Coordinating Knowledge: A New Lens to Understanding the Role of Technology in Episodic Coordination FREE

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Summary

Previous research in coordination lacked a practical explication of the metaknowledge used to enact coordination, which is particularly problematic as more coordination processes become (or attempt to become) digitized. One can better understand this meta knowledge by focusing on the coordination episode. The authors of this article define coordinating knowledge as knowledge that facilitates the exchange of information between two or more actors in order to achieve a shared goal by guiding (a) the timing, (b) the selection of actors, (c) the content, and (d) the method of the exchange. By integrating four bodies of literature (structured mechanisms, domain expertise, team familiarity, and transactive memory systems) that provide important insights into coordination the authors anatomize the framework into 14 specific types of coordinating knowledge that can impact how a coordination episode is enacted and its outcomes. Specifically, coordinating knowledge about triggers refers to knowledge indicating a need to initiate a coordination episode and may take the form of time-scheduled triggers, event-sequence triggers, and emergent triggers. Coordinating knowledge about actors refers to knowledge that helps select with whom to coordinate and may take the form of role, assignment, or individual knowledge about actors. Coordinating knowledge about content refers to knowledge that either helps select or present content shared during the coordination episode and may take the form of predetermined content selection or presentation, emergent content selection, recipient-tailored content selection, and shared understanding. Finally, coordinating knowledge about method refers to knowledge that helps select the appropriate medium of communication for a coordination episode and may take the form of predetermined method selection, media-fit method selection, or recipient-tailored method selection. Coordinating knowledge is conceptualized as a profile construct with meaningful combinations of coordinating knowledge that can be used to address different coordination dependencies and other contingencies. This conceptual framework affords a new understanding of how coordination is enacted and opens avenues to future research to explore how the presence and utilization of specific types of coordinating knowledge are likely to impact coordination performance. By explicating and elaborating upon coordinating knowledge, scholars and practitioners will be better positioned to design information systems to aid in the exchange of information by embedding different types of coordinating knowledge. Thus, the coordinating knowledge lens will be useful in understanding the evolving role of technology in coordination processes.

Keywords: coordinating knowledge, coordination process, digitized processes, coordination performance, coordination episodes

Subjects: Information Systems, Organizational Behavior

Understanding the Enactment of Coordination

Coordination has long been recognized as an important concept in understanding and predicting organizational performance (Argote, 1982; Gittell, 2002; Malone & Crowston, 1994; Okhuysen & Bechky, 2009; Rico et al., 2008; Willem et al., 2006). Modern organizations increasingly rely on teams of specialized experts, each bringing specific knowledge and information that is vital for successful completion of the team's task (Child & McGrath, 2001; DeSanctis & Monge, 1999; von Nordenflycht, 2010). Such experts often operate in dynamic contexts and must coordinate efforts to leverage each other's expertise in order to perform well (Faraj & Sproull, 2000; Faraj & Xiao, 2006; Gardner et al., 2012). While research on coordination (see Okhuysen & Bechky [2009] for a review) has significantly elevated our understanding of coordination, it has primarily viewed coordination as a whole rather than examining how coordination is enacted at an episodic level. The authors of this article suggest that complementary insights can be gained by examining coordination at this more granular level.

Conceptualizing coordination as a series of *coordination episodes* brings to the foreground the specific types of behaviors and associated metaknowledge that are required to *enact* coordination. Focusing on the microlevel of the coordination episode enables us to understand how the enactment of coordination may often involve a complicated amalgamation of several previously described coordination influences and patterns. It may, simultaneously, combine elements of routinization (e.g., Cohen & Bacdayan, 1994; Feldman & Pentland, 2003; Grant, 1996), implicit team patterns (e.g., Espinosa et al., 2004; Rico et al., 2008), transactive memory systems (TMS; e.g., Hsu et al., 2012; Ren & Argote, 2011; Zhang et al., 2007), relational coordination (e.g., Gittell, 2002; Gittell, 2016), and improvisation (e.g., Bechky & Okhuysen, 2011; Harrison & Rouse, 2014; Majchrzak et al., 2007).

To be successfully enacted, each coordination episode requires accurate knowledge of *when* to coordinate, with *whom* to coordinate, *what* to coordinate, and *how* to coordinate. The authors term this metaknowledge *coordinating knowledge*. The focus of this article is to elaborate upon coordinating knowledge and develop and describe its specific types. To do so, the authors leverage insights from prior coordination research (e.g., structured coordination, domain expertise, team familiarity, and transactive memory systems) to develop 14 specific types of coordinating knowledge that inform the when, who, what, and how to coordinate in each coordination episode. The coordinating knowledge framework provides us a new language and lens with which to study coordination and a foundation for future research to understand what types of coordinating knowledge may be embedded into technology.

