Initial intercoder agreement across all coded effect sizes was 90%. All instances of disagreement involved the coding of IS operationalization and were resolved through discussion.

Moderators. Two key aspects of IS were adopted in the primary studies (see Table 1): (a) IS uniqueness—discussion of

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[1] We thank an anonymous reviewer for pointing out this common underlying factor.

[2] For example, *(group OR team) AND information sharing*, *decision-making*, *discussion*, *critical OR unshared information*, *information exchange*, *hidden profile*, and *biased information sampling*.

[3] We checked conference programs from the Society for Industrial and Organizational Psychology and the Academy of Management meetings over the past 2 years to incorporate research results that had not yet been published. We contacted authors of potentially relevant studies directly via e-mail and received 80% of the manuscripts requested; half of those met criteria for inclusion in this study.

[4] As point-biserial correlations are attenuated (in this case, due to the dichotomization of IS), corrections were made to convert the correlations to a full ±1 scale. We also made adjustments to the sample sizes for the corrected correlations to avoid underestimating sampling error variance using procedures described in Hunter and Schmidt (1990, 2004) and Ones, Viswesvaran, and Schmidt (1993).

[5] Although this is the norm in meta-analysis, average correlations are flawed in that they can result in overestimates of sampling error. Although composite correlations would have been preferable, the majority of primary studies did not report sufficient data to compute them (i.e., correlations among facet measures). Importantly, the correlations we used to compute averages were highly similar, thus minimizing concerns associated with our approach.

previously unshared information (consistent with the biased information sampling approach; $k = 51$) and (b) IS openness—breadth of information discussed during group tasks/decision-making ($k = 21$). Three distinct indicators of team performance were adopted in the primary studies: decision effectiveness (e.g., solution quality, comparison to expert solution, correctness; $k = 46$), objective measures (e.g., profitability, market growth, computer simulation score; $k = 8$), and subjective measures (e.g., evaluations of performance; $k = 4$). As appropriate, tasks used in the primary studies were coded as to whether (a) a hidden profile was present or absent and (b) task demonstrability was high or low, resulting in the identification of four conceptually distinct types of decision-making tasks: hidden profile—intellective ($k = 23$), hidden profile—judgmental ($k = 5$), nonhidden profile—intellective ($k = 4$), and nonhidden profile—judgmental ($k = 4$). Further, group discussions in the primary studies were coded as either structured (e.g., instructed to share information, told to be vigilant about discussing all information prior to reaching a decision, provided with a discussion format designed to ensure member participation; $k = 12$) or unstructured ($k = 27$).

Correlates. An examination of the role of task demonstrability and decision structure in promoting IS was possible whenever a primary study examined decision tasks (judgmental vs. intellective) or decision structure (unstructured vs. structured discussions) in the same study and reported its relationship to IS. Cooperation during discussion was typically operationalized using a Likert-type scale assessing team members' perceptions of the team's cooperativeness in sharing information during discussion. Team member similarity was typically operationalized as surface-level similarity (e.g., similarity of function, knowledge) using either the group standard deviation or Likert-type scales of member perceptions. Positive correlations indicate homogenous teams shared more information. Positive correlations for information independence indicate more information was shared in teams where more members knew the correct solution prior to discussion. Finally, positive correlations for information distribution indicate teams discussed more shared than unshared (unique) information.

Analysis

The meta-analytic methods outlined by Hunter and Schmidt (2004) were employed. Corrections were made for sampling error, measure reliability, and, when necessary, attenuation of observed correlations due to dichotomization of IS.[6] Corrections were made for unreliability in both IS and correlate measures whenever possible. When reliability estimates were available only for IS, we corrected for reliability in this construct and made no correction for reliability in the other.[7] Finally, given the possibility of a file-drawer effect (wherein significant findings are more likely to be published; Rosenthal, 1979), we conducted a file-drawer analysis (Hunter & Schmidt, 2004) to estimate the number of studies reporting null findings that would be required to reduce reliability-corrected correlations to a specified lower value (we used $\rho = .05$).

