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The Science of Teamwork: Progress, Reflections, and the Road Ahead

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Abstract

We need teams in nearly every aspect of our lives (e.g., hospitals, schools, flight decks, nuclear power plants, oil rigs, the military, and corporate offices). Nearly a century of psychological science has uncovered extensive knowledge about team-related processes and outcomes. In this article, we draw from the reviews and papers of this Special Issue to identify 10 key reflections that have arisen in the team literature, briefly summarized here. Team researchers have developed many theories surrounding the multilayered aspects of teams, such that now we have a solid theoretical basis for teams. We have recognized that the collective is often stronger than the individual, initiating the shift from individual tasks to team tasks. All teams are *not* created equally, so it is important to consider the context to understand relevant team dynamics and outcomes, but sometimes teams performing in different contexts are more similar than not. It is critical to have teamwork supportive organizational conditions and environments where psychological safety can flourish and be a mechanism to resolve conflicts, ensure safety, mitigate errors, learn, and improve performance. There are also helpful teamwork competencies that can increase effectiveness across teams or tasks have been identified (e.g., coordination, communication, and adaptability). Even if a team is made up of experts, it can still fail if they do not know how to cooperate, coordinate and communicate well together. To ensure the improvement and maintenance of effective team functioning, the organization must implement team development interventions and evaluate relevant team outcomes with robust diagnostic measurement. We conclude with 3 main directions for scientists to expand upon in the future: (1) address issues with technology to make further improvements in team assessment, (2) learn more about multi-team systems, and (3) bridge the gap between theory and practice. In summary, the science of teams has made substantial progress but still has plenty of room for advancement.

**The Science of Teamwork: Progress, Reflections, and the Road Ahead**

The science of teams and teamwork has progressed dramatically over the last century. We know what effective teams do, think, and feel. We know what influences team dynamics and some interventions help develop teamwork (Bell, Brown, Colaneri, and Outland, 2018; Frazier et al., 2017; Hughes et al., 2016). We know that team leadership, role clarity, mutual trust, sound information exchange protocols, and having a compelling reason to be a team, matter (e.g., Marlow et al., 2017; Wang, Waldman, & Zhang, 2014). We know that effective teams self-correct, are adaptable, flexible, cohesive and hold shared mental models of their task, objectives, and teammates (DeChurch & Mesmer-Magnus, 2010; Driskell, Salas, &Driskell, 2018). We know a lot.

Teams are now commonplace in organizations – and society in general. We need them in every aspect of our lives, including hospitals, schools, flight decks, nuclear power plants, oil rigs, the military, and corporate offices. Our safety, security, comfort, and innovation depend on good teamwork and collaboration. And, over time, teams have become more complex (Mathieu, Wolfson, & Park, 2018). The good news is that we have amassed a wealth of information, reviews, and meta-analyses on teams and teamwork over the last three decades. Furthermore, our science has become more elaborate as we focus on studying teams *in the wild* (as opposed to laboratory settings). This now requires more multifaceted theory and messier designs – but in turn, generates greater relevance and impact.

This Special Issue sheds light on the discoveries and practical advances regarding teamwork, to set the stage for future research and move toward a deeper understanding of team inputs, dynamics, and outcomes. We draw from the papers in this issue as well as recent meta-analyses and reviews from a variety of disciplines (e.g., Hughes et al., 2016; Salas et al., 2017;

Mathieu, Hollenbeck, van Knippenberg, & Ilgen, 2017; Taplin, et al., 2014) in order to submit a set of reflections on the state of team science and offer a few suggestions for the road ahead.

## Reflections

**Theories abound in team science.**

Team researchers have developed many theories surrounding the multilayered aspects of teams such that now we have a solid theoretical basis for teams. These models provide a conceptual understanding about how to parse out the relevant factors to maximize team effectiveness. The most frequently used framework for studying organizational teams is the Input-Process-Outcome (IPO) model, initially sketched by McGrath (1964). Inputs refer to the organizational, team, and individual level factors that influence processes. Processes are the team behaviors. And, outcomes are any team related result.

