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A META-ANALYSIS OF TEAMWORK PROCESSES: TESTS OF A MULTIDIMENSIONAL MODEL AND RELATIONSHIPS WITH TEAM EFFECTIVENESS CRITERIA

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Drawing from Marks, Mathieu, and Zaccaro (2001), we proposed that narrowly focused teamwork processes load onto 3 higher-order teamwork process dimensions, which in turn load onto a general teamwork process factor. Results of model testing using meta-analyses of relationships among narrow teamwork processes provided support for the structure of this multidimensional theory of teamwork process. Meta-analytic results also indicated that teamwork processes have positive relationships with team performance and member satisfaction, and that the relationships are similar across the teamwork dimensions and levels of process specificity. Supplemental analyses revealed that the 3 intermediate-level teamwork processes are positively and strongly related to cohesion and potency. Results of moderator analyses suggested that relationships among teamwork processes and team performance are somewhat dependent on task interdependence and team size.

Scholars have conducted a great deal of research aimed at understanding factors that explain how and why teams achieve desired outcomes (Turner, 2001). The popularity of this type of research is consistent with the reliance on team-based work structures in organizations (Devine, Clayton,

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Philips, Dunford, & Melner, 1999). Unfortunately, however, research in this area has not accumulated in a very consistent manner, and as a result, scholars have not been able to offer many clear recommendations to managers regarding ways to improve the functioning and effectiveness of teams in their organizations (Guzzo & Shea, 1992; Turner, 2001).

One reason why research on teams has not accumulated effectively is that scholars have been studying concepts that are not clearly defined or differentiated from other similar concepts. This shortcoming may be especially true for research on teamwork processes, or the set of variables that reflect "members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing taskwork to achieve collective goals" (Marks, Mathieu, & Zaccaro, 2001, p. 357). In some cases, researchers focus on substantive relationships with narrowly defined aspects of team process without considering that the processes may be somewhat redundant or, at the very least, relate to one another in nontrivial ways (e.g., Campion, Papper, & Medsker, 1996). In other cases, researchers focus on relationships with broadly defined team process measures—sometimes labeled social cohesion or overall group process (e.g., Kirkman, Tesluk, & Rosen, 2001; Podsakoff, Ahearn, & MacKenzie, 1997). However, because the content of broadly defined team process has yet to be adequately specified, the extent to which these types of measures are contaminated, deficient, or comparable across studies is unknown. Moreover, the appropriateness of considering broad measures is unclear given the existence of the narrower process concepts that have received so much attention in the literature on small groups and teams.

Although scholars have begun conceptual work intended to clarify the nature and dimensional structure of teamwork process (e.g., Kozlowski, Gully, Nason, & Smith, 1999; Marks et al., 2001), no published empirical research has examined the issue directly. From a theoretical standpoint, such research is necessary given that the proper specification of constructs with multiple dimensions is needed to support construct validity and to make correct inferences from empirical tests of theoretically derived relationships (Edwards, 2001; Law, Wong, & Mobley, 1998). From a practical standpoint, such research is needed because teamwork processes are thought to represent points of leverage for practices aimed at improving team effectiveness, yet the utility of these practices is not altogether clear (Salas, Rozell, Mullen, & Driskell, 1999). It is possible that an improved understanding of the teamwork process construct and its dimensionality could aid in the development of practices that have greater usefulness.

Accordingly, the general purpose of our research was to develop and test a model that specifies the dimensional structure of teamwork processes. The model draws from the work of Marks et al. (2001) and suggests that narrow teamwork processes load onto three broad process dimensions, which then load onto a more general teamwork process factor. We examined the structure of this model using meta-analyses of relationships among narrow teamwork processes.

The secondary but related purpose of our study was to examine relationships among team effectiveness criteria and teamwork processes at narrow, intermediate, and general levels of specificity. Although this purpose may appear to be somewhat mundane given that scholars and practitioners often assume that teamwork processes and group effectiveness are positively related, we are unaware of any research that has examined this issue across different levels of process specificity and multiple criteria. Moreover, because the focus of our research was to better understand the nature of the domain of teamwork processes, it was important to examine whether relationships among teamwork processes and team effectiveness criteria differ as a function of the teamwork process under consideration.

Finally, given inconsistencies in empirical findings regarding the relationships between teamwork processes and team effectiveness, we examined the role of several moderators. Consistent with the tradition of meta-analysis, we considered the role of methodological features of the primary research. In addition, we considered moderators that were theoretically derived.

The Dimensional Structure of Teamwork Process

Although research on team processes has a long history, only recently have scholars begun to articulate theory that describes the domain of processes and how the concepts in this domain relate to one another. We draw from the work of Marks et al. (2001) who submitted that teams perform different processes at different times as related to what they called performance episodes—distinguishable periods of time over which work is performed and evaluated. They argued that *between episodes* teams execute transition processes as they review their previous efforts and prepare for future work.They also argued that teams perform action processes *during episodes* where the primary work is accomplished. Finally, they argued that teams orchestrate interpersonal processes both during and between episodes. Next, we review these three categories of teamwork process in more detail.

First-order teamwork processes. *Transition processes* describe actions that teams execute between performance episodes. They have a dual focus as teams seek to reflect upon and interpret previous team accomplishments, as well as prepare for future actions. Marks et al. identified three primary transition processes. The first type of transition process is *mission analysis*. This process involves the identification and evaluation of team tasks, challenges, environmental conditions, and resources available for performing the team's work. A second type of transition process is *goal specification* that involves activities centered on the identification and prioritization of team goals. *Strategy formulation and planning* is a third transition process. This involves developing courses of actions and contingency plans, as well as making adjustments to plans in light of changes or expected changes in the team's environment.

Action processes reflect four types of activities that occur as the team works toward the accomplishment of its goals and objectives (Marks et al., 2001, p. 366). The first action process is *monitoring progress toward goals*. This process involves members paying attention to, interpreting, and communicating information necessary for the team to gauge its progress toward its goals. *Systems monitoring* is a second type of action process. This involves activities such as tracking team resources (e.g., money) and factors in the team environment (e.g., inventories) to ensure that the team has what it needs to accomplish its goals and objectives. A third type of action process, called *team monitoring and backup behavior,* involves members going out of their way to assist other members in the performance of their tasks. As Marks et al. note, this process may involve indirect help to teammates (feedback or coaching), direct help to teammates (assistance with the task itself), or behaviors that directly compensate for teammates (taking on the task of a teammate who needs assistance). Team monitoring and backup behaviors have been studied in the context of research on synonymous concepts such as cooperation (e.g., Jehn & Shah, 1997), workload sharing (e.g., Campion, Medsker, & Higgs, 1993), and group-level organizational citizenship behavior (e.g., Hyatt & Ruddy, 1997). Finally, *coordination* refers to the process of synchronizing or aligning the activities of the team members with respect to their sequence and timing (Marks et al., 2001; Wittenbaum, Vaughan, & Stasser, 2002).