Results

Table 2 reports the results of the meta-analyses examining the role of information sharing (IS) in team outputs. In support of Hypothesis 1, IS positively predicted team performance ($\rho = .42$, $k = 43$). IS also positively predicted cohesion ($\rho = .20$, $k = 11$), member satisfaction ($\rho = .33$, $k = 3$),[8] and knowledge integration ($\rho = .34$, $k = 9$). Hypothesis 2 predicted IS conceptualization would differentially predict team performance, such that the uniqueness of the information shared would be more strongly related to team performance than would be the openness of IS. Indeed, the credibility interval (CV) surrounding ρ for the IS–performance relationship was fairly wide (.14, .70), suggesting moderators may exist.[9] Examining the IS–performance relationship by conceptualization of IS shows support for Hypothesis 2; specifically, IS uniqueness was more strongly predictive of team performance than was IS openness ($\rho = .50$, $k = 25$ vs. $\rho = .32$, $k = 19$). Further, the confidence intervals (CIs) for these estimates of ρ do not overlap, supporting our proposition that the form of IS (uniqueness vs. openness) results in a meaningful difference in team performance. Although not hypothesized, it is interesting that openness of IS was more strongly related to cohesion than uniqueness ($\rho = .31$, $k = 5$ vs. $\rho = .11$, $k = 6$; the corresponding CIs do not overlap).

Hypothesis 3 predicted operationalization of team performance would moderate the IS–performance relationship. As expected, meta-analyses between IS and each performance criterion revealed differences in the estimates of ρ, such that IS was most strongly related to subjective performance measures ($\rho = .51$, $k = 4$), followed by decision effectiveness ($\rho = .45$, $k = 31$); the smallest relationship was found for objective measures ($\rho = .21$, $k = 8$). Largely nonoverlapping CIs as well as smaller SD_ρ values for subcategories of performance compared with the overall category provide additional support for performance criteria as moderators of the IS–performance relationship (Judge & Piccolo, 2004).

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[6] Corrections for measure reliability were made using artifact distributions. Individual corrections for reliability were not preferable because reliability estimates were not consistently available for correlate/outcome variables (Hunter & Schmidt, 2004). Further, although the Hunter and Schmidt (2004) method also permits corrections for the effects of range restriction, there was no evidence provided of range restriction in IS or its correlates in the samples used in the primary studies.

[7] Resulting corrected correlations from both approaches can be compared across meta-analyses; however, ρ (the reliability-corrected mean correlation) may be slightly underestimated for meta-analyses wherein corrections were made for reliability in only one measure. Superscripts are included in the tables to indicate whether reliability was corrected in one or both measures in a given meta-analysis.

[8] Small k meta-analyses are subject to second-order sampling error (Hunter & Schmidt, 2004). Although second-order sampling error tends to affect meta-analytic estimates of standard deviations more than means, the reader is advised to interpret results of such meta-analyses with caution.

[9] We report both the CVs and the CIs, as each provides unique information about the nature of ρ (Hunter & Schmidt, 2004; Whitener, 1990). Specifically, the CV provides an estimate of the variability of corrected correlations across studies. Wide CVs or those that include zero suggest the presence of a moderator. An 80% CV that excludes zero indicates that more than 90% of the corrected correlations are different from zero (10% lie beyond the upper bound of the interval). The CI provides an estimate of the accuracy of our estimation of ρ (Whitener, 1990); in other words, the CI estimates the variability around ρ due to sampling error. A 90% CI that excludes zero indicates that if our estimation procedures were repeated many times, 95% of the estimates of ρ would be larger than zero (5% would fall beyond the upper limit of the interval).

