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Multiteam Systems in the U.S. Army: Conceptual Review, Training Considerations, and Future Research Directions

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14. ABSTRACT

Multiteam systems, or "teams of teams," are common in the U.S. Army, and are expected to become more prevalent in the future operational environment. Indeed, multiteam systems are better capable of accomplishing goals in complex task environments than single teams in part through more diverse specialization and greater flexibility. The literature on multiteam systems is still in its early stages, especially in comparison with the broader study of teams. The empirical research on multiteam systems is particularly lacking, which is understandable considering the difficulty of studying this topic. Researchers have in turn focused on theoretical articulation at the expense of providing empirical research that offers practical implications for improving the effectiveness of multiteam systems. The purpose of this review is to provide a conceptual overview of multiteam systems, with an aim toward identifying areas for research on multiteam systems training in the Army. Fundamental principles from the organizational training literature were used to develop 11 research questions. These questions provide the groundwork for future theoretical articulation and empirical research toward the ultimate goal of improving multiteam system effectiveness in the Army.

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August 2021

MULTITEAM SYSTEMS IN THE U.S. ARMY: CONCEPTUAL REVIEW, TRAINING CONSIDERATIONS, AND FUTURE RESEARCH DIRECTIONS

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army relies on coordination among units to accomplish its objectives. Multiteam systems, or "teams of teams," is a related concept, defined by two or more teams that work interdependently to accomplish a shared goal. Multiteam systems are especially effective at addressing the challenges in complex task environments by offering diverse specialization and allowing for greater flexibility than can be provided by a single team. The Army is structured to leverage the effectiveness of multiteam systems. However, the Army is also expected to face an increasingly complex operational environment, which in combination with recent doctrine on multi-domain operations, suggests that multiteam systems will be all the more important in the years ahead. However, much of the academic literature on multiteam systems ignores fundamental practical considerations, one of which is training. There are in turn a variety of unanswered questions about how best to train Soldiers to perform effectively in multiteam systems. The present review provides an overview of the multiteam systems literature and in connection with the broader literature on organizational training, with the specific aim to present research questions that will help guide future research toward the development of multiteam systems training in the Army.

Procedure:

This research began first with a review of the multiteam systems literature based on a search of relevant academic and military databases (i.e., ERIC, PsycINFO, Google Scholar, Defense Technical Information Center) using pertinent search terms (i.e., *multiteam system*, *MTS*, *teams of teams*). Sources detailed in this report include those that articulate a conceptual or theoretical framework of multiteam systems and any research or conceptual work that is directly relevant to training in that context. This literature search was combined with Army applications of multiteam systems and fundamental considerations in the broader multiteam systems and organizational training literatures to derive associated research questions.

Findings:

There were four primary findings from this review. First, much of the literature on multiteam systems has been directed at conceptual and theoretical articulation, and as a result the conceptual basis for multiteam systems is fairly detailed; however, this is not without some notable oversight, especially in articulating multiteam system effectiveness. Second, the empirical literature on multiteam systems is comparatively limited and largely inconsistent with the complexity of how multiteam systems function in the operational environment. Third, the multiteam systems literature has generally ignored more fundamental practical considerations; and indeed, there is little theoretical articulation or empirical study of training in multiteam systems. Fourth, the organizational training literature offers notable insight about how best to

design and develop training to enhance the effectiveness of Soldiers in multiteam systems. However, there are a number of essential preliminary steps toward the development of multiteam systems training. Future research that aims to address these considerations and 11 associated research questions will provide a rigorous groundwork in the development of training to enhance the effectiveness of multiteam systems in the Army.

Utilization and Dissemination of Findings:

This report provides useful and practically relevant information for the subsequent design, development, and evaluation of multiteam systems training in the Army. Thus, the intended audience for this research is primarily Army researchers and training developers who are interested in multiteam systems training; however, this report might also be useful for Army leaders who are more broadly interested in the use of multiteam systems, especially given that the Army is expected to rely more heavily on multiteam systems in the future operational environment.

MULTITEAM SYSTEMS IN THE U.S. ARMY: CONCEPTUAL REVIEW, TRAINING CONSIDERATIONS, AND FUTURE RESEARCH DIRECTIONS

CONTENTS

MULTITEAM SYSTEMS IN THE U.S. ARMY: CONCEPTUAL REVIEW, TRAINING CONSIDERATIONS, AND FUTURE RESEARCH DIRECTIONS

Introduction

The U.S. Army functions based on the coordinated effort among multiple teams[1] of Soldiers. Multiteam systems, also described as "teams of teams," are inherent in the hierarchical structure of the Army (DiRosa, 2013). Multiteam systems are also reflected in joint and multinational operations, in conceptual discussion of the future battlefield, and multi-domain operations (Department of the Army, 2019a; Goodwin et al., 2012). Interest in multiteam systems is understandable given the complexity of military operations, and considering that the future operational environment is expected to be characterized by even greater complexity (Department of the Army, 2018). Organizations in the public and nonpublic sector are also facing increasingly complex challenges; thus, they are relying more extensively on multiteam systems to accomplish goals that a single team or independent teams are less likely to achieve (Shuffler & Carter, 2018).

The conceptual basis of multiteam systems and empirical research is still in its early stages, especially in comparison with the broader study of teams (see Mathieu et al., 2017). The Army was involved in multiteam systems research from the very beginning. Mathieu et al. (2001) provided the initial conceptualization of multiteam systems. Their origination of this concept was a direct result of incidents caused by coordination problems in military training exercises (Goodwin et al., 2018; Mathieu, 2012). Much of the empirical study of multiteam systems that accumulated since was funded by the U.S. military, and used samples of military service members and/or military specific tasks (for relevant examples, see Davison et al., 2012; DeChurch & Marks, 2006; DiRosa, 2013).

Despite increasing interest in and research attention directed at multiteam systems, there are some notable gaps between the academic literature that has only more recently studied this topic and the extensive present and future reliance of the Army on multiteam systems. Some researchers have acknowledged this disparity, which is likely due in part to the challenges of studying this topic (DeChurch & Zaccaro, 2010; Shuffler & Carter, 2018). As a result, researchers have often focused on conceptual reviews and theoretical discussion of multiteam systems, at the expense of providing empirical analyses (e.g., Ascencio & DeChurch, 2017; Luciano et al., 2018; Shuffler & Carter, 2018; Shuffler et al., 2015; Zaccaro et al., 2020).

The practical impact of the multiteam systems literature is lacking, and indeed most research is aimed at assessing the dynamics of processes and performance at the team and multiteam system levels (e.g., de Vries et al., 2016; DiRosa, 2013; Doty, 2013; Murase et al., 2014). This type of research is an important initial step in a fairly recent domain, but nevertheless provides limited insight about how to enhance the effectiveness of multiteam systems. There are a variety of unanswered research questions that would offer clear, practical impact. Training is one particularly impactful topic in the Army, considering the extensive time and money that the Army dedicates to training in order to ensure Soldier readiness. The Army spent over $3.5 billion

[1] In this discussion, I refer to Army units and teams interchangeably because Army units are teams in that they rely on interdependence among multiple Soldiers, who work together to achieve shared goals (Baker & Salas, 1997).

on accession, basic skill, and advanced training in 2019 (Department of the Army, 2019b). The *purpose* of the present review is to provide an overview of the conceptual and empirical literature on multiteam systems and in connection with organizational training, with the primary aim to derive related research questions that will guide future research.