Interpersonal processes represent the third aspect of teamwork and reflect those team activities that are focused on the management of interpersonal relationships (Marks et al., 2001). Whereas Marks and colleagues presented the transition and action processes as cyclically triggering one another over time, they submitted that managing the interpersonal dynamics among members is an on-going activity salient at all times. The first dimension of interpersonal process is *conflict management,* which refers to the manner in which team members proactively and reactively deal with conflict. Effective conflict management includes showing mutual respect, willingness to compromise, and developing norms that promote cooperation and harmony. Second, *motivating and confidence building* refers to activities that develop and maintain members' motivation and confidence with regard to the team accomplishing its goals and objectives.

Finally, *affect management* represents those activities that foster emotional balance, togetherness, and effective coping with stressful demands and frustration.

The hierarchical structure of teamwork processes. As outlined above, Marks et al. (2001) organized relatively narrow teamwork activities as mapping onto three higher-level dimensions. Although not described explicitly in their article, the narrow processes can be viewed as being reflections or indicators of the higher-order dimensions. Extending this thought one step further, the three higher-order dimensions can be viewed as being reflections or indicators of an even more general teamwork process factor. The theoretical basis for this suggestion is as follows.

There are a constellation of factors (e.g., team inputs, emergent states) that impact the effectiveness with which members interact with one another, and as a consequence, activities that reflect different types of teamwork processes should be strongly correlated. For example, teams with members that possess knowledge, skills, and abilities related to teamwork should collectively understand what types of interpersonal activities it takes for a team to be effective (Stevens & Campion, 1994). Accordingly, members in these teams should tend to work together effectively by specifying goals and formulating strategies (transition processes), monitoring their progress toward their goals, coordinating effectively (action processes), and engaging in motivation and confidence building (interpersonal processes). Although there may be some unique variance in the dimensions due to differences in opportunities or capabilities to engage in process-specific activities, each process is more or less a reflection of the characteristic quality of interactions among team members.

Scholars have often used broad measures of team processes to indicate the overall quality of teamwork. However, some have noted that the strong relationships among specific processes suggest the possibility that they might be hierarchically ordered (e.g., Hyatt & Ruddy, 1997; Kirkman et al., 2001). The most direct evidence comes from the work of Mathieu, Gilson, and Ruddy (2006) who employed multi-item scales to assess each of the three first-order dimensions and then used those scale scores as indicators of a higher-order team process construct in the context of a structural model linking team empowerment with team effectiveness. Similarly, Mathieu and Taylor (2007) performed a hierarchical analysis that associated a small set of process survey items to the three first-order latent variables, which in turn were linked to an overall team process construct. Thus, although there is limited evidence consistent with the hierarchical structure that we are advancing, to date there has yet to be a comprehensive analysis that has linked indicators of all 10 of the narrow dimensions to their corresponding first- and second-order dimensions.

Teamwork Process Relationships With Criteria

Although there are numerous variants, the input–process–outcome heuristic (IPO) is the most popular way of framing relationships among variables associated with team effectiveness (Campion et al., 1993; Cohen & Bailey, 1997; Guzzo & Shea, 1992; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; LePine, Hanson, Borman, & Motowidlo, 2000; Marks et al., 2001; McGrath, 1964; Sundstrom, De Meuse, & Futrell, 1990). From this perspective, characteristics of the team's members, tools, technologies, and context (i.e., inputs) influence the team's effectiveness (i.e., outcomes) indirectly through the nature of interdependent activity among team members (i.e., process). In fact, high-quality teamwork processes not only transmit the influence of members' contributions associated with task completion but also help to foster perceptions of a satisfying team experience. Stated, more directly, and consistent with narrative reviews of the small groups and teams literature, teamwork process should have a positive influence on team outcomes such as performance and members' satisfaction (e.g., Bettenhausen, 1991; Cohen & Bailey, 1997; Goodman, Ravlin, & Schminke, 1987; Guzzo & Shea, 1992; Sundstrom, McIntyre, Halfhill, & Richards, 2000). Moreover, because the narrower processes are more specific indications of the higher-order process, these positive relationships with the criteria should hold across the three levels of specificity in our hierarchical model.

Moderators of Group Process–Effectiveness Relationships

There are many reasons to believe that teamwork processes are positively related to team effectiveness criteria. However, research results have been somewhat less than consistent (cf., Baldwin, Bedell, & Johnson, 1997; Mohammed & Ringseis, 2001; Smith, Peterson, & Misumi, 1994). Although it is likely true that differences in research methodology across studies could explain some of these inconsistencies, there are plausible theoretical explanations as well. One such explanation is rooted in the general idea that effects of teamwork processes may depend on the nature of the interactions the teams employ to complete their work (LePine et al., 2000). That is, when the level, mindfulness, or complexity of taskwork is relatively high, team processes should play a more central role in task accomplishment and thereby exhibit stronger relationships with team outcomes. In contrast, when the level, mindfulness, or complexity of taskwork is relatively low, team processes should evidence weaker relationships with outcomes. We suggest there are two team characteristics that impact the nature of interaction among members and thus may serve as moderators of the relationship among teamwork processes and team effectiveness criteria.

The first potential moderating variable is *task interdependence*, which refers to the degree to which team members depend on one another for their efforts, information, and resources (Van de Ven, Delbecq, & Koenig, 1976; Wageman & Baker, 1997). When task interdependence in a work unit is higher, there are a larger number of interpersonal interactions and also greater complexity in coordinating these interactions (Thompson, 1967). When task interdependence in a work unit is lower, members work more independently, requisite interpersonal interaction is more limited, and member contributions are pooled rather than integrated (Thompson, 1967). Therefore, consistent with the logic outlined above, we expect that teamwork process should have stronger relationships with team effectiveness in teams with higher task interdependence and weaker relationships with team effectiveness in teams with lower task interdependence.