This granular view of the metaknowledge necessary to enact a coordination episode also positions us to make sense of how previously identified important factors in coordination (e.g., structured coordination, domain expertise, team familiarity, and transactive memory systems) *coexist and interplay* to shape enacted coordination episodes. It is a rare situation where coordinating knowledge described in only one of these bodies of literature influences a coordination episode. It is far more likely that a coordination episode is shaped by a confluence of multiple, divergent influences—the influence of each perspective can be understood by

recognizing how it is the origin of some of the coordinating knowledge necessary to enact that particular coordination episode. The coordinating knowledge framework provides a platform to understand how these disjointed forces coexist and what tensions may arise when conflicting pieces of coordinating knowledge are present. Coordination performance is the result of the coordinating knowledge used to shape each episode, so we are positioned to understand how to enhance the efficiency and effectiveness of coordination.

Furthermore, as work continues to shift towards digitization of coordination processes (Claggett & Karahanna, 2018), it often involves the embedment of coordinating knowledge into information systems. For example, a report may be automatically forwarded to the email address of the worker assigned to the project or the completion of one task may prompt a coordination episode in the form of an automated notification. Coordinating knowledge provides the scaffolding for us to understand how technology can automate, augment, or hinder the coordinating knowledge being brought to bear in a coordination episode. This foundational understanding is a helpful lens as technologies, such as machine learning, become able to generate new coordinating knowledge and leverage it to facilitate coordination episodes.

An Episodic View of Coordination

Coordination theory suggests that an actor engages in (a) processes necessary to achieve the task-related goal (i.e., a task that creates a good or performs a service) as well as (b) processes that serve to primarily manage interdependencies (Malone & Crowston, 1994). In studying coordination, the authors of this article focus on the second set of engagements and consider individual coordination episodes as the level of analysis. They confine their research to coordination that involves the *exchange of information*, as this type of coordination is likely to take place over technology, providing new opportunities to understand how technology may impact the process. Splitting up processes into subprocesses for greater understanding of the phenomenon is certainly not new to management research. An episodic framework has been used to develop a taxonomy of team processes (Marks et al., 2001) and to understand performance as it unfolds via a series of episodes (Mathieu & Schulze, 2006). When knowledge workers coordinate, a coordination episode is usually a situation where information is shared between two or more actors (Boden, 1994; Quinn & Dutton, 2005). The authors follow in this tradition and define a coordination episode as a single episode in which the actors engage in actions necessary to manage interdependencies by sharing information with other actors, in order to reach their goal.

Achieving the outcome of interest often necessitates a series of coordination episodes. For example, suppose a patient is admitted to a hospital for heart surgery. There is likely to be a long series of coordination episodes between the nurses, the cardiologist, and the hospitalist involved in his treatment. Each coordination episode is an episode in a larger coordination series, where the goal is to support and improve patient care. The healthcare treatment delivery has a tangle of interdependencies, as it results from a series of decisions and tasks that the healthcare professionals make that benefit from successful coordination episodes between the experts. By considering coordination at the granularity of a single instance, we are able to unpack the *enactment* of coordination at a level of detail that is impractical when coordination is studied as an

aggregate of the series of instances. It brings to the foreground metaknowledge, both human-known and that programmed into technology, that is used during coordination, which allows us to contrive the coordinating knowledge framework.

Defining Coordinating Knowledge

Recent work has suggested that coordination be defined as "a temporally unfolding and contextualized process of input regulation and interaction articulation to realize a collective performance" (Faraj & Xiao, 2006, p. 1157; Okhuysen & Bechky, 2009), which yields an appreciation for the complexity of the situations in which coordination occurs. Gittell and Weiss (2004, p. 132) explain that coordination "is fundamentally about the connections among interdependent actors who must transfer information and other resources to achieve outcomes," highlighting the fundamental importance of *actors* in coordination and the transfer of *content* between them (Claggett & Karahanna, 2018). Faraj and Xiao (2006) suggest that a reconceptualization of coordination should focus on the *content* and *circumstances* of coordination and Malhotra et al. (2021) describe knowledge exchange as requiring "that participants decide what and when to share their knowledge (p. 1375)." Looking across these descriptions, the authors suggest that at an episodic level, coordination occurs between two or more *people*, at a *specific time*, when they share *specific content* via a *method of communication*. Consequently, they conceptualize four major *components* which all need to be known for a coordination episode to be enacted: (a) the trigger, (b) the actors, (c) the content, and (d) the method.