Literature Search

The first step in this review was a literature search for published research in relevant databases (i.e., Defense Technical Information Center, ERIC, Google Scholar, PsycINFO) using the following search terms: *multiteam systems*, *MTS*, and *teams of teams*. The terminal date for the literature search was January 2020 (inclusive). References from conceptual articles identified in the literature search (e.g., Luciano et al., 2018; Shuffler & Carter, 2018; Shuffler et al., 2015) were also reviewed for inclusion.

The articles identified in the literature search were initially screened for eligibility to be included in the present review. Articles were retained if they presented a conceptual or theoretical framework of multiteam systems, or if they involved research or conceptual work that is directly relevant to training in multiteam systems. The application of these eligibility criteria resulted in the inclusion of seven conceptual articles (DeChurch et al., 2019; Luciano et al., 2018; Mathieu et al., 2001; Rico et al., 2017; Rico et al., 2018; Sessa et al., 2019; Zaccaro et al., 2012) and two empirical studies of training in multiteam systems (DeChurch & Marks, 2006; Firth et al., 2015). This literature search was combined with Army applications of multiteam systems based on relevant academic articles and Army doctrine, and fundamental considerations in the broader multiteam systems and organizational training literatures.

Multiteam Systems Defined

Mathieu et al. (2001) were the first to define multiteam systems and most of the subsequent conceptual and empirical literature relies on their definition. According to Mathieu et al. (2001), multiteam systems refer to:

> Two or more teams that interface directly and interdependently in response to environmental contingencies toward accomplishment of collective goals. MTS [multiteam system] boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in doing so exhibit input, processes and outcome interdependence with at least one other team in the system (p. 290).

Inherent in this definition are three key distinguishing characteristics of multiteam systems (see also DeChruch & Zaccaro, 2013; Mathieu, 2012; Mathieu et al., 2018). First, multiteam systems consist of at least two component teams. There is no upper limit on the number of teams that can constitute a multiteam system, although multiteam systems with large numbers of component teams are likely to act appreciably different than those with only a few constituent teams (Lanaj et al., 2013). Second, multiteam systems have at least one system-level, superordinate goal that is shared among the component teams, while each team has their own set of distinct goals. Third, teams that make up multiteam systems share at least some, but typically

extensive interdependence through shared inputs, processes, and/or outcomes. These latter two characteristics of multiteam systems—superordinate goal(s) and interdependence—are fundamental (Mathieu et al., 2018).

There are a few additional defining features of multiteam systems described in more recent discussion (Mathieu, 2012; Mathieu et al., 2018). Specifically, multiteam systems are not simply one large team (DeChurch & Mathieu, 2009). The teams that comprise multiteam systems are distinct in that while they share higher-order goals, they each have unique goals and interdependence (Mathieu, 2012). Relatedly, an underlying assumption in the articulation of multiteam systems is that they are a unique organizational form, or "something different from teams, organizations, or other organizational entities" (Mathieu, 2012, p. 541). Multiteam systems reside at a level above individuals and teams, but below organizations, and might span multiple organizations (DeChurch & Mathieu, 2009). Thus, what we know about teams and organizations is not necessarily applicable to multiteam systems. Empirical research largely supports this rationale (e.g., Lanaj et al., 2018).

Multiteam Systems in the Army

Multiteam systems are inherent in the Army structure and design of forces (DiRosa, 2013; Goodwin et al., 2012). Soldiers are typically assigned to squads, which are embedded in platoons. Army squads that compose platoons each have unique leaders, tasks, and goals, but they also share the superordinate goals of the platoon (DiRosa, 2013). Army squads work together to achieve the overall objective of their platoon through the accomplishment of a series of interrelated goals that are organized in a goal hierarchy (Rico et al., 2017).

Research related to multiteam systems is uniquely applicable to both the current operational environment and characteristics expected to define the future environment. Multiteam systems are implemented primarily in complex task environments in order to leverage diverse specialization and provide for greater flexibility than can be offered by a single team (Shuffler & Carter, 2018). Multiteam systems are particularly beneficial for task environments that are ambiguous, multifaceted, dynamic, and time-sensitive (Shuffler & Carter, 2018). These are some of the fundamental characteristics of the current operational environment and align with expectations for the future operational environment, a primary aspect of which is heightened complexity (Department of the Army, 2019a). The Army is developing the multi-domain operations framework to meet challenges in the future environment (Department of the Army, 2018). The tenets of multi-domain operations (i.e., calibrated force posture, multi-domain formations, and convergence) will rely on coordination and synchronization among multiple domains, and thus the effective functioning of multiteam systems.

Joint operations are a prime example of multiteam systems in the Army because they depend on coordination among a vast number of teams that are geographically dispersed and often hampered by differences in culture, language, and military approach (Goodwin et al., 2012). The present state of technology and rapid pace of advancement means that successfully addressing threats will necessitate the continued efforts and effective coordination among the U.S. military and its allies (Department of the Army 2019a; Department of the Army, 2018). The

following discussion articulates two related joint operations that serve as exemplars for the use of multiteam systems.

Multiteam Systems in Counterinsurgency Operations

Counterinsurgency (COIN) operations are a somewhat dated but nonetheless historically relevant and well-known example of multiteam systems. Specifically, COIN operations rely on an extensive system of teams from the U.S. military, other government and nongovernment agencies, and a host nation, that work toward the ultimate goal of improving security (Goodwin et al., 2012). This is accomplished directly through combat and civil security operations and the development and training of the host nation security forces (Department of the Army, 2006). These more direct actions are accompanied by the development of the host nation's essential services (e.g., sewage, water), governance, and economy, which are also key in establishing security. Figure 1 provides an exemplar multiteam system via a goal hierarchy of combat operations and host nation security forces in counterinsurgency, based on Army doctrine (see Figure 5-2 in Field Manual 3-24; Department of the Army, 2006) and related discussion of multiteam systems (Goodwin et al., 2012).

Multiteam Systems in Cyberspace Operations

Multiteam systems are also fundamental to cyberspace operations, which are of increasing focus in the Army, and "inherently joint, inter-organizational, multinational, and commercial" (Field Manual 3-12, p. 1-3; Department of the Army, 2017). Cyberspace is defined as "the interdependent networks of information technology infrastructures and resistant data, including the Internet, telecommunications networks, computer systems, and embedded processors and controllers" (Joint Publication 3-12, GL-4; Joint Force Development, 2018). The burgeoning focus on cyberspace in the Army is understandable because it is integral to the effective functioning of every operational domain.