A second variable that may moderate the relationship between teamwork processes and team effectiveness is team size. Larger teams have more linkages among members than do smaller ones and therefore face greater coordination challenges. Larger teams are also more prone to motivation and coordination losses that further emphasize the need for effective teamwork activities (Fleishman, 1980; Steiner, 1972). Finally, larger teams may have greater difficulty developing and maintaining role structures that replace the need for ongoing mutual adjustment to integrate task contributions (Gersick & Hackman, 1990; LePine, 2003). For these reasons we expect that team outcomes will hinge more on effective teamwork processes among larger, as compared to smaller, teams.

Method

Literature Search

We searched the PsycINFO database up through January 1, 2007 for studies (articles and book chapters) that included the terms *group(s)* or *team(s)* together with terms that scholars have used to reflect teamwork processes (e.g., interaction, cooperation, workload sharing, coordination, communication, conflict, mission, strategy, goal, motivation, monitoring). We also searched for studies that included team effectiveness criteria (e.g., performance, productivity, quality, effectiveness, member satisfaction, viability) in the hope that some of these studies would include effect sizes of relationships among processes, and between processes and our two focal criteria (team performance and member satisfaction). To identify studies not captured in the electronic searches, we reviewed the reference lists of reviews and meta-analyses of the relevant literatures (e.g., Beal, Cohen, Burke, & McLendon, 2003; Bettenhausen, 1991; Cohen & Bailey, 1997; De Dreu & Weingart, 2003; Devine & Philips, 2001; Gully, Devine, & Whitney, 1995; Martins, Gilson, & Maynard, 2004; Mullen & Copper, 1994; O'Leary-Kelly & Martocchio, 1994; Sundstrom et al., 2000) and a list of all the articles that have cited Marks et al. (2001). We also examined programs and proceedings of national conferences that were in our possession in order to identify data that could be included. Finally, we e-mailed researchers who have published widely in the team process literature to request copies of working papers and unpublished data. We then reviewed each of the 825 articles and manuscripts we found and eliminated those that did not include primary data, or did not include an effect size (or data that could be converted to one) of the relationship between two processes, or an effect size of the relationship between a team process and at least one aspect of team effectiveness. We then examined each of the remaining 303 papers in order to identify those that included enough information to calculate at least one relevant effect size. One hundred and thirty-eight studies met the criteria for inclusion in the final database. These studies reported 1,507 correlations from 147 independent samples.

Coding

Prior to our review of the articles, we created a coding system to ensure accurate and reliable assessment of the information contained in each paper. Because three coders coded a majority of papers independently, we needed to estimate interrater reliability with respect to the coded information that would apply to the individual raters. To accomplish this, we randomly selected 12 articles that were then independently coded by the three raters. We then estimated the appropriate intraclass correlation (Shrout & Fleiss, 1979) for the following types of information: (a) the categorization of the relationship in our 16×16 matrix (i.e., 10 narrow processes, 3 first-order processes, overall team process, team performance, member satisfaction), (b) number of teams, (c) number of individuals, (d) correlation, (e) reliabilities of the variables in the relationship, (f) same-source relationships, (g) time lag between measurement, (h) laboratory versus field research setting, (i) task interdependence, and (j) team size. Overall, the results demonstrated a remarkable degree of convergence. The three raters agreed that there were 45 relationships that could potentially be coded, and the ICC's averaged .93. All discrepancies were discussed, and sources of all disagreements were identified and resolved. Thus, reliability of coding for a majority of the articles should have been significantly higher than these original estimates. To increase reliability further, coders set aside articles where there was uncertainty, and final coding decisions on these particular articles were reached using consensus among the three coders. Finally, a fourth author randomly selected articles throughout the coding process to verify coding accuracy. We decided to conduct meta-analyses of relationships as long as there were three or more relevant effect sizes. Where possible, we manually examined the content of items in each article to ensure we coded the teamwork process relationships appropriately.

Our data set consisted of many studies that included direct measures of either the broad (transition, action, interpersonal) or narrow (mission analysis, goal specification, strategy formulation, monitoring progress, systems monitoring, team monitoring, coordination, conflict management, motivation, affect management) processes defined by Marks et al. (2001). Other studies included measures of teamwork process that we coded into one of the Marks et al. categories (e.g., cooperation, workload sharing, conflict, communication) on the basis of the degree to which the content of the items in the measure corresponded to (a) the Marks et al. definitions and (b) items that have been written to directly tap the process categories (Mathieu & Marks, 2006). As a consequence, most measures of cooperation and workload sharing were coded as team monitoring. Measures of conflict were generally coded as either conflict management or affect management depending on whether the measure focused on task conflict or relational conflict. Note that we reversed the effect sizes for measures of conflict so that the direction of the relationships would be consistent in meaning across process concepts. Researchers have used many different types of communication measures, and accordingly, these were coded in different categories depending on the focus of the communication. A summary chart of how processes were coded with respect to the Marks et al. taxonomy is available by request from the first author.

There were nine studies that included team-level measures of organizational citizenship behavior (OCB), or something similar (e.g., helping), that we believe should be coded as a teamwork process. Scholars have noted previously that when considered in the aggregate, organizational citizenship behavior and related concepts reflect teamwork process because they characterize the nature of interaction among team members (LePine et al., 2000). Moreover, scholars have explicitly conceptualized team-level OCB as an indicator of team functioning (De Dreu & Van Vianen, 2001) and have positioned OCB concepts as mediators of the relationship between team inputs and outcomes (Naumann & Bennett, 2002). These authors have also supported their justification for aggregation using the appropriate statistics.

When authors of a particular study (a) described the overall quality of team interaction, (b) labeled the measure of interaction as either teamwork or team (or group) process, or (c) included items reflecting team process that fell into each of the three broad Marks et al. (2001) dimensions, we coded the measure as "overall team process." When measures included items from multiple facets of transition, action, or interpersonal process, we coded these as "overall transition," "overall action," or "overall interpersonal."

In terms of team effectiveness criteria, we coded team performance and member satisfaction. Consistent with conceptualizations of team performance, we considered measures that indexed team-level outcomes but not aggregations of independent individual-level outcomes. Accordingly, we included effect sizes from measures of supervisor-rated team performance, quantity of team output, quality of team output, innovation, and member-rated team performance. There were a small number of instances where the primary research included multiple measures of team performance, and although we could have formed composites for these, we instead used a set of decision rules that we believed would lead to conservative estimates. First, if there was a choice among alternative measurement sources, we only used the one that produced the non-same-source relationship. Second, if there were different types of measures used from the same source, we chose the one with the most conservative (weakest) relationship. Finally, we used the simple average of the effect sizes in instances where performance was measured repeatedly using the same measure. We considered member satisfaction only when it was conceptualized and measured as a team-level concept. Most often, it was measured by aggregating members' ratings of their satisfaction with their team. Although the unit of measurement was the individual, aggregation was typically supported empirically.