Table 2
Information Sharing (IS) and Team Outcomes

Meta-analysis variable	k	N	r	SD_r	ρ	SD_ρ	80% CV	90% CI	% SEV	% ARTV	FD k
Team performance (all indicators)[a]	43	2,701	.37	.22	.42	.22	.14, .70	.35, .49	24.29	25.97	319
IS–uniqueness[a]	25	1,490	.44	.25	.50	.25	.18, .82	.40, .60	18.44	21.03	225
IS–openness[a]	19	1,295	.28	.17	.32	.14	.14, .50	.25, .39	45.27	46.21	103
Decision effectiveness[a]	31	1,917	.40	.23	.45	.22	.17, .72	.37, .53	22.83	24.09	248
IS–uniqueness[a]	21	1,220	.45	.27	.47	.25	.15, .79	.37, .57	16.01	16.29	177
IS–openness[a]	11	777	.29	.14	.35	.09	.23, .46	.27, .43	66.52	67.32	66
Team performance–objective measures[b]	8	498	.21	.19	.21	.16	.01, .41	.09, .33	38.44	38.49	26
IS–uniqueness[b]	2	140	.24	.07	.24	0	.24, .24	.16, .32	100	100	8
IS–openness[b]	6	358	.21	.22	.22	.18	−.02, .45	.07, .37	32.35	32.39	21
Team performance–subjective measures[a]	4	286	.42	.09	.51	0	.51, .51	.43, .59	100	100	37
IS–uniqueness[a]	2	129	.43	.10	.49	0	.49, .49	.36, .62	100	100	18
IS–openness[a]	2	157	.40	.07	.48	0	.48, .48	.38, .58	100	100	18
Cohesion[a]	11	682	.18	.14	.20	.06	.13, .28	.12, .28	83.69	84.69	33
IS–uniqueness[a]	6	369	.10	.13	.11	.04	.06, .16	.01, .21	92.57	92.62	8
IS–openness[a]	5	313	.25	.09	.31	0	.31, .31	.23, .39	100	100	26
Satisfaction[a]	3	213	.28	.18	.33	.17	.12, .54	.13, .53	38.45	38.84	17
Knowledge integration[b]	9	467	.33	.28	.34	.26	.01, .67	.18, .50	19.75	19.83	53

Note. k = number of correlations meta-analyzed; N = total number of groups; r = sample-size-weighted mean observed correlation; SD_r = sample-size-weighted standard deviation of the observed correlations; ρ = sample-size-weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80% CV = 80% credibility interval around ρ; 90% CI = 90% confidence interval around ρ; % SEV = percent variance due to sampling error; % ARTV = percent variance due to all corrected artifacts; FD k = file-drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.
[a] Corrections for reliability were possible for both IS and team performance. [b] Corrections for reliability were possible for only IS.

Table 3 reports the results of meta-analyses testing Hypothesis 4, which predicted IS would more positively predict team performance on intellective hidden profile tasks than on nonhidden profile and/or judgmental tasks. Indeed, IS was more predictive of performance on intellective hidden profile tasks (ρ = .53, k = 23) than for any other task type (for judgmental hidden profile tasks, ρ = .36, k = 5; for intellective nonhidden profile tasks, ρ = .36, k = 4; for judgmental nonhidden profile tasks, ρ = .37, k = 4). However, the associated CIs overlapped, suggesting results should be interpreted with caution, and additional research is needed to disentangle the role of task type.

Table 4 reports the results of meta-analyses testing Hypothesis 5, which predicted discussion structure would moderate the IS–performance relationship such that IS would more positively predict performance when structure was high than low. Results suggest that discussion structure only moderated the IS–performance relationship for uniqueness; IS–uniqueness was more positively related to performance when discussion structure was high (ρ = .46, k = 8 vs. ρ = .34, k = 14), suggesting that structuring discussion enhances the importance of unique IS to team performance.

Table 5 reports the results of meta-analyses examining correlates of IS. Results suggest teams share more information wherein (a) task demonstrability is high (ρ = .45, k = 5), (b) discussion structure is high (ρ = .41, k = 13), and (c) members are more cooperative during discussion (ρ = .57, k = 14; although the CV for this relationship excludes zero, it is fairly wide, suggesting a more complex relationship may exist), thus providing support for Hypotheses 6–8.

Further, although teams are often deliberately composed of diverse members in an effort to enhance decision quality, results suggest that IS was actually greater in teams wherein member similarity is high (ρ = .22, k = 9), which provides support for

Table 3
Task Type as a Moderator of the Relationship Between Information Sharing (IS) and Team Performance

Meta-analysis variable	k	N	r	SD_r	ρ	SD_ρ	80% CV	90% CI	% SEV	% ARTV	FD k
Hidden profile tasks											
Intellective[a]	23	1,307	.46	.25	.53	.25	.21, .85	.43, .63	18.14	22.07	221
Judgmental[a]	5	260	.32	.19	.36	.15	.17, .56	.20, .52	45.02	45.40	31
Nonhidden profile tasks											
Intellective[a]	4	352	.34	.08	.36	0	.36, .36	.29, .43	100	100	25
Judgmental[a]	4	181	.30	.11	.37	0	.37, .37	.25, .49	100	100	26

Note. k = number of correlations meta-analyzed; N = total number of groups; r = sample-size-weighted mean observed correlation; SD_r = sample-size-weighted standard deviation of the observed correlations; ρ = sample-size-weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80% CV = 80% credibility interval around ρ; 90% CI = 90% confidence interval around ρ; % SEV = percent variance due to sampling error; % ARTV = percent variance due to all corrected artifacts; FD k = file-drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.
[a] Corrections for reliability were possible for both IS and team performance.