Cyberspace operations envisage offensive, defensive, and support, and actions within these operations consist of security, defense, exploitation, or attack (Department of the Army, 2017; Joint Force Development, 2017, 2018). However, for the purposes of this discussion, multiteam systems are linked to cyberspace via defensive operations. Specifically, Figure 2 is a goal hierarchy of a multiteam system in defensive cyberspace operations, based on Army and joint military doctrine (Department of the Army, 2017; Joint Force Development, 2017, 2018). This figure depicts the lower-order goals that must be accomplished to achieve the ultimate goal of defensive cyberspace operations to defeat ongoing or imminent malicious cyberspace activity. These goals are accomplished based on the coordinated efforts among a variety of U.S. and allied military teams, other DOD cyberspace teams, and teams from the private sector.

Theoretical Models of Multiteam Systems

Much of the literature on multiteam systems has been theoretical, and as a result conceptual description is fairly detailed and has over time become more complex. Zaccaro et al. (2012) developed the first theoretical framework for understanding the effectiveness of

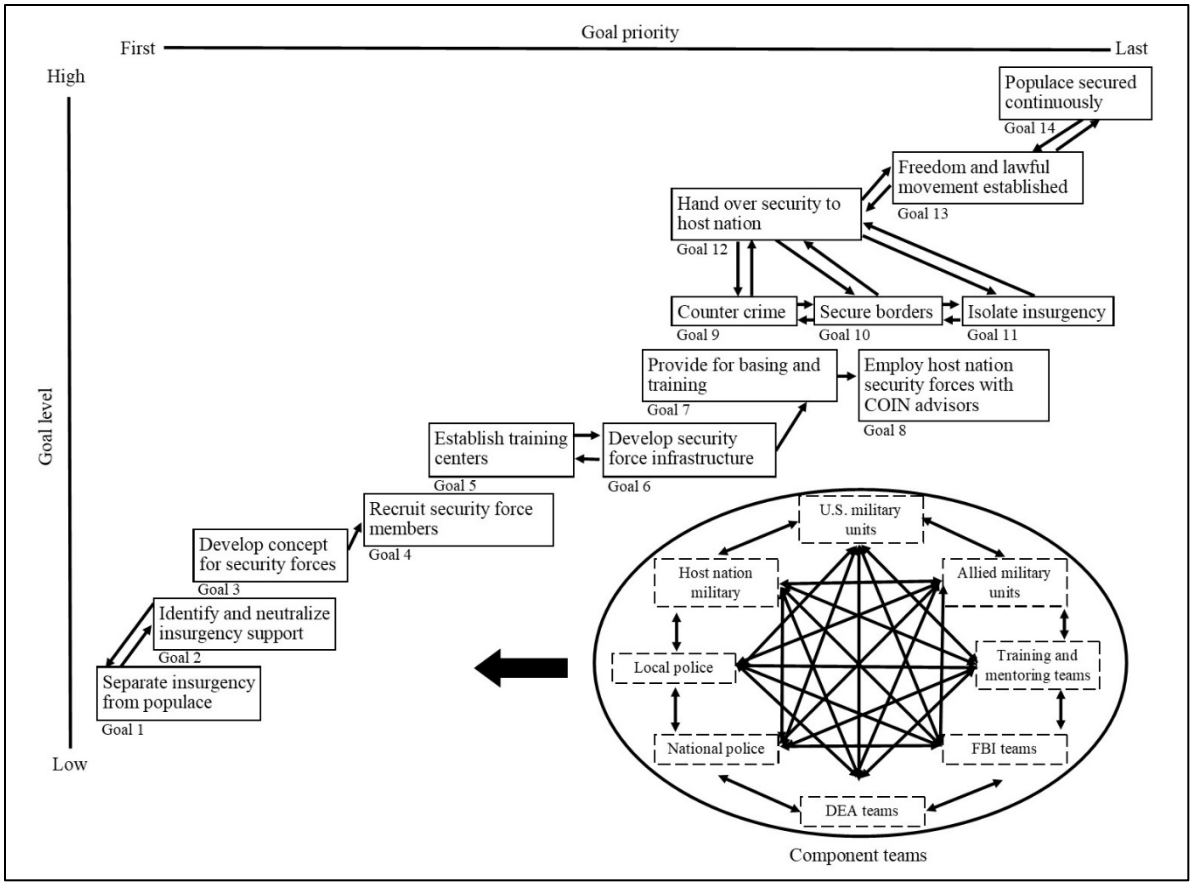

Figure 1. A goal hierarchy of multiteam systems in counterinsurgency operations.

multiteam systems, although their framework does not reflect the complexity of multiteam systems as articulated in more recent conceptual work. Zaccaro et al. (2012) categorized multiteam system characteristics into compositional, linkage, and developmental attributes, which serve as distal predictors of multiteam system effectiveness. These characteristics indirectly influence multiteam system effectiveness through intrateam and interteam processes. The theoretical overview in the subsequent section follows this conceptual framework in combination with other common theoretical forms (Luciano et al., 2018; Rico et al., 2017; Rico et al., 2018).

Multiteam System Characteristics

Zaccaro et al. (2012) provided a useful categorization schema for the characteristics of multiteam systems, differentiating between compositional, linkage, and developmental attributes. Few researchers have explicitly examined how these characteristics influence multiteam system effectiveness, given the difficulty of manipulating these variables (for an exception, see Sullivan et al., 2015). Compositional attributes include demographic characteristics of the overall system and of the teams contained therein, including for instance the number of component teams, the overall size of the multiteam system, and geographic dispersion (Zaccaro et al., 2012). Linkage