We coded information so that we could examine potential moderators of relationships between teamwork process and the criteria. In terms of methodological moderators, we coded whether data for the relationships were from the same source (0 = *multiple sources*, 1 = *same source*), whether there was time lag in measurement (0 = *no time lag*, 1 = *time lag*), and the research setting (0 = *laboratory*, 1 = *field*). In terms of theoretically derived moderators, we coded task interdependence using a 10-point scale ranging from 1 = *pooled interdependence with members performing their work alone* to 10 = *comprehensive interdependence with all task work performed in the presence of the other members*. This scale accounted for both the archetypical modes of interdependence (i.e., pooled, sequential, reciprocal, comprehensive) as well as the complexities of ongoing tasks that impact the nature of interactions among members (e.g., Thompson, 1967; Van de Ven et al., 1976). Team size was coded simply as the number of core team members.

Meta-Analytic Procedures

Using the meta-analytic method described by Hunter and Schmidt (1990), we corrected each primary correlation for attenuation due to unreliability in both the predictor and the criterion, and then computed the sample-weighted mean of these corrected correlations. We used estimates of internal consistency reliability to correct observed correlations because this was the form of reliability that was most consistently reported in the primary research. In rare cases where coefficient alphas were not reported, we used the average reliability reported in studies that used a similar measure. The average reliabilities for the narrow group process measures were as follows: mission analysis—$\alpha = .84$, goal specification—$\alpha = .82$, strategy formulation—$\alpha = .86$, monitoring progress—$\alpha = .90$, systems monitoring—$\alpha = .83$, team monitoring—$\alpha = .82$, coordination—$\alpha = .82$, conflict management—$\alpha = .85$, motivation—$\alpha = .88$, affect management—$\alpha = .85$ (overall average—$\alpha = .85$). Average reliabilities for the broad measures of group process were as follows: overall transition—$\alpha = .86$, overall action—$\alpha = .84$, overall interpersonal—$\alpha = .82$, overall team process—$\alpha = .87$. To estimate parameters describing the variability of, and confidence in, these estimates, the variance of the observed individual estimates was corrected for the effects of both sampling and measurement error.

We reported 90% confidence intervals around the estimated population correlations to provide an estimate of the variability around the estimated mean-corrected correlation. A 90% confidence interval around a positive estimate that excludes zero indicates that there is less than a 5% chance that the population correlation is zero or negative (and also less than a 5% chance that the population correlation is greater than the upper bound of the interval). We also reported 80% credibility intervals to describe the variability of relationships across the studies. An 80% credibility interval that excludes zero indicates that less than 10% of the correlations in the primary research were less than zero (and also less than 10% of the correlations in the primary research were greater than the upper bound of the interval). Finally, we also reported the Q-statistic that tests for homogeneity in the correlations. A significant Q-statistic (which is approximately distributed as a chi-square [χ^2]) indicates the potential for moderation.

Results

The true correlations among the narrow team process concepts appear in Table 1. Without exception, these true correlations are positive and strong in magnitude.

TABLE 1

Meta-Analytic Relationships Among Narrow Teamwork Processes

	MI		GS		SF		MP		SM		TM		C		CM		M	
	k (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ	*k* (*N*)	ρ
MI																		
GS	10 (674)	.74																
SF	11 (726)	.70	11 (701)	.87														
MP	8 (550)	.67	9 (958)	.75	10 (645)	.68												
SM	9 (565)	.59	8 (550)	.71	8 (550)	.69	8 (550)	.64										
TM	9 (650)	.68	11 (704)	.75	14 (819)	.72	10 (645)	.62	8 (550)	.77								
C	10 (674)	.72	12 (786)	.75	14 (916)	.70	9 (592)	.64	10 (661)	.67	16 (1,061)	.75						
CM	9 (567)	.42	9 (589)	.56	10 (679)	.42	7 (505)	.52	7 (505)	.47	10 (692)	.56	8 (529)	.60				
M	9 (681)	.53	10 (743)	.55	10 (673)	.52	7 (501)	.51	6 (449)	.47	10 (735)	.56	12 (904)	.57	11 (748)	.57		
AM	8 (605)	.55	8 (605)	.55	10 (773)	.51	7 (505)	.45	8 (547)	.41	17 (1,065)	.66	11 (781)	.60	28 (2,025)	.66	12 (901)	.58

Note. k = number of correlations, N = combined sample size (number of teams), ρ = estimated true-score correlation, MI = mission analysis, GS = goal specification, SF = strategy formulation, MP = monitoring progress, SM = system monitoring, TM = team monitoring, C = coordination, CM = conflict management, M = motivation, AM = affect management. All correlations are significant at $p < .05$.

TABLE 2
Fit Statistics for Alternative Models of Teamwork Processes

Model	χ^2	*df*	NFI	CFI	SRMR	$\Delta\chi^{2a}$	$\Delta\chi^{2b}$
One factor	783.85	35	.92	.94	.062		
Two factors[c]	767.71	34	.93	.94	.063	16.14*	
Two factors[d]	646.66	34	.94	.95	.058	137.19*	
Two factors[e]	569.37	34	.95	.95	.045	214.48*	
Three factors[f]	462.85	32	.96	.96	.043	321.00*	
Two factors[c] –three factor							304.86*
Two factors[d] –three factor							183.81*
Two factors[e] –three factor							106.52*

Note. Harmonic mean = 941. $^*p < .05$. NFI = normed fit index, CFI = comparative fit index, SRMR = standardized root mean residual.
[a] $\Delta\chi^2$ (*df*) = Chi-square comparisons from one-factor model.
[b] $\Delta\chi^2$ (*df*) = Chi-square comparisons from two-factor models.
[c] Two factors: (1) interpersonal & transition, (2) action.
[d] Two factors: (1) interpersonal & action, (2) transition.
[e] Two factors: (1) interpersonal, (2) transition & action.
[f] Three factors: three-factor model is equivalent to second-order model.