Over the years, researchers have become discontent with the simplicity of the IPO model, emphasizing the significance of systemic interactions among elements based on the rich advancements in team research (Mathieu, Wolfson, & Park, 2018). Newer models have expanded upon this foundational structure to better depict the cyclical manner of team performance (Goodwin, Blacksmith, Coats, 2018), such as the input-mediator-outcome-input (IMOI) model (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). Using these models can provide researchers with guidance to uncover the essential factors necessary for optimal team performance, effectiveness, and other team related outcomes (Rosenfield, Newell, Zwolski, & Benishek, 2018). Moving forward, contemporary theory is better reflecting the reality of teams (e.g., fluid boundaries and multiple memberships). For example, there is a focus on incorporating temporal issues, such as characteristics of the team composition or task changing over time (Kozlowski & Chao, 2018; Mathieu et al., 2017).

As noted decades ago by Kurt Lewin—that there is nothing so practical than a good theory. Team effectiveness theories are paving the way to evidence-based practice.

**The collective is often stronger than the individual.**

Organizations have recognized that teams can be more effective than the sum of the work from individuals, so they have shifted from individual tasks to team tasks. Teams can take on more involved work than individuals because team members can combine their diverse, complementary capabilities to provide back-up behavior, monitor one another to reduce errors, and shift the workload as needed (Goodwin, Blacksmith, & Coats, 2018. This shift from an individual to a team focus has occurred in a variety of settings including STEM fields (Kniffin & Hanks, 2018), academia (Hall, Vogel, Huang, Serrano, Rice, Tsakraklides, & Fiore, 2018; Tebes & Thai, 2018), the military (Goodwin, Blacksmith, & Coats, 2018), K-12 schools (Rosenfield, Newell, Zwolski, & Benishek, 2018), and medicine (Ervin, Kahn, Cohen, & Weingart, 2018; Fiscella & McDaniel ). Tebes and Thai (2018) point out that the academia is transforming its values, norms, and practices to fit a more collaborative approach that incorporates multiple methods, individuals from multiple disciplines, and more diverse stakeholders. Not only are organizations changing from individuals to teamwork, teams are becoming more interprofessional (Ervin, Kahn, Cohen, & Weingart, 2018), interdisciplinary (Hall et al., 2018; Tebes & Thai, 2018), and cross-cultural (Feitosa, Grossman Salazar Campo, 2018). Simply put, much of modern-day work cannot be done without teams or larger collectives.

**No two teams are the same.**

As is apparent throughout every article in this issue, all teams are *not* created equal. There are countless factors that affect the makeup of a team and subsequently influence the team's interactions. Even within one sector, different types of teams have very distinct features,

such as in the healthcare industry (Rosen et al., 2018). For example, intensive care unit teams are

low in temporal stability compared to primary care teams (Ervin, Kahn, Cohen, & Weingart,

2018). Teams can vary on their skill differentiation, level of task interdependence (i.e., the

degree to which team members have to depend on each other to accomplish a task), lifespan,

variability in virtuality (i.e., how often team members interact face-to-face versus virtual

communication), authority differentiation (i.e., the degree to which decisions are left up to a

single individual on the team or distributed among the team members), team size, and team

composition of gender, culture, and personality (Hollenbeck, Beersma, & Schouten, 2012).

Every team is uniquely composed to serve a specific purpose. This is important to note because,

as Ervin, Kahn, Cohen, and Weingart (2018) state, "it is difficult to characterize effective teams,

in that high performance along one domain does not necessarily translate to high performance

along another…" (p. 6).

So, it is important to consider the level of task interdependence, context, purpose, and

makeup of a team to understand relevant team dynamics and outcomes.

**Although teams vary across contexts, insight into one context can provide understanding**

**about teams more broadly.**

Although no two teams are the same, a team's context and purpose can provide a general

sense for the kind of team that it is. For example, astronaut teams work in isolated, confined, and

extreme environments (Blackwell Landon, Slack & Barrett, 2018). Primary care teams with

members that are geographically dispersed are typically ambiguous and loosely coordinated with

relatively low interdependence, while teams that work together on-site such as teamlets and

integrated behavioral health teams, are typically well-functioning, well-coordinated, and require

interdependent and reciprocal coordination to complete various primary care tasks (Fiscella &

McDaniel, 2018). Emergency teams form quickly and are made of team members who are unfamiliar with one another (Power, 2018). Innovation teams must create novel solutions, which creates a challenge of uncertainty (Thayer, Petruzzelli, & McClurg, 2018). And, terrorist teams are often loosely coupled structures with sporadic communication held together by strong commitment and unifying belief systems (Spitzmuller & Park, 2018).