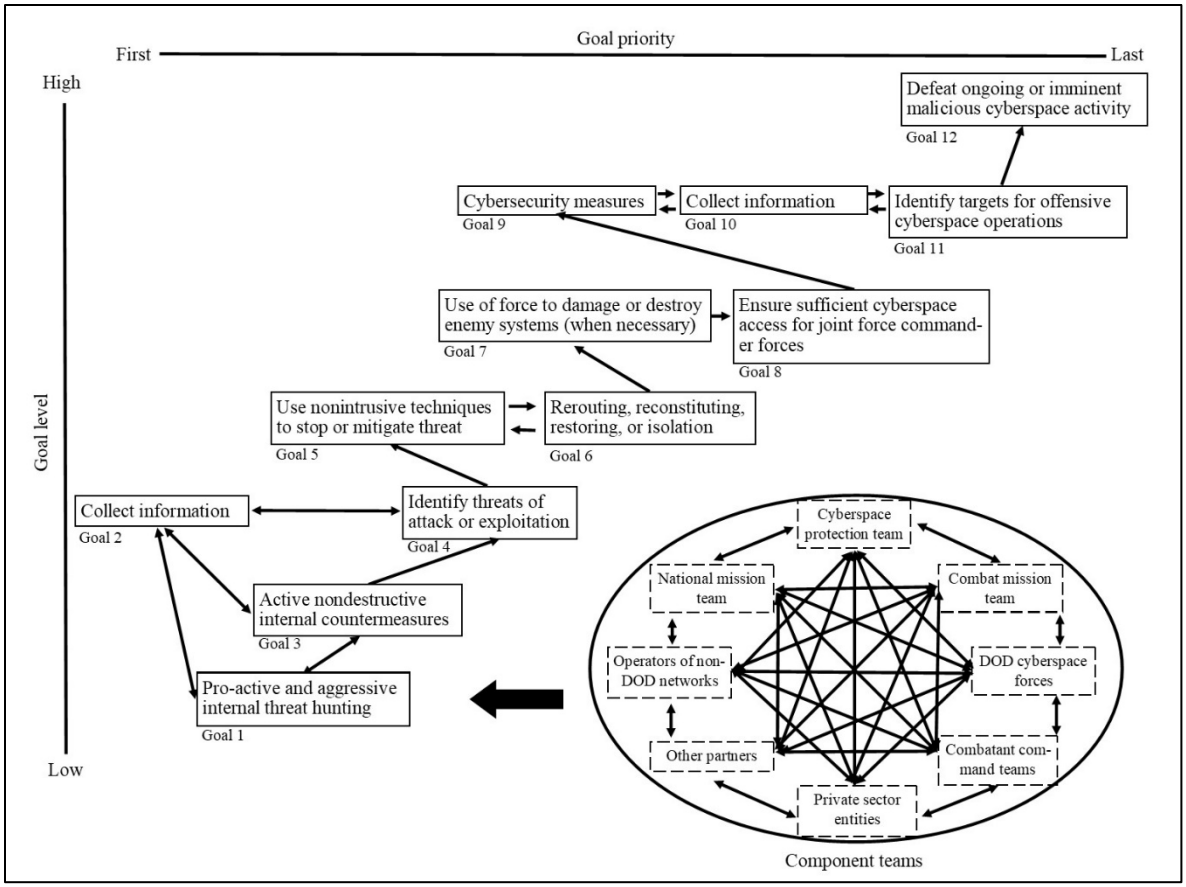

Figure 2. A goal hierarchy of multiteam systems in defensive cyberspace operations.

attributes refer to the linking mechanisms that connect component teams, including interdependence, arrangement and power distribution, and communication structure (Zaccaro et al., 2012). The final set of characteristics described by Zaccaro et al. (2012) are developmental dynamics and patterns, which include genesis (appointed or emergent), the direction of development (i.e., its evolution from an early formal state), anticipated duration (i.e., tenure), stage, and the degree of transformation in membership (fluidity versus constancy).

Luciano et al. (2018) provided a complementary theoretical framework for understanding multiteam systems. They specified two key structural features of multiteam systems, namely, differentiation and dynamism. Differentiation encompasses various factors that differentiate component teams, including goal discordancy, work process, and dissonance (Luciano et al., 2018). Dynamism accounts for the largely unstudied, but inherent variability in multiteam systems over time. Component factors underlying dynamism include change in goal hierarchy, uncertainty of task requirements, and structural and composition changes (Luciano et al., 2018). Greater differentiation and dynamism in multiteam systems is expected to undermine system effectiveness because members are more likely to orient their motivation toward their component teams versus the needs of the multiteam system (Luciano et al., 2018).

Intrateam and Interteam Processes

The proximal predictors of multiteam system effectiveness are intrateam and interteam processes (Zaccaro et al., 2012). Processes refer to "[team] members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing taskwork to achieve collective goals" (Marks et al., 2001, p. 357). The inclusion of process variables as mediators between multiteam system characteristics and effectiveness follows from the input-process-outcome (IPO) model (Gist et al., 1987; Guzzo & Shea, 1992). In multiteam systems, process variables emerge within the constituent teams (i.e., *intrateam processes*), and across teams (i.e., *interteam processes*). Numerous processes have been examined in the teams literature; however, some of the most often researched include cohesion, communication, coordination, cooperation, and conflict (LePine et al., 2008). Much of the empirical literature on multiteam systems focuses on processes, including most commonly coordination, but also cohesion and communication (de Vries et al., 2016; DiRosa, 2013; DiRosa et al., 2015; Doty, 2013; Jiménez-Rodríguez, 2012). A common finding is that the beneficial effects of processes for individual teams can be to the detriment of the multiteam system. For instance, strong intrateam cohesion that is known to enhance the effectiveness of standalone teams can contribute to competition and conflict at the multiteam system level (i.e., interteam; Lanaj et al., 2013; Tajfel, 1982).

Multiteam System Effectiveness

The effectiveness of multiteam systems has largely been ignored as a topic of discussion (for one exception, see Mathieu et al., 2018). Zaccaro et al. (2012) explicitly mentioned the effectiveness of multiteam systems only twice in their edited book on the topic (see also Mathieu et al., 2018). The ultimate criterion of the multiteam system is its superordinate goal(s), which is accomplished through the collective efforts of the constituent teams (Mathieu et al., 2018). However, this is not the only criterion. Multiteam systems contain numerous lower-order and higher-order goals, existing in complex goal hierarchies (Rico et al., 2017; Rico et al., 2018). Multiteam system effectiveness is best understood as the extent to which both higher-order and more proximal goals are maximized by the efforts of the component teams (Mathieu et al., 2018; Rico et al., 2017).

Goals, Goal Hierarchies, and Interdependence

Rico et al. (2017) relied in part on the aforementioned theory, but their conceptual framework differs from previous efforts in that it is founded on goal setting (Locke & Latham, 1990). Goals refer to the object or aim of an action, which direct behavior (Latham & Locke, 2002; Locke & Latham, 1990). Rico et al. (2017) describe multiteam system effectiveness as fundamentally goal directed, in that each of the component teams in a respective multiteam system have their own separate goals, but they also work interdependently to accomplish the higher-order goal of the system. Consequently, the fundamental motivational process in multiteam systems and their constituent teams is goal choice and goal striving (Chen & Kanfer, 2006).

Rico et al. (2017) expanded on the factors that contribute to goal choice and goal striving in multiteam systems. Specifically, goal choice is influenced primarily by the multiteam system

goal hierarchy (see Figures 1 and 2 for illustrative goal hierarchies in the Army). Goals in the hierarchy differ with respect to their level, priority, and compatibility (Mathieu et al., 2001; Rico et al., 2017; Zaccaro et al., 2012). Goal level constitutes the position of goals in the goal hierarchy, such that the higher-order goals of the system are contingent on the accomplishment of lower-order goals (Lork & Kernan, 1989; Mathieu et al., 2001). Goal priority refers to the proximal order within which goals must be accomplished, beginning with lower-order goals and moving on to the higher-order goals of the system. Goal compatibility is the degree to which goals at the same level (i.e., horizontal compatibility) or different levels (i.e., vertical compatibility) are aligned, such that they are not in conflict. A few additional factors influence goal choice in multiteam systems, namely, the reward structure (i.e., compensation for which activities and at what level [individual, team, multiteam system]) and where in the goal hierarchy feedback is provided (i.e., lower-order versus higher-order goals).