Table 4
Discussion Structure as a Moderator of the Relationship Between Information Sharing (IS) and Team Performance

Meta-analysis variable	k	N	r	SD_r	ρ	SD_ρ	80% CV	90% CI	% SEV	% ARTV	FD k
Structured discussion (IS combined)[a]	12	764	.32	.20	.39	.20	.14, .64	.27, .51	32.00	33.54	82
IS–uniqueness[a]	8	405	.38	.13	.46	.02	.44, .49	.36, .56	93.94	98.16	66
IS–openness[a]	4	287	.24	.27	.29	.29	−.08, .66	.03, .55	17.33	18.02	20
Unstructured discussion (IS combined)[a]	27	1,585	.33	.12	.36	.02	.32, .38	.31, .41	95.40	97.22	168
IS–uniqueness[a]	14	730	.33	.14	.34	.07	.26, .43	.27, .41	77.95	78.78	82
IS–openness[a]	13	855	.33	.08	.37	0	.37, .37	.34, .40	100	100	84

Note. k = number of correlations meta-analyzed; N = total number of groups; r = sample-size-weighted mean observed correlation; SD_r = sample-size-weighted standard deviation of the observed correlations; ρ = sample-size-weighted mean observed correlation corrected for unreliability in both measures; SD_ρ = standard deviation of ρ; 80% CV = 80% credibility interval around ρ; 90% CI = 90% confidence interval around ρ; % SEV = percent variance due to sampling error; % ARTV = percent variance due to all corrected artifacts; FD k = file-drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.
[a] Corrections for reliability were possible for both IS and team performance.

Hypothesis 9. Also, as predicted in Hypothesis 10, as members became more informationally independent (i.e., as the proportion of the team that could have reached a correct decision without discussion increased), more information was shared (ρ = .52, k = 4).

Table 6 reports meta-analytic estimates of the size of the team information sampling bias. Specifically, Hypothesis 11 predicted teams would discuss more commonly held than uniquely held information. Indeed, teams tended to spend more discussion time on shared than unshared information (ρ = .69, k = 23).[10] Interestingly, this effect was even stronger when task demonstrability was low (ρ = .86, k = 4 vs. ρ = .62, k = 19; the CIs around these estimates are distinct, suggesting differences in the nature of information shared by task type).

Discussion

Organizations are increasingly relying upon the outputs of knowledge-based project and management teams (Devine, 1999; Sundstrom, 1999). An intuitive expectation is that knowledge-based teams share and ultimately benefit from a greater pool of available information and members' collective processing of that information. However, a seminal study by Stasser and Titus (1985) cast doubt on expectations of groups as effective information processors, and a stream of empirical work has followed. We cumulated 22 years of empirical research on information sharing (IS), some conducted within the Stasser and Titus tradition and some more broadly focused on team process, in order to (a) better understand the correlates and consequences of team IS and (b) explore moderators of the IS–performance relationship. Findings show IS is enhanced by factors that promote information processing (e.g., task demonstrability) and reflect various aspects of member redundancy (e.g., similarity). Further, our results confirm that IS is a clear driver of team performance and that although the effect is moderated, the relationship remains positive across levels of all moderators.

Implications of Definitions of Information Sharing and Performance

Importantly, the manner in which IS has been theoretically and operationally defined moderates the strength of the positive IS–performance relationship. IS defined as uniqueness (i.e., sharing information not commonly held by all team members) is more predictive of team performance than IS defined more broadly as openness (i.e., breadth of information shared). Interestingly, our results suggest the reverse is true when predicting team cohesion; specifically, IS openness was more strongly correlated with team cohesion than IS uniqueness. This pattern of findings is consistent with the idea that the uniqueness and openness aspects of IS parallel the task and socio-emotional functions of teams. Sharing unique information builds the available knowledge stock, directly improving the team's task outcomes. Openness was also related to performance, though less strongly than uniqueness. A plausible explanation for this differential relationship is that openness influences performance indirectly through promoting high-quality relationships and enabling members to have greater trust in one another's informational inputs. Another possible explanation is that discussing information with greater breadth may permit more in-depth information processing, thus enhancing the quality of team decisions. And third, although the current literature has not allowed us to jointly consider openness and uniqueness, perhaps when teams are more open during discussions, the potential increases that unique information surfaces, thus promoting quality performance.