Spitzmuller and Park (2018) examined an unconventional team setting – terrorist teams – and demonstrated the implications of studying this type of team for research on teams in general. They note that research has mainly focused on highly structured teams but that studying terrorist teams is fitting for investigating complex team structures that alternate between order and chaos, low and high task interdependence, and complexity. Team researchers have done a great job at untangling when one team context can inform others, and when specific characteristics are particular to that situation. The Goodwin, Blacksmith, and Coats (2018) article provides a thorough elaboration on how military team research has had a large influence on general team science. Military team research has contributed to our understanding of team effectiveness and performance, team processes and emergent states, team leadership, team staffing and composition, and team training.

So, context matters in teams—but sometimes teams performing in different contexts are more similar than not.

**Teams need psychological safety to prosper.**

Sooner or later, all teams run into conflict. In order to resolve conflict, teammates need to participate in open and honest communication. This can only occur if they do not feel worried about being judged or ridiculed by the others on the team, have the "license to speak-up," and can engage in difficult conversations about a problem. This is why psychological safety is a must

in teamwork. Psychological safety is a trusting behavior that is defined as the team's shared belief that it is safe to take interpersonal risks without fear of backlash (Edmondson, 1999; Ilgen et al. 2005). Culture can influence how psychological safety is formed in a team (Feitosa et al., 2018). For example, as Feitosa et al. point out, Americans tend to develop trust through friendship ties, whereas Chinese individuals develop trust based on how competent the other person is on a task. Generally, psychological safety can be developed and/or enhanced through effective team debriefs and leadership communication (Allen et al., 2018). During a debrief, if members are taught to take a learning approach and diagnose areas in need of development, they will be more likely to feel comfortable speaking up. Other team meetings work the same way. Leaders also play an important role in fostering a psychologically safe environment. When leaders admit their own faults, they make others feel they too can safely communicate errors they make. All in all, psychological safety has been shown to be critical for effective teamwork (Edmondson, 1999).

It is critical that organizations, team leaders, and teammates create environments where psychological safety can flourish and be a mechanism to resolve conflicts, ensure safety, mitigate errors, learn, and improve performance (see Frazier et al., 2017 meta-analysis).

**Transportable teamwork competencies have been identified.**

Over the past few decades, team researchers have examined teams of all kinds with all sorts of tasks and purposes. Through these examinations, they have uncovered a handful of teamwork competencies that are *transportable*, meaning they can be used irrespective of the team or task. Although the team or task can alter exactly how these teamwork competencies are carried out in different settings, they are for the most part, applicable in any team environment.

Competencies that were frequently referenced throughout the Special Issue are coordination, communication, and adaptability.

   *Coordination* is the process of organizing different individuals' skills, behaviors and knowledge to meet a combined goal. An effective way to coordinate among team members is to engage in team goal setting. Specifying goals reduces ambiguity by giving the team a shared understanding of the team's objectives. This also establishes a *shared mental model;* it puts all teammates on the same page. *Communication* is the process of sending and receiving information between teammates. It's about the information exchange protocols put in place for team functioning. Although it can take different forms across contexts (e.g., face-to-face, email), a consensus from the literature is that quality is more important than frequency (Marlow, Lacerenza, Paoletti, Burke, & Salas, 2017). For example, a teammate with unique expertise should share information that is exclusively known to them yet critical for the team's effort.  This communication must be a clear and understandable, avoiding jargon (Ervin, Kahn, Cohen, & Weingart, 2018). *Adaptability* is the adjustment of behaviors and strategies in response to changes in the team's circumstance. This skill has been deemed "one of the few universally effective group strategies" (Driskell, Salas, &Driskell, 2018) because it modifies the team's actions to be as efficient and functional as possible. Engaging in team reflections, or debriefs, can help team members understand how to adapt their future behaviors (Allen, Reiter-Palmon, Crowe, & Scott, 2018).