Goal striving in multiteam systems (i.e., the combined set of behaviors that are enacted to accomplish goals) is influenced primarily by functional process interdependence, or the degree to which constituent teams rely on each other to accomplish their goals (Mathieu et al., 2001; Rico et al., 2017). These process interdependencies are categorized as sequential, reciprocal, and intensive (Mathieu et al., 2001; Tesluk et al., 1997). Multiteam systems are characterized by sequential interdependence when the process of accomplishing its goals occur in a sequential step-by-step order. Multiteam systems that follow a reciprocal form of interdependence necessitate a cyclical pattern of effort by their constituent teams. Intensive interdependence is characterized by simultaneous and collective effort among component teams (Mathieu et al., 2001). Each of these process interdependencies are applicable in the Army to some degree; however, multiteam systems are most commonly characterized by intensive interdependence in the Army. For instance, the aforementioned counterinsurgency and cyberspace operations incorporate a wide variety of teams that must work simultaneously to accomplish their goals and the goals of the multiteam system. These efforts in some cases must occur in a step-by-step order or cyclical pattern (e.g., exhaust all indirect defensive cyberspace operations before use of force), but they typically necessitate a high degree of simultaneous effort. More broadly, multiteam systems are expected to benefit from congruence within and between teams in their process interdependence and with the goal hierarchy (e.g., high-order goals are combined with intensive interdependence; Rico et al., 2017).

The primary contribution of Rico et al. (2018) was in expanding on functional process interdependence in multiteam systems. Specifically, they argued that the interdependence of the multiteam system drives the type of coordination that is required to accomplish system-level goals. However, the influence of interdependence depends in part on the type of integration, either hierarchical or lateral. In hierarchical integration, the interdependencies of teams in multiteam systems are managed by a distinct, separate, and higher-level organizational entity, whereas in lateral integration, coordination occurs at the level of the task. The Army is structured based on hierarchical integration. Rico et al. (2018) further differentiated between two distinct forms of coordination, which occur through explicit planning and communication among teams (i.e., explicit coordination) or by anticipating other teams' needs and adjusting behavior accordingly (i.e., implicit coordination). They contended that the type of functional process interdependence of the multiteam system interacts with the type of integration mechanism (i.e.,

hierarchical or lateral) to drive coordination (i.e., implicit and/or explicit) both within and between component teams (Rico et al., 2018).

Training to Improve Multiteam System Effectiveness

The aforementioned theoretical rationale provides the necessary groundwork for understanding multiteam systems, and the factors that likely contribute to and detract from its effectiveness (Luciano et al., 2018; Rico et al., 2017, 2018; Zaccacro et al., 2012). Theoretical articulation is an important initial step in this burgeoning research area, but the multiteam systems literature is in need of more empirical research that offers practical insight. Training is a particularly impactful consideration in the Army because of the extensive time and money that is directed at training to ensure Soldier and unit readiness. The subsequent discussion leverages the multiteam systems and organizational training literatures to derive unanswered questions, with the aim to spur future research on training in multiteam systems that will ultimately provide useful application for the Army.

Researchers have provided numerous definitions of training, and a summation of these varied definitions is beyond the scope of this discussion. Brown and Sitzmann's (2011) definition serves for the purposes of this discussion as fairly encompassing; that is, training refers to "a formal, planned effort to help employees gain job-relevant knowledge and skills" (p. 469). Training is distinct from development, which includes more discretionary activities that help employees gain knowledge and skills for future jobs (Brown & Sitzmann, 2011; Noe, 2013), and informal learning behaviors "that take place outside formally-designed learning contexts" (Cerasoli et al., 2018, p. 204).

Learning in Multiteam Systems

DeChurch et al. (2019) provided a recent conceptual overview of learning in multiteam systems, which is important to this discussion because training is a systematic technique aimed at enabling learning (Brown & Sitzmann, 2011). DeChurch et al. (2019) relied on the organizational literature to specify the learning process in multiteam systems as consisting of knowledge generation, retention, and transfer (Argote & Miron-Spektor, 2011; DeChurch et al., 2019). This process is thought to differ at the interteam and intrateam levels as a function of multiteam system characteristics (DeChurch et al., 2019).

DeChurch et al. (2019) described multiteam system learning in connection with differentiation and dynamism (Luciano et al., 2018). Differentiation is expected to promote intrateam learning through conflict and introspection that leads to knowledge creation and retention within teams (DeChurch et al., 2019). However, at the interteam level, differentiation should undermine knowledge sharing, and lead to less openness to receive knowledge from others. DeChurch et al. (2019) also contended that dynamism has both positive and negative effects on multiteam system learning. Dynamism should impede interteam knowledge creation and retention because teams are less stable and thus less able to generate new knowledge and retain this information over time (DeChurch et al., 2019). However, dynamism is also expected to contribute to greater willingness to share and receive information as a means of offering greater stability (DeChurch et al., 2019).

DeChurch et al. (2019) proposed that shared leadership in the multiteam system is influential at enhancing learning when confronted with differentiation and dynamism. Shared leadership is a dynamic and interactive process whereby individuals influence each other, as opposed to leadership that is characterized by a single person or a few people in leadership roles (Pearce & Conger, 2003). Shared leadership is expected to help in the learning process when multiteam systems are characterized by differentiation and dynamism by contributing to positive affective (e.g., motivation, cohesion) and cognitive (transactive memory, shared mental models) emergent states.

Shared leadership is not common in the Army, nor is it likely to become common without extensive fundamental changes. Joint operations for instance encompass a strict hierarchical leadership structure whereby a centralized command team oversees the activities of all the component teams in the multiteam system (Goodwin et al., 2012). Relatedly, conceptual rationale and empirical evidence does not summarily support the benefits of shared leadership in multiteam systems. There is some evidence to suggest that the positive effects of shared leadership on multiteam systems are outweighed by coordination failures (Lanaj et al., 2013). Thus, the vertical leadership structure of the Army might be the best option at ensuring effective coordination that is key to the success of multiteam systems.

Previous Empirical Assessments

Only a few researchers have provided empirical studies of training in multiteam systems (i.e., DeChurch & Marks, 2006; Firth et al., 2015). DeChurch and Marks (2006) used a college student sample who were assigned to six-person multiteam systems, and tasked with completing an Air Combat simulation (see also Mathieu et al., 2004). The multiteam system consisted of ground, air, and leadership teams. DeChurch and Marks (2006) tested the effect of two training manipulations aimed at strategy and coordination for those in the leadership team. The strategy training involved a structured presentation of an effective strategy in the simulation, followed by a practice planning session and feedback. The coordination training involved a prerecorded video with a structured script that highlighted effective coordinating behavior. DeChurch and Marks (2006) found that those who were trained in the strategy or coordination intervention engaged in more effective leadership behavior (e.g., relaying critical information about each of the component teams to one another), based on a pre-post design using the aforementioned Air Combat simulation.

Firth et al. (2015) tested the effect of a frame-of-reference training on coordination. They used a sample of U.S. Air Force officers, who were assigned to 14-person multiteam systems to perform in a leadership development simulation (see also Davison et al., 2012; Lanaj et al., 2013). Those in the experimental condition received a 3-minute frame-of-reference training, which involved a handout and description of behavioral criteria for making confidence ratings about the certainty of a target's location, a key determinant of effectiveness on the task. This information was given only to members of the leadership team in each multiteam system. The frame-of-reference training was expected to contribute to better interteam coordination by ensuring a common understanding and communication about the operating environment, and reducing idiosyncrasies between teams (Firth et al., 2015). Results generally supported this

rationale; however, the positive effects of the frame-of-reference training on coordination were typically small.