Confirmatory Factor Analysis

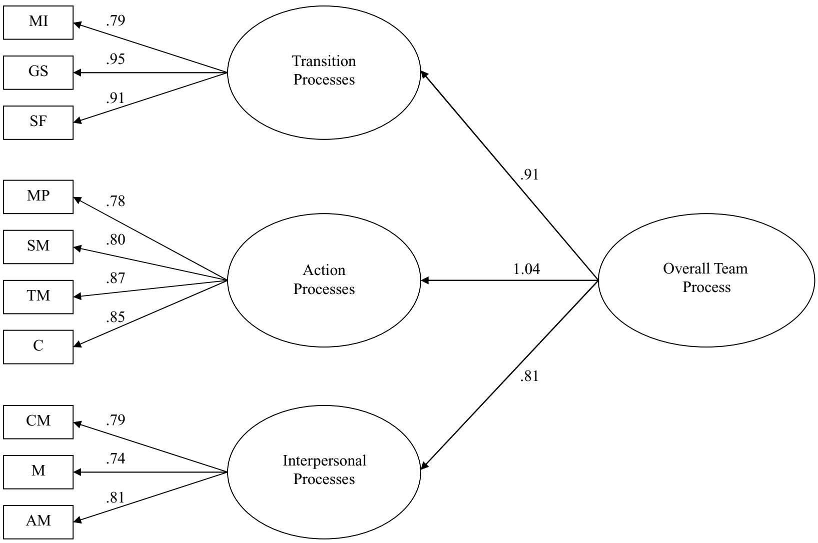
To assess the dimensional structure of team processes, we submitted the matrix of relationships to confirmatory factor analysis (CFA) using the harmonic mean of the sample size for each of the estimates (941), and we specified several alternative models. Although we report the chi-square for each model to be consistent with convention, using this statistic to assess absolute model fit is problematic because it is sensitive to sample size. Accordingly, we assessed absolute model fit to the data with the normed fit index (NFI), the comparative fit index (CFI), and the standardized root mean residual (SRMR). Good model fit is typically indicated by NFI and CFI values $>.90$ and SRMR values $<.10$. We assessed relative fit of alternative models by performing chi-square difference tests and by examining NFI, CFI, and SRMR values.

The first row in Table 2 shows the results of a one-factor model (which in effect constrains the covariances among the three teamwork process latent variables to be 1.0). In this model, the 10 narrow team processes were specified to load onto a single overall teamwork process factor. The resulting fit statistics indicated that this model fits the data well (χ^2 (35) = 783.85, $p < .05$, NFI = .92, CFI = .94, SRMR = .062).

The second, third, and fourth rows in Table 2 show the results of three two-factor models where we specified that each of the 10 narrow processes load onto one of two corresponding higher-order factors. For the first model we specified that the narrow interpersonal processes and the narrow transition processes would load onto Factor 1 and that the narrow action processes would load onto Factor 2. For the second model we specified that the narrow interpersonal processes and the narrow action processes would load onto Factor 1 and that the narrow transition processes would load onto Factor 2. For the third we specified that the narrow action processes and the narrow transition processes would load onto Factor 1 and that the interpersonal processes would load onto Factor 2. Overall, each of these models fits the data very well in an absolute sense (NFIs and CFIs $> .90$, SRMR $< .10$), and the fit of each is superior to the fit of the one-factor model. All three chi-square difference tests are significant, and the NFI, CFI, and SRMR are marginally superior for each of the two-factor models.

The fifth row in Table 2 shows the results for a model where we specified three correlated first-order teamwork processes. This three-factor model fit the data very well in an absolute sense (χ^2 (32) = 462.85), $p <$ .05; NFI = .96, CFI = .96, SRMR = .043) and also in relative sense as compared to the one-factor and two-factor models. All chi-square difference tests are statistically significant, and the NFI, CFI, and SRMR values indicate marginally better fit to the data. Statistically speaking, these results support the suggestion of Marks and her colleagues (2001) that the 10 narrow teamwork dimensions reflect three first-order dimensions that correspond to transition, action, and interpersonal processes. However, it is important to note that the estimated correlations among the three first-order teamwork processes in the three-factor model are quite strong (average estimated true correlation = .83). Strong relationships among first-order factors along with the good fit of the data to the one-factor model suggest the presence of an overarching, higher-order teamwork process factor.

Accordingly, we specified an additional model in which we loaded the three first-order processes onto a second-order teamwork process factor. Because the number of estimated endogenous relationships and degrees of freedom is the same as for the three-factor model, the fit statistics of the second-order model indicate the same good fit with the data and, in turn, the same superior fit to the data relative to the one-factor and various two-factor models. However, as shown in Figure 1, the second-order factor loadings are all positive, strong, and statistically significant. Thus, consistent with our proposed hierarchical model of teamwork processes, transition, action, and interpersonal processes may be reflective of an even broader team process concept—one that reflects the overall quality of teamwork processes.



Note: Harmonic mean = 941. Standardized factor loadings. All factor loadings $p < .05$.

Figure 1: **Factor loadings for the Second-Order Model.**

Relationships With the Team Effectiveness Criteria

The overall true correlations among the 10 narrow team process variables and the two team effectiveness criteria appear in Table 3. As shown on the left hand side of the table, and consistent with our expectations, narrowly defined teamwork processes are positively associated with team performance, and this is true regardless of the nature of the process in question. As indicated by the overlapping confidence intervals, there are no statistically significant differences in the relationships between any of the 10 processes and team performance.

The overall true correlations among the 10 narrow team process variables and member satisfaction appear on the right hand side of Table 3. As with the analysis on team performance, all 10 team process variables are positively associated with member satisfaction. Also consistent with the previous analysis, there are no statistically significant differences in the relationships between any of the narrow processes and member satisfaction.

In Table 4 we report relationships among the more broadly defined aspects of teamwork process and team effectiveness. The statistics on the left-hand side of the table reveal that transition, action, interpersonal, and overall teamwork processes have positive relationships with team performance, and these relationships are remarkably similar in magnitude