**A team of experts does not necessarily make an expert team.**

   Although technical skills are essential, members of a team must be able to effectively interact and work with each other. In other words, a team of experts does not necessarily make an expert team. How can these individuals be identified and selected? Initially, research focused

on individual level factors (e.g., cognitive ability and personality traits) that contribute to team performance. Among these traits, researchers generally agree that selecting individuals who have a collectivist view or team value orientation are more engaged in teamwork than those who have an individual orientation (Feitosa et al., 2018; Rosenfield et al., 2018; Spitzmuller & Park, 2018). But, as Feitosa et al. note, this does not necessarily remain the case in cross-cultural teams if members do not identify with their other teammates as part of their 'in-group'. Related to the Big Five Personality traits, emotional stability has been found to be positively related to team performance (Blackwell Landon et al., 2018).

Over time, researchers realized that the *combination* of varying traits was possibly a better predictor of team performance (Bell, Brown, Colaneri, & Outland, 2018). Research on astronaut teams found that rather than there being an ideal personality, team performance is more about how the team members' personalities and other characteristics complement each other (Blackwell Landon et al., 2018). Today, researchers are investigating more about interactions between team member characteristics and are faced with the challenge to use more complex statistical methods that are suitable for a dynamic composition model (Goodwin, Blacksmith, & Coats, 2018). Researchers are also considering more complex forms of composition, such as temporal considerations and membership change (Mathieu, Tannenbaum, Donsbach, & Alliger, 2014). Some diversity characteristics that have been studied are demographic attributes, educational background, tenure, and personality (Mathieu et al., 2017). For a review of robust findings regarding the influence of team composition on affective states, behavioral processes, and cognitive states of teamwork, see Bell, Brown, Colaneri, and Outland, 2018.

In essence, even a team made up of experts can fail if they do not know how to cooperate, coordinate and communicate well together. And, rather than one ideal personality that predicts

success on teams, it is the combination of team members that matters more for processes and outcomes.

**It is essential to evaluate relevant team outcomes with robust diagnostic measurement.**

The complex nature of teams and team performance requires innovative, robust, and psychometrically sound assessment methods. Much progress has been made in discovering effective ways to measure teams (Goodwin, Blacksmith, & Coats, 2018). A few key approaches to measuring team outcomes and team process dynamics are to: (1) collect data unobtrusively, (2) use a triangulation approach (i.e., collecting data from different sources), and (3) measure over time (Kozlowski & Chao, 2018).

For a team to function normally, it is best for the researcher to stay out of the way as much as possible. Observational ratings, behavioral anchored rating scales, and behavioral checklists have been used in the military and in medicine (Goodwin et al., 2018; Rosen et al., 2018). These methods have been found to be useful and less intrusive than self-report, but they are sometimes impractical because they require observers, which can be hard to find and train (Goodwin, Blacksmith, Coats, 2018). These challenges led to the use of more unobtrusive measurements such as trace data (e.g., tracking email and using wearable sensors for face-to-face interactions). Relying on more than one method, or using a triangulation approach, can reduce single-source bias and the need to allot an excessive amount of time to either self-report surveys or observations, consequently reducing fatigue for survey responders and observers. Lastly, collecting longitudinal data is imperative to understand the emergent phenomena and team process dynamics that occur over time.

We need better measurement and assessment of teamwork, especially over time and unobtrusively. Advances have been made and, while not perfect, we capture team dynamics

better than decades ago (e.g., Rosen et al., 20XX). As advancements in technology,

methodologies and measurement approaches are made, we will uncover more nuanced team

outcomes.

**Team development interventions work to improve team functioning – but conducting one is not a "cure-all".**

Organizations rarely form teams that effectively carries out team processes at the outset.

This highlights the importance of team interventions. Compelling evidence shows the

effectiveness of team development interventions (TDIs) to improve performance across a variety

of settings, most notably in the military (Goodwin, Blacksmith, & Coats, 2018) and healthcare

(Fiscella & McDaniel, 2018; Power, 2018). Meta-analyses demonstrate that team training

improves teamwork competencies (Hughes et al., 2016; Salas, et al, 2008), leadership training

improves leader capabilities (Lacerenza et al., 2017), team building improves interpersonal

relationships (Klein et al., 2009), and team debriefing improves team processes (Tannenbaum &

Cerasoli, 2013). These interventions are especially impactful when paired with each other.