Future research ought to explore uniqueness and openness in combination. Figure 2 proposes a two-dimensional view of IS uniqueness and openness; we do not submit that openness and uniqueness are orthogonal, but rather, at least conceptually, that they are not so perfectly correlated as to represent ends of a single dimension (e.g., team discussion can be high in both openness and uniqueness). We hope this framework spawns research that will

[10] Were equal discussion time devoted to shared and unshared information, we would expect this correlation to be near zero. The reliability-corrected correlation can also be converted to a d statistic (δ) for ease of interpretation. The effect size d captures the same effect as the t statistic, but it is a better measure of effect because it allows for a consistent metric across studies (i.e., does not rely upon sample size for interpretation; Hunter & Schmidt, 2004). A ρ of .69 converts to a δ of 1.38, which captures the difference in average discussion time devoted to shared versus unshared information, and indicates a large effect (Cohen, 1988) of biased IS on group discussion.

Table 5
Correlates of Team Information Sharing (IS)

Meta-analysis variable	k	N	r	SD_r	ρ	$SD_ρ$	80% CV	90% CI	% SEV	% ARTV	FD k
Task demonstrability[b]	5	416	.41	.06	.45	0	.45, .45	.40, .50	100	100	40
IS–uniqueness[b]	5	414	.41	.06	.46	0	.46, .46	.41, .51	100	100	40
IS–openness[b]	2	150	.34	.09	.36	0	.36, .36	.24, .48	100	100	13
Decision structure[a]	13	688	.40	.14	.41	0	.41, .41	.34, .48	100	100	94
IS–uniqueness[b]	11	566	.43	.12	.44	0	.44, .44	.37, .51	100	100	86
IS–openness[a]	2	122	.25	.07	.27	0	.27, .27	.19, .35	100	100	9
Cooperation during discussion[a]	14	1,028	.49	.29	.57	.32	.16, .97	.42, .72	9.35	11.43	146
IS–uniqueness[a]	4	338	.40	.30	.44	.31	.04, .85	.16, .72	9.32	9.96	32
IS–openness[a]	10	690	.53	.28	.63	.30	.24, 1.0	.45, .81	9.83	12.24	116
Member similarity[a]	9	565	.19	.18	.22	.14	.04, .41	.10, .34	49.01	49.25	31
IS–uniqueness[a]	4	247	.25	.15	.27	.09	.15, .39	.14, .40	66.57	66.66	18
IS–openness[a]	5	318	.15	.18	.18	.17	.03, .39	.02, .34	45.78	45.81	13
Informational independence[b]	4	268	.49	.11	.52	.07	.44, .60	.42, .62	70.03	70.05	38
IS–uniqueness[b]	3	227	.31	.13	.34	.08	.23, .44	.21, .47	64.25	64.24	18
IS–openness[b]	2	112	.65	.05	.69	0	.69, .69	.62, .76	100	100	26

Note. k = number of correlations meta-analyzed; N = total number of groups; r = sample-size-weighted mean observed correlation; SD_r = sample-size-weighted standard deviation of the observed correlations; ρ = sample-size-weighted mean observed correlation corrected for unreliability in both measures; $SD_ρ$ = standard deviation of ρ; 80% CV = 80% credibility interval around ρ; 90% CI = 90% confidence interval around ρ; % SEV = percent variance due to sampling error; % ARTV = percent variance due to all corrected artifacts; FD k = file-drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.
[a] Corrections for reliability were possible for both IS and team performance. [b] Corrections for reliability were possible for only IS.

ultimately enable a richer understanding of how multiple facets of knowledge utilization impact team effectiveness.

Furthermore, although there are construct-based explanations for the observed differential pattern of findings with uniqueness and openness, there are equally plausible methodological explanations. These two streams of research have tended to differ in the extent to which they rely on manipulations (uniqueness) versus self-report retrospective measures (openness). Manipulations may strengthen observed relations via situational strength and weaken them due to artificial dichotomization. Likewise, sources of contamination in self-report measures of openness (e.g., hindsight bias) may inflate correlations with performance, though this would imply the actual relationship of openness to performance is weaker than the current findings suggest. Other methodological explanations exist as well, for example, differential reliance on ad hoc (uniqueness) versus intact teams (openness) and differential use of decision effectiveness as the primary criterion (uniqueness) versus using a more balanced set of performance criteria (openness). The current findings show a clear pattern where uniqueness is more predictive of team performance than openness, but the extent to which these differences are attributable to conceptual versus methodological sources remains an open question.