TABLE 3

Relationships Among Narrow Teamwork Processes and Team Effectiveness Criteria

	Team performance							Member satisfaction						
	k	N	r	ρ	90% CI	80% CV	Q	k	N	r	ρ	90% CI	80% CV	Q
MI	20	1,164	.23	.27	(.19, .35)	(.12, .42)	32.27	8	655	.27	.32	(.19, .45)	(.13, .50)	19.17
GS	25	1,612	.29	.34	(.24, .45)	(.04, .65)	100.22	7	544	.29	.36	(.19, .52)	(.12, .59)	21.23
SF	26	1,587	.30	.35	(.26, .44)	(.10, .60)	77.92	10	791	.33	.38	(.27, .50)	(.20, .57)	25.68
MP	15	874	.22	.25	(.15, .35)	(.09, .41)	26.34	5	457	.27	.30	(.16, .45)	(.15, .46)	11.06
SM	14	770	.14	.17	(.04, .29)	(−.06, .39)	30.76	6	499	.25	.29	(.21, .37)	(.16, .42)	4.24
TM	36	1,891	.25	.30	(.22, .37)	(.08, .51)	75.19	10	658	.24	.29	(.13, .45)	(.01, .56)	34.11
C	30	2,012	.24	.29	(.22, .36)	(.12, .47)	58.72	11	902	.28	.34	(.21, .46)	(.11, .56)	33.93
CM	32	2,049	.22	.26	(.17, .34)	(.00, .52)	98.32	13	1,039	.27	.32	(.25, .39)	(.28, .36)	13.89
M	22	1,525	.30	.34	(.25, .44)	(.10, .59)	71.23	6	644	.35	.41	(.19, .63)	(.08, .75)	47.23
AM	39	2,478	.26	.30	(.23, .38)	(.06, .54)	107.88	16	1,240	.40	.47	(.35, .59)	(.20, .75)	74.46

Note. k = number of correlations, N = combined sample size, r = sample- weighted average correlation, ρ = estimated true-score correlation, CI = confidence interval, CV = credibility interval, Q = test for homogeneity in the true correlations across studies. All Q-statistics are significant at $p <$ .05. MI = mission analysis, GS = goal specification, SF = strategy formulation, MP = monitoring progress, SM = system monitoring, TM = team monitoring, C = coordination, CM = conflict management, M = motivation, AM = affect management.

TABLE 4

Relationships Among Broad Teamwork Processes and Team Effectiveness Criteria

	Team performance							Member satisfaction						
	k	N	r	ρ	90% CI	80% CV	Q	k	N	r	ρ	90% CI	80% CV	Q
Transition	26	1,838	.25	.29	(.19, .39)	(.01, .57)	97.39	13	1,073	.38	.45	(.29, .62)	(.10, .82)	95.50
Action	30	1,921	.25	.29	(.22, .36)	(.10, .48)	67.69	12	998	.39	.46	(.36, .57)	(.27, .65)	33.47
Interpersonal	28	1,891	.25	.29	(.21, .38)	(.05, .53)	78.05	13	1,002	.31	.37	(.27, .46)	(.21, .53)	25.72
Overall	40	3,125	.27	.31	(.24, .37)	(.09, .52)	113.66	14	1,062	.38	.43	(.34, .53)	(.25, .61)	34.96

Note. k = number of correlations, N = combined sample size, r = sample-weighted average correlation, ρ = estimated true-score correlation, CI = confidence interval, CV = credibility interval, Q = test for homogeneity in the true correlations across studies. All Q-statistics are significant at $p < .05$.

($\hat{\rho}_{\text{Transition}} = .29$, $\hat{\rho}_{\text{Action}} = .29$, $\hat{\rho}_{\text{Interpersonal}} = .29$ $\hat{\rho}_{\text{overall}} = .31$). Similarly, the broadly defined teamwork processes have strong, positive, and highly similar relationships with member satisfaction ($\hat{\rho}_{\text{Transition}} = .45$, $\hat{\rho}_{\text{Action}} = .46$, $\hat{\rho}_{\text{Interpersonal}} = .37$ $\hat{\rho}_{\text{overall}} = .43$). Overall, when taken together, the results in Tables 3 and 4 suggest that relationships between teamwork processes and team effectiveness do not vary significantly as a function of the nature of the specific process in question.

Supplemental Analysis: Relationships With Emergent States

To further explore the possibility that relationships with teamwork processes may depend on the nature of process, we conducted a supplemental analysis with an expanded set of criteria. Specifically, we reexamined the studies in our database and coded relationships among teamwork processes and emergent states, which can be defined as team-level concepts that reflect certain types of shared affect and cognitions (Marks et al., 2001). Whereas teamwork processes are generally considered to function as mechanisms through which team inputs impact team outcomes (Guzzo & Shea, 1992; Ilgen et al., 2005), emergent states are equally likely to appear as team inputs, mediators, or outcomes (Marks et al., 2001). Although there are a fairly large set of emergent states (Kozlowski & Bell, 2003), we focused on the two that have been studied most by scholars: cohesion and potency. Cohesion has been defined as team members' attraction and commitment to their team, team members, and the team's task (Evans & Jarvis, 1980; Goodman et al., 1987). Potency is more motivational and refers to team members' shared belief that the team can be effective (Shea & Guzzo, 1987). Both cohesion and potency have been found to be positively associated with team performance (Gully et al., 1995; Gully, Joshi, Incalcaterra, & Beaubien, 2002), and we expected that these emergent states would also be positively associated with teamwork processes.

Our data set included 17 studies with relationships among teamwork processes and variables that reflect these two emergent states. Although the research included in the primary studies precluded us from conducting meta-analyses of relationships with about half of the narrow teamwork processes, we were able to use this research to estimate meta-analytic relationships with teamwork processes defined more broadly. The results of this analysis, which are reported in Table 5, generally confirm our expectations that teamwork processes and emergent states are positively correlated. The statistics on the left-hand side of the table reveal that transition, action, and interpersonal teamwork processes have strong positive relationships with team performance that are similar in magnitude ($\hat{\rho}_{\text{Transition}} = .60$, $\hat{\rho}_{\text{Action}} = .61$, $\hat{\rho}_{\text{Interpersonal}} = .53$). Similarly, the broadly defined teamwork processes have strong, positive, and similar relationships with

TABLE 5

Relationships Among Broad Teamwork Processes and Emergent States

	Cohesion							Potency						
	k	N	r	ρ	90% CI	80% CV	Q	k	N	r	ρ	90% CI	80% CV	Q
Transition	6	553	.52	.60	(.50, .70)	(.50, .70)	10.45*	6	684	.56	.63	(.51, .75)	(.47, .80)	24.54*
Action	6	619	.52	.61	(.46, .77)	(.40, .83)	29.09*	4	500	.58	.65	(.61, .70)	(.65, .65)	1.76
Interpersonal	7	812	.45	.53	(.26, .80)	(.08, .98)	117.01*	5	488	.63	.70	(.53, .86)	(.48, .92)	35.17*

Note. k = number of correlations, N = combined sample size, r = sample-weighted average correlation, ρ = estimated true-score correlation, CI = confidence interval, CV = credibility interval, Q = test for homogeneity in the true correlations across studies. $^{*}p < .05$.

potency ($\hat{\rho}_{\text{Transition}} = .63$, $\hat{\rho}_{\text{Action}} = .65$, $\hat{\rho}_{\text{Interpersonal}} = .70$). Overall, the results in this table suggest that the positive relationships among teamwork processes and emergent states do not vary as a function of the nature of the process in question.