However, there are several design, delivery, and condition elements that influence their

effectiveness. In this issue, Lacerenza et al. discuss the science-based approaches that have been

shown to work. The following are a few general guidelines for team and leadership training

elaborated on in their article: (1) ensure organizational support, (2) conduct a needs analysis, (3)

implement information, demonstration, and practice methods, (4) provide constructive feedback,

and (5) evaluate the training.

One major challenge is sustaining training effects. One simple strategy to sustain trained

behavior and continue further learning is to conduct debriefs directly after training and

periodically over time. Allen et al.'s article (2018) focuses solely on the impact of debriefs. The

reflective team meeting is particularly appealing because it is relatively inexpensive and quick to conduct – sometimes even lasting under five minutes. Allen et al. point out that debriefs help team members to better understand their situation (i.e., sensemaking) and adapt their strategies (i.e., team reflexivity). To maximize effectiveness, debriefs need to be structured and focus on key events and learning objectives.

There are still remaining questions on TDIs. One concern is how environmental factors might influence the effectiveness of specific TDIs. There is also a need to focus more on how TDIs should be tailored for virtual teams, software development teams, and self-managed teams (Lacerenza et al., 2018). But clearly, TDIs have generally demonstrated to have a positive influence on teams, and pairing interventions with each other is even more impactful.

So, well designed and delivered team training works. Debriefing works. The data is compelling, not perfect. But these need to be paired with other organizational activities (e.g., team coaching) for improving and maintaining effective team functioning.

**Supportive organizational conditions are needed – bad conditions trump potential for effective teamwork.**

Before the development, conceptualization, and implementation of a team, the organization must establish suitable conditions for teamwork. Supportive organizational conditions communicate the importance of teamwork to personnel, enhancing their effort to engage in effective teamwork. An individual who has the ability to work effectively in a team may not exert the same effort to collaborate with others if he or she believes that team structures are incompatible with the organization (Salas et al. 2015).

In a field where the individual has a choice of whether to work as a part of a team or work independently, if the benefits do not outweigh the costs, that person may not participate in

a group effect. This demonstrates the relevance of the organization's role in fostering teamwork. For example, Kniffin and Hanks (2018) found that PhD holders in science, technology, engineering, and mathematic (STEM) fields who engage in teamwork have higher salaries and work more hours, but have no difference in overall job satisfaction compared to those who do not work in teams. Also, Tebes and Thai (2018) note that many universities and academic medical centers apply policies and practices that work against interdisciplinary collaboration, such as tenure requirements that do not support team-based research. In Kniffin et al.'s example, individuals may be less likely to work in a team because there is not a sufficient incentive, unless higher salaries are enough of a driver. In Tebes and Thai's example, there is even less of an incentive because individuals might feel as if collaborations can harm their careers. Organizations can reverse this effect by providing supportive conditions for teamwork.

To increase the likelihood of individuals selecting to work in teams, the organization can implement various reward structures for teamwork, such as distributing rewards to the entire team instead of just individual team members (Thayer, Petruzzelli, & McClurg, 2018). Organizations can also demonstrate support by providing resources and procedures that facilitate teamwork. These include providing teams with team training, extra compensation, emotional support, and time and space for meetings (Rosenfield et al., 2018). Lastly, the organization can make teams a part of the organizational culture, meaning that the organization identifies as a workplace that needs and conducts work in teams, as is now the case in healthcare (Rosen et al., 2018).

Organizations have to be aligned to support teamwork and collaboration. It is the top leadership that sends the signals that teamwork matters. They are the engine to foster teamwork; they set the culture for teamwork. They sustain teamwork.

**What More We Need to Learn Regarding Teams**

The reflections covered in this article demonstrate how much progress has been made in the science of teams. However, there is still much to learn. Below, we elaborate on three concerns for future research that were discussed throughout this Special Issue.