Future Research Directions: Key Considerations

The academic literature provides some practically relevant information about multiteam systems, which has been the focus of extensive theoretical discussion and comparatively less empirical research. However, researchers have generally ignored how training is best applied to multiteam systems, which offers clear practical value for the Army. Thus, greater research attention should be directed at developing and testing the effect of training on multiteam system effectiveness. This research would provide needed specifics about how best to enhance the effectiveness of multiteam systems in the Army and improve the coordination among Army teams that is key to successfully accomplishing their missions. However, there are some essential initial steps that need to be made in order to develop and/or examine the effectiveness of multiteam system training. The specific areas for future research follow from basic principles and practices in the organizational training literature, and include in particular a needs analysis, a determination of training criteria, level, and focus, and an understanding of task, training, and trainee characteristics (Bell et al., 2017; Brown & Sitzmann, 2011; Noe, 2013; Salas et al., 2012). Each of these considerations are reviewed in the subsequent section, followed by pertinent research questions that set the groundwork for future research.

Needs Analysis

Ideally, the first step in the development of any training is a needs analysis, which involves a determination of the appropriateness of training based on an organization, task, and people analysis (Arthur et al., 2003; Brown & Sitzmann, 2011; Noe, 2013; Surface, 2012). A needs analysis is rarely implemented prior to developing training and largely ignored as a research topic (Arthur et al., 2003); however, it is particularly pertinent for multiteam systems given the present state of the literature. Multiteam systems are a distinct organizational form, and thus what we know about training at other levels—most notably team training—will likely not summarily apply to training in multiteam systems (Mathieu, 2012).

In the Army, a training needs analysis would help determine if the challenges faced in multiteam systems are a training problem, in that Soldiers are lacking in knowledge and skills, or if another type of intervention is more appropriate (Noe, 2013). For instance, an intervention might involve changes in the structural characteristics of the multiteam system, including but not limited to the replacement of a poor performing team or poor performing leaders in key roles (e.g., boundary spanners; Luciano et al., 2018; Zaccaro et al., 2012). Moreover, a training needs analysis would provide specific guidance about who in the Army would most benefit from training in multiteam systems, and the training features likely to be most beneficial for improving multiteam system effectiveness (Arthur et al., 2003). However, without a training needs analysis, it is difficult to know if the challenges faced in multiteam systems are a training problem, or require a different type of intervention.

Research Question 1. Is training an appropriate intervention for improving multiteam system effectiveness in the Army?

Training Criteria

A fundamental consideration in the development and assessment of training is determining the criteria to evaluate its effectiveness (Bell et al., 2017). The effectiveness of training can be assessed based on various criteria, but continues to be most commonly assessed using Kirkpatrick's (1994) four levels of evaluation: reactions, learning, behavior, and results (e.g., Hughes et al., 2016). This continues despite concerns with this approach; most notably, Kirkpatrick's (1994) four levels of evaluation are an oversimplification of the variety of ways in which training can be evaluated (e.g., Salas et al., 2012). In comparison, teams researchers often evaluate training based on performance, cognitive (i.e., knowledge), attitude (e.g., socialization, trust), and process (e.g., communication, coordination, cooperation) criteria (Kraiger et al., 1993).

The literature on multiteam systems training has focused largely on coordination because it is one of (if not the most) influential process variable in multiteam systems (DeChurch & Marks, 2006; Firth et al., 2015). However, training interventions might be directed at other criteria, as more knowledge is accumulated about multiteam systems. For instance, Murase et al. (2014) studied mental models at the multiteam system level, termed multiteam-interaction mental models. Future research might be directed at multiteam-interaction mental models and training approaches that are particularly adept at improving these types of cognitive criteria (e.g., cross-training; Mohammed et al., 2010). A key consideration moving forward is determining the criteria that are most relevant for evaluating multiteam systems training in the Army, which is accomplished in part through a needs analysis (Arthur et al., 2003; Surface, 2012).

Research Question 2. Which criteria are most relevant to evaluate the effectiveness of multiteam systems training in the Army?

Training Level and Focus

Training in multiteam systems can be directed at individuals, constituent teams, or the multiteam system. Work by Kozlowski and colleagues (Kozlowski & Bell, 2012; Kozlowski & Salas, 1997; Kozlowski et al., 2000) in the teams literature provides some guidance in this regard. They contend that the nature of the task should dictate at what level to train. Training should be directed at the team when performance requires coordinating disparate actions but at the individual when workflow is primarily additive (Kozlowski & Bell, 2012). This same rationale suggests that for most multiteam systems, which are often if not summarily coupled with complex tasks and workflows (Shuffler & Carter, 2018), training should be directed at the multiteam system level. Moreover, a training approach that is directed at the individual or the component teams might undermine multiteam system effectiveness because it orients trainees' motivation to their individual goals and the goals of their component teams versus the superordinate goals of the system (Luciano et al., 2018; Rico et al., 2017). DeShon et al.'s (2004) multilevel individual and team performance process framework would appear to support this rationale (see also Rico et al., 2017), which is relevant to the Army because training is largely, if not summarily, applied at the individual or team level, not at the level of the multiteam system. However, research is needed to provide some empirical basis for these claims.

Research Question 3. At what level should multiteam systems training be directed at in the Army?

Multiteam systems training might also be directed at and catered for members with specific roles. Extant research on multiteam systems suggests that training should be provided only to those individuals in leadership roles (DeChurch & Marks, 2006; Firth et al., 2015). This is likely a function of the specific focus of these training approaches at enhancing interteam coordination. Training might also focus on other essential roles, including in particular boundary spanners. Boundary spanners are often (but not necessarily) formal leaders who communicate with multiple teams across the system (Davison et al., 2012; Shuffler et al., 2015; Vessey, 2014). Ultimately, a key consideration moving forward is determining whether training should be directed at members who serve specific roles in the multiteam system, or military occupational specialties (MOS), and if these training approaches should be catered as such.

Research Question 4. Should multiteam systems training in the Army be directed at and/or catered to members of the multiteam system based on their role?

Task, Training, and Trainee Characteristics

Training effectiveness depends in part on the influence of task, training, and trainee characteristics (Arthur et al., 2003; Bell et al., 2017; Keiser & Arthur, 2021). *Task characteristics* refer to specifics of the learning task (i.e., operator/motor or cognitive/mental tasks; Bell et al., 2017), including for instance its complexity, which guide what is trained. *Training characteristics* are readily controllable aspects of a given training program, encompassing training design, delivery, and methods (e.g., lectures and/or discussion; Arthur et al., 2003). Training characteristics receive considerable research attention given that they offer the clearest practical impact. *Trainee characteristics* encompass various attributes of the individuals who are being trained, including their individual differences (e.g., cognitive ability), attitudes and emotions, and perceptions (Bell et al., 2017).