Moderating Effects

As indicated by the significant Q-statistics, there is variability in the effect sizes across studies even after sampling and measurement error were taken into account. Accordingly, we had reason to believe that an examination of potential moderators might be worthwhile. Because the moderators would likely be correlated, and because the number of effect sizes to be analyzed would be relatively small, we conducted the moderator analyses using weighted least squares regression (WLS) with n–3 as the weighting factor in conjunction with the Fisher's Z transformation (Steel & Kammeyer-Mueller, 2002). We first performed a WLS regression of the effect sizes (for both criteria) on two dummy variables that captured the three process categories. Results of this preliminary analysis indicated that the process categories did not explain a statistically significant amount of variance in the effect sizes ($R^2_{\text{team performance}} = .01$, $F(2, 266) = 1.02$, $p = .36$, $R^2_{\text{member satisfaction}} = .03$, $F(2, 89) = 1.43$, $p = .24$), and thus we did not attempt to account for this distinction in the subsequent analyses. Because primary research often reported relationships between the criteria and multiple process categories, we averaged across effect sizes from the same sample to avoid double counting. The actual moderator analysis consisted of two steps. First, we regressed the effect sizes onto the three variables that captured features of the method used in the primary research (common method, time lag, research design). Second, we regressed the effect sizes onto statistically significant moderators from the previous regression models along with the two moderators discussed earlier (interdependence and team size).

The results from this analysis indicated that the methodological moderators did not explain variance in the effect sizes, and this was true of relationships with team performance ($R^2 = .05$, $F(3, 86) = 1.63$, $p = .19$) as well as with member satisfaction ($R^2 = .16$, $F(3, 19) = 1.18$, $p = .34$). Moreover, when examined as a set, none of the regression weights for the individual moderators were statistically significant. However, when we examined each moderator separately, the regression coefficient for common source was statistically significant for both team performance ($B = .15$, $p<.05$) and member satisfaction ($B = .23$, $p < .05$). Accordingly, we entered common source in the regression models that included task interdependence and team size.

TABLE 6

Test of Moderators of Relationship Among Teamwork Processes and Team Effectiveness Criteria

	Team performance		Member satisfaction	
	B	R^2	*B*	R^2
Common method	.17	.12*	.28	.22
Interdependence	.02*		−.04	
Team size	.03*		.03	
df	3, 76		3, 17	

Note. $^*p < .05$, B = unstandardized coefficient, Common method: 0 = process and criterion measured from different sources, 1 = process and criterion measured from the same source.

On the left side of Table 6 are the results for the teamwork process–team performance moderator analysis, which revealed that task interdependence and team size coefficients were both positive and statistically significant ($B_{\text{interdependence}} = .02, p < .05$, *one-tailed*; $B_{\text{team size}} = .03, p < .05$, *one-tailed*). That is, consistent with our expectations, relationships between teamwork processes and team performance tended to be stronger in studies where teams had higher task interdependence and where the teams were larger in size. On the right side of Table 5 are the results for the teamwork process–member satisfaction moderator analysis. Results revealed that neither task interdependence nor team size coefficients were statistically significant ($B_{\text{interdependence}}$ = -.04, *ns;* $B_{\text{team size}}$ = .03, *ns*), suggesting that these two variables do not account for significant variation in observed relationships between team process and member satisfaction.

Discussion

Our first goal for this study was to test the validity of the teamwork process framework advanced by Marks et al. (2001). Specifically, we assessed the degree to which different types of teamwork process fit a model with three hierarchical levels of concept specificity. We examined this model using meta-analyses of the empirical research on teamwork processes that has accumulated over the past several decades. After applying the meta-analytic relationships to CFA, we found that the data fit a model where 10 narrow teamwork processes loaded onto three first-order teamwork process dimensions (i.e., transition, action, interpersonal), which in turn reflected an even more general omnibus teamwork process dimension. Therefore, the data were very consistent with the hierarchical structure of team processes that we anticipated. We do note that from a statistical standpoint it was impossible to determine whether this hierarchical structure is superior to a structure in which the three first-order teamwork processes are simply correlated. However, although this is an issue that should be examined more directly with primary research, the high degree of shared variance among the three first-order factors is highly suggestive of an underlying higher-order cause.

The second goal of our study was to test the generalizability of relationships among teamwork processes and team effectiveness criteria in the context of the hierarchical framework. We found that teamwork processes were positively associated with team performance and member satisfaction, and that these relationships were consistent across types of processes and levels of process specificity. In a supplemental analysis, we found that teamwork processes were also positively associated with cohesion and potency. Although there were too few studies to assess the generalizability of these relationships with these emergent states across the full range of narrow processes, we did find that relationships with emergent states were consistent across the types of teamwork processes when they were defined more broadly.

Implications to Researchers

Our findings in support of the hierarchical structure of teamwork processes have important implications for future research, in that they provide some guidance for specifying and testing relationships involving teamwork processes. When theory focuses on relationships with the overall quality of team processes, hypotheses could be tested with broad measures of teamwork. To avoid deficiency, such measures should either consist of items written to tap the general concept itself or a representative array of items from the narrower teamwork processes. When theory focuses on relationships with a more specific aspect of teamwork, or teamwork in the context of a specific phase of a team's existence, hypotheses could be tested using appropriate midlevel measures of teamwork (transition, action, interpersonal processes). Such measures could include items written to tap the appropriate first-order concept directly or include items from narrower measures that correspond to the first-order measure. Finally, if the theory is focused on understanding fine-grained interpersonal activities and drawing distinctions among them, then hypotheses should be tested with measures that tap the narrowest teamwork processes. In effect, we are advocating an application of Fishbein and Ajzen's (1974) classic compatibility principle, in that there should be an alignment between the level of specificity/generalizability of predictor and criterion constructs. Therefore, there is not necessarily a single answer to the question of whether one should employ measures of focused team processes or their successively more general first-order or second-order derivatives. Rather, researchers should employ measures of team processes that are most suitable, both in terms of contents and specificity, for their criteria of interest (see, Harrison, Newman & Roth, 2006; and Marks et al., 2001, for similar sentiments).