**We need to understand more about multi-team systems.**

Just as organizations have shifted from individual to team work, teams have shifted from single to multi-team systems (MTSs), or teams of teams, which have collective goals. MTSs serve to solve complex, multifaceted, ambiguous, and time-sensitive problems (Shuffler & Cater, 2018). MTSs are typically large, and geographically and functionally diverse. They are distinct from ordinary teams in that teamwork must also occur *across* teams, which brings its own challenges. For example, MTSs are made up of teams with diverse skills, resources, and perspectives, which can create a barrier for collaboration across teams (Shuffler & Carter, 2018). Nearly every article in this Special Issue acknowledged the existence of MTSs but also pointed out that the science on MTSs is still in its nascent stage (e.g., Blackwell Landon et al.; Ervin et al.; Fiscella & McDaniel; Power; Shuffler & Carter). Future investigations can include the use of debriefs at the MTS level (Allen et al.), inter-team leadership functions (Goodwin et al.), and coordinated communication between teams, particularly in conditions with communication delays or other barriers (Blackwell Landon et al.). Recently, Luciano, DeChurch, and Mathieu (2015) developed a theory on MTSs, and, in this issue, Shuffler and Carter outline opportunities to advance the science of MTSs, which can both guide future research in this area. As team networks are expanding, more research is needed on MTSs.

**We need to increase the use of technology for measurement, understanding teamwork and for team interventions.**

Advances in technology can greatly improve efforts to measure team related processes and outcomes. As we mentioned before, measurements should strive to be unobtrusive and robust. Relatively unobtrusive team interaction sensors have a promising future in team research. So far, these sensors have been used to measure distance and time between teammates to predict team performance. There are still challenges in accuracy (such as those related to validity issues and technical glitches), but these inaccuracies should decrease with time (Kozlowski & Chao, 2018). Luciano, Mathieu, Park, and Tannenbaum (2017) provide a roadmap for exactly how to develop and use new technologies that leverage big data on dynamic constructs. An additional consideration for measuring team behaviors, is developing real-time analysis approaches that can alert team members of negative behaviors that can change with prompt intervention. Timely interventions are particularly useful for extreme teams (e.g., emergency teams, astronaut teams) and during training.

Kozlowski and Chao (2018) note that computational modeling (CM) is another compelling research method for team research. CM is a theory-driven, software-based simulation to imitate a system of interest. Many other fields have incorporated CM (e.g., weather forecasting, physics, and biology). As these technologies are validated, more will be used. Future research can identify how to incorporate this technology into team settings. As noted, measurement and interventions for teams still have plenty of room for improvement regarding the incorporation of technology.

It's worth noting that as a science and practice, we probably, need to accept and see the value of replicable, robust, rich and "anthropological-like" case studies (Ns of 1). Significant

insights about team dynamics could be gained (that can be subjected to further testing) in studying a team *in the wild.* And these technologies and methodologies as they mature can be instrumental and valuable.

**We need to close the gap between theory and practice.**

A gap between theory and practice exists in which researchers do not clearly describe the applications of their findings to practitioners, and practitioners use approaches depicted in the literature without them being empirically tested for effectiveness (Power, 2018). One way to resolve this issue is through empirical validation in applied settings. Another, as suggested by Tebes and Thai (2018), is to involve individuals from multiple domains in the research process including the public to create an "all-hands-on-deck" approach to addressing real-world problems. Using multiple perspectives provides a more holistic view of the issue, increasing the applicability of the research to practice. But, in general there is still a gap that we need to close.

## Final Thoughts

The articles in this issue demonstrate the discoveries in the science of teamwork, with co-authors collaborating across academic disciplines such as industrial/organizational psychology, education, organizational behavior, human factors and medicine and even applied psychologists outside of academia.  However, more is needed. The science of teamwork does not belong to a single discipline—it belongs to many; it is (and should be) multidisciplinary.

In closing, the science of teams has made substantial progress in several avenues including the development of multi-level theoretical frameworks to address the dynamic nature of teams, the composition and processes that lead to team effectiveness, and the identification of unobtrusive measures of team processes and outcomes. As teamwork research continues, efforts

are being made to: (1) address issues with technology to make further improvements in team assessment, (2) learn more about multi-team systems, and (3) bridge the gap between theory and practice. We hope that researchers and practitioners, alike, are encouraged by the progress we have made in team and teamwork research, and are motivated to journey onto the road ahead.

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