Performance criterion also moderates the IS–performance relationship; specifically, IS shows stronger effects to subjective and decision-making effectiveness measures than to objective indices. Beal et al. (2003) discovered a similar pattern with cohesion and performance. Hence, both cohesion and IS show stronger relations to behavioral than outcome/results criteria, likely because behaviors are more controllable by teams (Campbell et al., 1992). Future investigations of team processes such as IS ought to explicitly consider controllability (i.e., the extent to which the outcome is within the domain of control of the team) in choosing an outcome metric.

Implications of Task Type and Discussion Structure

A concern in the IS literature revolves around whether the IS–performance relationship holds only for highly demonstrable,

Table 6
Impact of Knowledge Distribution on Information Sharing (IS) in All Hidden Profile Tasks: Proportion of Discussion Devoted to Shared Versus Unshared Information

Hidden profile task type	k	N	r	SD_r	ρ	$SD_ρ$	80% CV	90% CI	% SEV	% ARTV	FD k
All[a]	23	901	.65	.24	.69	.23	.39, .98	.61, .77	15.95	17.82	295
Intellective[a]	19	690	.58	.22	.62	.20	.37, .87	.54, .70	27.22	29.09	217
Judgmental[a]	4	211	.86	.19	.86	.19	.63, 1.0	.70, 1.0	3.81	3.81	65

Note. k = number of correlations meta-analyzed; N = total number of groups; r = sample-size-weighted mean observed correlation; SD_r = sample-size-weighted standard deviation of the observed correlations; ρ = sample-size-weighted mean observed correlation corrected for unreliability in both measures; $SD_ρ$ = standard deviation of ρ; 80% CV = 80% credibility interval around ρ; 90% CI = 90% confidence interval around ρ; % SEV = percent variance due to sampling error; % ARTV = percent variance due to all corrected artifacts; FD k = file-drawer k representing the number of "lost" studies reporting null findings necessary to reduce ρ to .05.
[a] Corrections for reliability were possible for only IS.

Team Task Outcomes

Team Relationship Outcomes

	Low Uniqueness	High Uniqueness
Low Openness	Teammates do not openly discuss information; when information is discussed, there is a large bias in discussion time spent on commonly held as opposed to initially distributed information (i.e., limited, commonly-held information is discussed)	Teammates do not openly discuss information; when information is discussed, there is a small bias in discussion time spent on commonly held as opposed to initially distributed information (i.e., limited, uniquely-held information is discussed)
High Openness	Teammates openly discuss information; there is a large bias in discussion time spent on commonly held as opposed to initially distributed information (i.e., extensive/frequent discussion of commonly-held information)	Teammates openly discuss information; there is a small bias in discussion time spent on commonly held as opposed to initially distributed information (i.e., extensive/frequent discussion of uniquely-held information)

Figure 2. Two-dimensional typology of team information sharing and team outcomes.

hidden profile tasks (Mohammed & Dumville, 2001). Although we found IS had the strongest impact on performance on intellective hidden profile tasks, IS also positively affected performance on less demonstrable as well as nonhidden profile tasks, supporting the generalizability of the effect and Laughlin's (1980, 1996) classic postulate that team performance on more demonstrable (intellective) tasks requires greater information processing than does performance on less demonstrable tasks.

Although discussion structure alone did not alter the strength of the IS–performance relationship, there was evidence of a more complex interaction involving uniqueness and openness. Uniqueness and openness have similar effects on performance in unstructured (free-form) discussions. Yet, in structured discussions, there is more overall variation in effect size estimates, and uniqueness shows a somewhat larger effect on performance than does openness. Comparing the effects of uniqueness within structured versus unstructured discussions suggests the impact of uniqueness has a magnified effect on team performance in structured discussions. Research is needed to further examine the impact of structure on different aspects of IS.

When Do Teams Share Information?