Complicating our understanding of how these characteristics influence the effectiveness of training is the consistent finding that their effects are interactive (e.g., Arthur et al., 2003; Keiser & Arthur, 2021; Scott et al., 2004). In the subsequent discussion, task, training, and trainee characteristics are described separately because the multiteam systems literature is not advanced enough to provide specifics about the interactive effects among these characteristics. Nevertheless, it is important to acknowledge that some of these characteristics will interact to influence the effectiveness of training in multiteam systems, which should be acknowledged and accounted for in future research.

Research Question 5. In what ways do task, training, and trainee characteristics interact to influence the effectiveness of multiteam systems training in the Army?

Task Characteristics. The advantages of using a multiteam system instead of relying on a single team include a more diverse skillset and greater flexibility, which are particularly important in complex task environments (Shuffler & Carter, 2018). Most of the tasks used in the

empirical literature on multiteam systems were developed with internal validity concerns in mind, while also attempting to envisage aspects of the complex environments that are most prevalent for multiteam systems (e.g., Davison et al., 2012; de Vries et al., 2016; Lanaj et al., 2013).

Despite these efforts, the present empirical literature on multiteam systems uses tasks that are limited proxies for the complexity within which multiteam systems are most often used (Shuffler & Carter, 2018). This is particularly apparent for the Army. For instance, counterinsurgency operations utilize a complex system of teams spanning boundaries, governments, and cultures (Goodwin et al., 2012). In much the same way, the multi-domain operations framework and future battlefield will necessitate the effective performance of multiteam systems in extremely complex environments (Department of the Army, 2018, 2019a). Consequently, future research on training at enhancing the effectiveness of multiteam systems needs to better account for complex tasks that are ambiguous, multifaceted, dynamic, and time sensitive (Shuffler & Carter, 2018). This research in so doing will offer a better assessment of the degree to which training is effective at enhancing multiteam systems as they live and operate across a variety of contexts.

Research Question 6. Does multiteam systems training enhance multiteam system effectiveness in tasks that are common to the Army (i.e., ambiguous, multifaceted, dynamic, and time sensitive)?

Training Characteristics. Some of the most commonly applied and studied training characteristics include lectures, discussion, problem-based learning, case studies, behavior modeling, error management training, and simulations (Arthur et al., 2003; Bell et al., 2017; Brown & Sitzmann, 2011; Noe, 2013). This is, however, not a summative list and indeed training characteristics also include instructional media (Bell et al., 2017; Sitzmann et al., 2006), and specifics about who leads the training and training structure, among a host of other features (see Noe, 2013).

Relatively little is known about which training characteristics are best utilized in the context of multiteam systems. DeChurch and Marks (2006) and Firth et al. (2015) used common design and delivery techniques, including handouts, lecture, discussion, and video. The organizational training literature suggests that studying training design features alone provides limited value (e.g., Clark, 1994). What is more crucial is understanding the underlying mechanisms and theoretical processes of training characteristics that are more or less influential in particular contexts (Bell et al., 2017). Thus, a need moving forward is specifying those training characteristics that are particularly relevant to the theoretical underpinnings of multiteam systems (Luciano et al., 2018; DeChurch et al., 2019; Zaccaro et al., 2012). Addressing the subsequent question should be based on theoretical articulation coupled with direct empirical tests using operational multiteam systems in the Army.

Research Question 7. Which training characteristics are associated with the largest influence of multiteam systems training on multiteam system effectiveness in the Army?

Another consideration is the extent to which common training approaches can be altered to enhance multiteam system effectiveness. Most notably, teams researchers have developed various training approaches (Salas et al., 2008). Two such approaches that have received extensive support are the after-action review (AAR) and cross-training (Bell et al., 2017; Keiser & Arthur, 2021; Marks et al., 2002; Villado & Arthur, 2013). These training approaches were developed for the single team, not multiteam systems. They might be particularly adept at improving multiteam system effectiveness, but likely necessitate alterations to their associated components or characteristics to be most effective in that context. For instance, there has been considerable research attention directed at various characteristics of after-action reviews, including facilitator (self-led versus expert-led), performance review media (objective versus subjective), type of reviewed performance (failure versus success), and source of reviewed performance (personal versus canned; e.g., Boet et al., 2011; Keiser & Arthur, 2021; Tannenbaum & Cerasoli, 2013; Villado & Arthur, 2013). Application of the after-action review to multiteam systems will necessitate an understanding of the theoretical processes underlying these characteristics—feedback (Kluger & DeNisi, 1996), observational learning and behavior modeling (Bandura, 1986), and goal setting (Locke & Latham, 1990, 2002, 2006)—and their relative importance in multiteam systems (Keiser & Arthur, 2021; Villado & Arthur, 2013). Additionally, a clear practical advantage of the AAR is that it does not necessitate face-to-face interaction, and is thus amenable to distributed administration (i.e., trainees are geographically dispersed). The limited research that has examined this issue generally suggests that geographic dispersion has little impact on the effectiveness of the AAR (Jarret et al., 2016; Kring, 2004; Oden, 2009). Thus, it would appear that the AAR is a relevant training approach for multiteam systems in the Army that typically, if not summarily, consist of distributed teams.

Research Question 8. Can existing team training interventions be altered to enhance multiteam system effectiveness in the Army?

Trainee Characteristics. The multiteam system is a unique organizational form that is distinct from the individuals and teams that are comprised therein (Mathieu, 2012). Thus, trainee characteristics encompass characteristics of the individuals, constituent teams, and the larger multiteam system. Characteristics at each of these levels are likely to contribute to the effectiveness of multiteam systems training; however, there is relatively little conceptual rationale for understanding the potential ways in which these factors influence the effectiveness of multiteam systems training.

Individual Characteristics. Trainee characteristics encompass individual differences (e.g., general mental ability), attitudes and perceptions (e.g., self-efficacy), and various demographics of the individuals who complete the training (Bell et al., 2017; Brown & Sitzmann, 2011). Previous research is often directed at how these characteristics interact with instructional methods to influence training effectiveness (also referred to as the Aptitude × Treatment interaction; Brown & Sitzmann, 2011; Noe, 2013). This has not been examined in the context of multiteam systems training; however, there is little reason to believe that individual differences and their interactions with training design features will act differently in the context of multiteam systems training. This is nevertheless an empirical question that has not received any empirical investigation.

Research Question 9. How and in what ways do individual-level characteristics influence the effectiveness of multiteam systems training in the Army?

Team Characteristics. A more interesting and pertinent consideration is the extent to which both team and multiteam system characteristics influence the effectiveness of multiteam systems training. Various team characteristics have been examined as moderators of the effectiveness of team training, including composition (e.g., interprofessional and interdisciplinary), membership stability, team size, and colocation (e.g., Hughes et al., 2016; Jarrett et al., 2016; Salas et al., 2008). The influence of team characteristics on team performance and the effectiveness of training is a longstanding topic of interest in the Army (Goodwin et al., 2018). These same team-level characteristics should likewise influence the effectiveness of multiteam systems training; however, their influence is likely to be different than what is observed in the teams literature because multiteam systems are a distinct organizational entity. The specifics of these differences are unknown.

Research Question 10. How and in what ways do team-level characteristics influence the effectiveness of multiteam systems training in the Army?