Our research also demonstrated that teamwork processes have non-trivial relationships with team performance and member satisfaction, and this is true regardless of the teamwork process in question. Indeed, a one standard deviation increase in the overall team process translated into over a one-third standard deviation increase in team performance and nearly a one-half standard deviation increase in member satisfaction. Moreover, the magnitudes of these relationships were about the same when considering overall transition, action, and interpersonal processes. The same general pattern emerged in our supplemental analysis where we considered relationships with cohesion and potency. Although few readers will be surprised to learn that teamwork processes are positively associated with team performance, member satisfaction, cohesion, and potency, our results are noteworthy given that no previous research has examined the issue as comprehensively.

Another contribution of our research is that we examined the degree to which the teamwork process–team effectiveness relationships varied as a function of team characteristics. After taking into account the influence of methodological factors, we found that task interdependence and team size affected relationships between teamwork processes and team performance. Specifically, relationships tended to be stronger in studies where the teams had higher levels of task interdependence and where the teams tended to be large. Although these same team characteristics did not appear to impact relationships among teamwork processes and member satisfaction, the analysis was based on a much smaller number of studies. We were also unable to examine the potential moderating role of these team characteristics on the relationships between teamwork processes and the emergent states because of the limited amount of primary research. Given that there are strong theoretical reasons to believe that team characteristics should moderate the relationship between teamwork processes and these other criteria, future research should focus more attention on this issue.

Limitations

There are several limitations with our research that should be highlighted. First, meta-analytic estimates were derived from results of primary research, and, therefore, hidden problems with the primary research may be reflected in our results. Granted, the meta-analytic method attempts to account for study artifacts and the aggregation across studies tends to cancel out other problems; however, limitations of the primary research should be kept in mind.

A second limitation with our research is that the number of studies with relationships among different aspects of teamwork processes was fairly small. Although this characteristic of the research may be somewhat limiting with respect to our ability to draw strong conclusions regarding relationships among concepts, it is unclear how the inclusion of additional studies would alter the pattern of relationships that fit our proposed hierarchical model. Moreover, the limited number of studies highlights a significant shortcoming of the literature on group process. That is, scholars clearly have not conducted enough research on the construct validity of narrow group processes. We suggest that if scholars wish to study narrow aspects of group process, research aimed at supporting their theoretical and empirical distinctiveness should come first.

Along the same lines, there were relatively few primary studies with relationships among teamwork processes and member satisfaction, cohesion, and potency. This not only hindered our ability to conduct somewhat more complex moderator analyses (e.g., examining effects of moderators within process categories), but it also played a role in the wide confidence intervals around the estimates. Although there remains a need for research that addresses open questions regarding relationships among teamwork processes and team performance, the field might be just as well served by research that examines relationships with other criteria. In fact, considering relationships with a broader array of team inputs and outcomes may be necessary in order to build support for the validity of the distinctions among the narrower facets of teamwork.

A fourth limitation of our study is that our coding scheme only captured the average level of interdependence and the size of the teams included in each study. As a consequence, we did not account for variability within each study with regards to the moderating variables. Given that the true relationships are likely to differ somewhat as a function of which variance components are included in the estimate, our moderator results should be interpreted cautiously.

Applied Implications and Directions for Future Research

With the limitations noted above in mind, our findings regarding team process–outcome relationships are encouraging and, in general, appear to be consistent with the framework advanced by Marks et al. (2001). However, we did find a great deal of uniformity in the effect sizes, and this raises the question of whether or not there is enough unique variance in the first-order dimensions (as well as the narrower facets) to be theoretically and practically important. We suspect that some of this uniformity in the effect sizes may be an artifact and that this is something that needs to be addressed in order to uncover meaningfully unique differences in relationships among processes and the criteria.

To understand why this might be true, it is necessary to consider that the modal research design in the extant literature consists of surveys to members about assorted team processes that are correlated with concurrent or lagged outcome measures (e.g., Mathieu et al., 2006). Yet, Marks et al.'s (2001) framework suggested that different team processes are most salient at different periods of time, as related to the rhythm of team performance episodes. If researchers simultaneously survey members about all team processes, then respondents must perform a mental synthesis of processes that have occurred over time as they formulate their answers. No doubt, some form of halo or attributional biases may leak into such reports (e.g., Staw, 1975). Even if researchers employ uninvolved observers of team processes (e.g., Cobb & Mathieu, 2000), who are asked to evaluate transition processes while observing teams that are actively engaged in task performance, then observers' ratings may be artificially inflated as well. As an example, one could deduce that a lack of planning probably contributed to a team that appeared confused and argued about what they were supposed to be doing during the action phase, but that is different from obtaining assessments of team processes back in the planning stage (see Weingart, 1992 for a good illustration). The point of this discussion is that we encourage future research to employ time-based research designs whereby measures of different team processes can be aligned with when they are anticipated to occur (e.g., DeChurch & Marks, 2006). We anticipate that such designs should not only produce less uniform process-related correlations but should also begin to illustrate the utility of narrower teamwork process dimensions.

From an applied perspective, our results attest to the importance of team processes as related to important outcomes. Whereas we just noted that simultaneous assessment of all team processes may lead to more inflated correlations than would time-sensitive designs, we hasten to add that they may nevertheless provide valuable diagnostic information for practitioners and researchers alike. Field settings may simply not be amenable to multiple measurement occasions. Yet, knowing that members report difficulties in interpreting their performance and developing performance strategies, versus that they know what they want to do but experience coordination breakdowns, versus the fact that failure to manage interpersonal relationships is undermining their performance, may be important as it relates to the potential utility of different interventions. Rather than merely rolling out a generic team-building type of intervention, organizational change agents armed with this type of information may be in a better position to focus their energies and development efforts. Moreover, a better appreciation of the temporal dynamics of team processes may well cue practitioners about *when* to monitor *which* types of team processes more closely in order to facilitate their development.

A final comment, with both research and applied implications, is that we encourage researchers to seriously consider nontraditional means of assessing team processes that may be less intrusive while still providing temporally sensitive data. For example, with the advent of "virtual teams" and other technologically mediated or recorded forms of member interactions (e.g., knowledge communities of practice, knowledge repositories, customer resource management systems, etc.), process data may be available through nontraditional means. For example, a text analysis of a threaded discussion list may well reveal the types (and qualities) of processes that teams engage in over time. Current technologies provide abundant opportunities to index team processes in a far richer manner than earlier generations of archival indices and physical traces ever yielded.

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