The current findings point to three situations wherein teams may naturally avoid sharing information at times when it is particularly critical for them to do so. Specifically, teams share more information when (a) all members already know the information (biased information sampling), (b) members are all capable of making accurate decisions independently (informational independence), and (c) members are highly similar to one another (member similarity). These findings suggest that less knowledge-redundant teams, precisely those teams who stand to gain the most from sharing information, actually share less information than do more knowledge-redundant teams. This redundancy effect reflects a divergence in what teams actually do (normatively) and what they should do in order to be maximally effective (prescriptively), and it has particularly meaningful implications for expert decision-making teams, like those employed for emergency response and medical decision-making (Burke, Salas, Wilson-Donnelly, & Priest, 2004). Highly complex task domains typically require specialized, nonredundant experts with dissimilar training and background characteristics to integrate information in order to reach a quality solution. Future research is needed to elucidate reasons for the member redundancy effect (e.g., conformity pressure, social identity, and/or relational motivation) as a first step toward developing interventions to mitigate it.

Current findings regarding knowledge distribution (i.e., an aspect of redundancy) demonstrate the robustness of Stasser and Titus's (1985) biased information sampling effect; cumulating 22 years of subsequent research shows teams deviate markedly from an even balance of time spent discussing both shared and unshared information. Furthermore, information sampling is even more biased toward shared information on judgmentally (compared to intellectively) framed tasks. In practice, framing tasks as intellective rather than judgmental shows promise as a way to enhance the sharing of unique information.

Findings show IS can be enhanced by (a) structuring team discussions, (b) framing team tasks as intellective, and (c) promoting a cooperative team climate. All three factors have been found to enhance teams' in-depth processing of information. Structure appears to have similar effects on information sampling in team discussions, as in personnel selection interviews (Conway, Jako, & Goodman, 1995); structure increases the team's retrieval of decision-relevant information. Similarly, suggesting to teams that they have the necessary knowledge, skills, and abilities to come to a superior solution likely sparks a greater vigilance in seeking out and integrating decision-relevant information. Lastly, promoting a cooperative climate is linked to greater use of informational resources by teams.

New Directions in Information Sharing Research

Two exciting new directions are to examine IS across dimensions of team virtuality and team boundaries. Widespread trends toward globalized, digitized work are transforming the way teams communicate. Future research is needed to examine IS and information processing in teams operating under various configurations of *team virtuality*, that is, "the extent to which team members use virtual tools to coordinate and execute team processes, the amount of informational value provided by such tools, and the synchronicity of team member virtual interaction" (Kirkman & Mathieu, 2005, p. 700). Likewise, thus far, this paradigm has explored how individuals in a single team exchange and process information. The increased complexity of team operating environments as networked structures (Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005) raises the issue of how knowledge and information are effectively shared both within and across distinct interdependent teams. Many factors operating to promote IS within a team (e.g., shared identity, trust, and cohesion) are reduced when it comes to collaborating with members of other teams (Sherif, 1966; Tajfel & Turner, 1986).

Limitations

Although this study makes an important contribution to the team performance literature, it is not without its limitations. First, although we are unaware of any concrete guidelines regarding a minimum number of studies necessary to utilize meta-analysis, the small number of articles available in some of our meta-analyses heightens concerns of second-order sampling error (Hunter & Schmidt, 2004). Second, there is causal ambiguity in some of the relationships we examined. This is a clear concern with team cooperation; because most primary studies reported a correlational relationship, it is equally plausible that cooperative groups share more information and/or that IS improves team cooperation. This is less of a concern with relationships involving task demonstrability or discussion structure because experimental designs were used in the primary studies.

A third limitation is that correlations among the four moderators we tested may operate to confound effects. Essentially, because we could not directly calculate correlations among the moderators themselves, it is certainly possible that if they are highly correlated, one factor or the other is the primary moderator. This issue was discussed earlier as it concerns the uniqueness/openness and performance criterion moderators; we raise it again here to note that it applies to all of the moderator combinations. As such, these results are best interpreted as supporting the presence of moderators in the IS–performance relationship. These four moderators we have examined explain variation in the relationship between IS and performance, but research is needed to disentangle them.

Conclusion

Teams are increasingly tasked with making high-stakes decisions (Burke et al., 2004) in settings as varied as hospital operating rooms (e.g., surgical teams), executive boardrooms (e.g., top management teams), and provinces of Iraq (e.g., provincial reconstruction teams). Teams typically possess an informational advantage over individuals, enabling diverse personal experiences, cultural viewpoints, areas of specialization, and educational backgrounds to bring forth a rich pool of information on which to base decision alternatives and relevant criteria. However, the current findings confirm that although sharing information is important to team outcomes, teams fail to share information when they most need to do so.

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