Multiteam System Characteristics. Luciano et al. (2018) and Zaccaro et al. (2012) identified a variety of multiteam system characteristics that are likely to have considerable impact on the effectiveness of training approaches. Training should be less effective, but all the more essential in multiteam systems characterized by greater dynamism and differentiation because these characteristics contribute to more insular teams (DeChurch et al., 2019). In these cases, training interventions might be best tailored for leadership (DeChurch et al., 2019). Likewise, training that helps to reorient motivation toward higher-level versus proximal goals is likely to be most important when differentiation and dynamism are high (Luciano et al., 2018). More conceptual and empirical work needs to be done to better understand how multiteam system characteristics such as differentiation and dynamism (Luciano et al., 2018) and compositional, linkage, and developmental attributes (Zaccaro et al., 2012) influence the effectiveness of multiteam systems training. These considerations are especially relevant for counterinsurgency and cyberspace operations, which are characterized by high differentiation and dynamism due to a large degree of variability within and across teams over time (e.g., changes in the structure or composition of component teams).

Research Question 11. How and in what ways do multiteam system level characteristics influence the effectiveness of multiteam systems training in the Army?

Discussion

The primary purpose of this review was to provide an overview of multiteam systems, and in connection with fundamental considerations in the organizational training literature in order to identify unanswered research questions that will serve as a guide in the development of multiteam systems training. Research on multiteam systems offers clear practical impact in the Army, and is especially important given that the future operational environment and multi-domain operations will necessitate greater reliance on multiteam systems (Department of the

Army, 2018, 2019). Interest in multiteam systems has grown in recent years, despite originating in the academic literature nearly 20 years ago (see Zaccaro et al., 2020).

There are a few broad conclusions that can be drawn from the present review. First, much of the literature to date on multiteam systems has been conceptual, and thus theoretical articulation of multiteam systems is fairly detailed and increasingly complex (Luciano et al., 2018; Rico et al., 2017, 2018; Zaccaro et al., 2012). There are, however, some notable oversights in this theoretical work, including in particular little theoretical articulation about what constitutes multiteam system effectiveness (for one exception, see Mathieu et al., 2018). Rather, researchers typically focus on factors within and outside of multiteam systems that are purported to influence its effectiveness (Luciano et al., 2018; Rico et al., 2017, 2018; Zaccaro et al., 2012).

Second, the empirical research literature is comparatively limited, typically experimental, lab-based, and largely discounts the complexity of how multiteam systems operate in real-world settings (see also Shuffler et al., 2015; Shuffler & Carter, 2018). Indeed, one of the defining characteristics of multiteam systems is its application to complex and ambiguous environments (Shuffler & Carter, 2018). The limited empirical research on multiteam systems is likely due in part to the very complexity of the topic itself and the challenges of studying the vast number and nature of multiteam systems as they live and operate. The extant research literature thus provides a deficient understanding of multiteam systems. Relatedly, whereas researchers have made considerable progress in articulating the theoretical processes underlying the effectiveness of multiteam systems (Luciano et al., 2018; Rico et al., 2017, 2018; Zaccaro et al., 2012), there has yet to be an empirical research study that directly examines the claims inherent in these theoretical frameworks (Zaccaro et al., 2020).

The third broad conclusion based on this review is that research on multiteam systems has largely ignored some of the more impactful practical considerations that have been the focus of extensive research in the teams literature, one of which is training. The aforementioned limitations of the multiteam systems literature are not uniquely discussed here (see also Mathieu et al., 2018: Shuffler et al., 2015; Shuffler & Carter, 2018; Zaccaro et al., 2020), and thus the contribution of this review is in relying on the organizational training literature. A detailed review of the multiteam systems literature revealed that there is limited theoretical articulation about training in multiteam systems, and only a few studies that have applied and empirically examined the effect of specific training approaches at enhancing multiteam system effectiveness (i.e., DeChurch & Marks, 2006; Firth et al. 2015). This is a considerable oversight in the academic literature on multiteam systems that is relevant to the Army, which relies heavily on multiteam systems and spends considerable time and money on training.

Fourth, the organizational training literature offers notable insight about how to design and develop training to enhance the effectiveness of multiteam systems, including exemplar training approaches (e.g., after-action reviews, cross-training). However, the training literature also suggests that there are a number of essential preliminary steps toward the development of training, including in particular a needs analysis, a determination of training criteria, level, and focus, and an understanding of task, training, and trainee characteristics (Bell et al., 2017; Brown & Sitzmann, 2011; Noe, 2013; Salas et al., 2012). Research that aligns with these practices and

aims to provide answers to the associated questions will provide the rigorous basis toward the development of training that enhances the effectiveness of multiteam systems in the Army.

Glossary of Key Terms

Compositional attributes: The overall demographic features of the MTS, as well as the relative characteristics of the component teams (Zaccaro et al., 2012, p. 13).

Developmental attributes: The characteristics of MTS pertaining to their developmental dynamics and patterns (Zaccaro et al., 2012, p. 20).

Differentiation: The degree of difference and separation between the component teams at a particular point in time (Luciano et al., 2018, p. 1071).

Dynamism: The variability and instability of the [multiteam] system over time (Luciano et al., 2018, p. 1076).

Explicit coordination: Overt communication-based efforts to align different component teams (Rico et al., 2018, p. 336).

Functional interdependence: A state by which entities have mutual reliance, determination, influence, and shared vested interest in processes they use to accomplish work activities (Mathieu et al., 2001, p. 293).

Goal choice: What a multiteam system chooses to do (Chen & Kanfer, 2006; Rico et al., 2017).

Goal striving: The strategies by which a multiteam system seeks to accomplish goals (Chen & Kanfer, 2006; Rico et al., 2017).

Hierarchical integration mechanisms: Bring together needs that transcend particular component teams with the authority to make decisions in defining other component teams' operating context (Rico et al., 2018, p. 335).

Implicit coordination: Team members anticipate the actions and needs of their colleagues and the task demands, dynamically adjusting their behavior without directly planning or communicating with each other (Rico et al., 2018, p. 336).

Interteam processes: Between-team processes in multiteam systems (Zaccaro et al., 2012).

Intrateam processes: Within-team processes in multiteam systems (Zaccaro et al., 2012).

Lateral integration mechanisms: Aim to coordinate activities horizontally across the same hierarchical level (Rico et al., 2018, p. 336).

Linkage attributes: The different kinds of linking mechanisms that connect component teams (Zaccaro et al., 2012, p. 18).

Multiteam system: Two or more teams that interface directly and interdependently in response to environmental contingencies toward accomplishment of collective goals. MTS [multiteam system] boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in doing so exhibit input, processes and outcome interdependence with at least one other team in the system (Mathieu et al., 2001, p. 290).

Needs analysis: The process used to determine if training is necessary (Noe, 2013, p. 114).

Team processes: [Team] members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing taskwork to achieve collective goals (Marks et al., 2001, p. 357).

Team: Two or more individuals working together to achieve a common goal (Baker & Salas, 1997).

Training: A formal, planned effort to help employees gain job-relevant knowledge and skills (Brown & Sitzmann, 2011, p. 469).

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