Thus, they define coordinating knowledge as knowledge that facilitates the exchange of information in order to achieve a shared goal by guiding the selection of the timing, actors, the content, and the method of the exchange. Coordinating knowledge is what needs to be known in order to engage in a coordination episode—that is, with whom to coordinate, when to do so, what to communicate, and how to communicate in order to manage a specific interdependency. For a coordination episode to occur, these coordinating knowledge components need to be either known by a person engaging in the episode or be embedded in a process or system.

While the coordinating knowledge framework (specifying the metaknowledge involved to engage in a coordination episode) is novel, prior research involving coordination mechanisms, transactive memory systems, domain expertise, and team coordination yields insights into where and how users develop their knowledge of when to coordinate, with whom to coordinate, what to coordinate, and how to coordinate (see Figure 1).

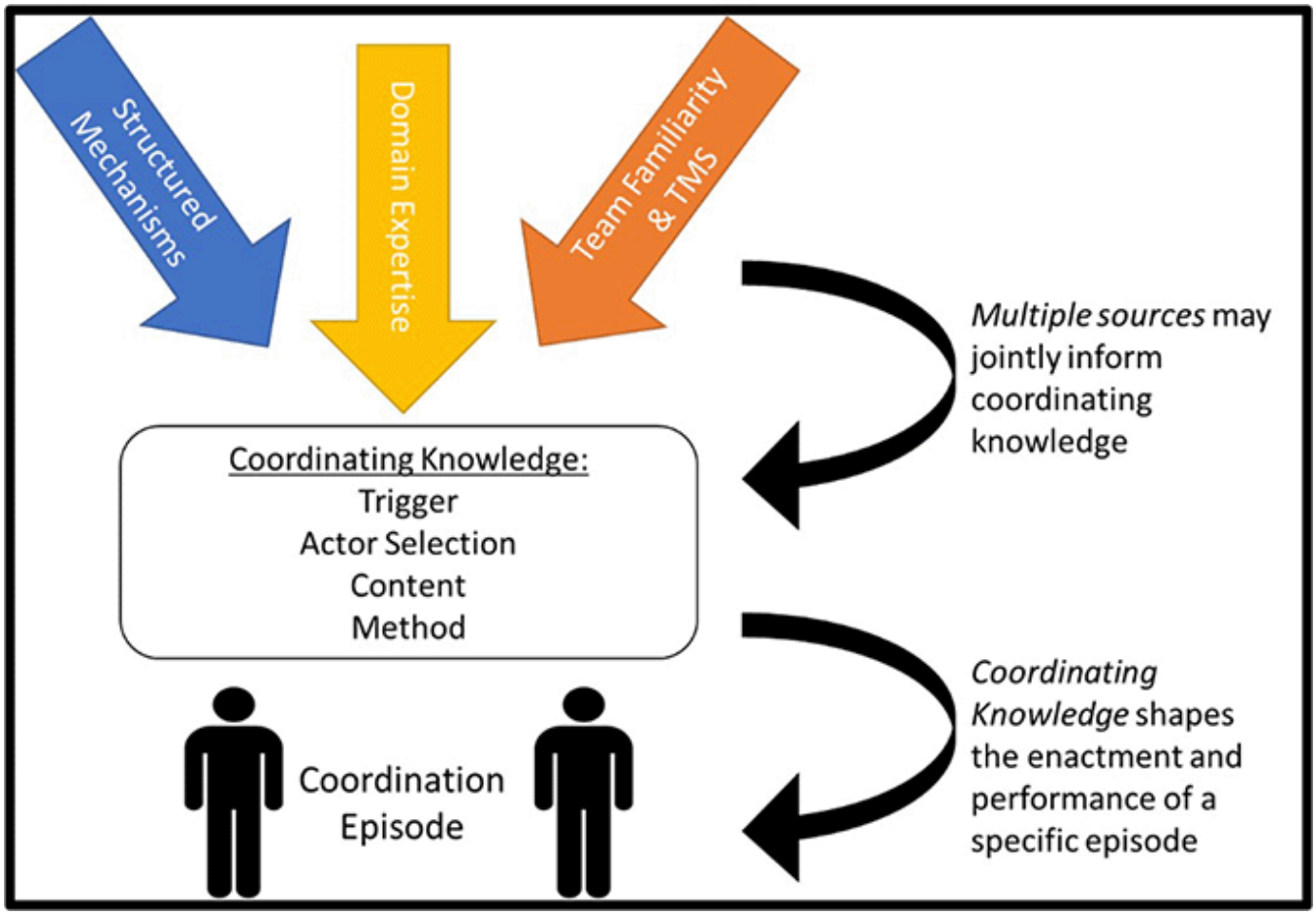

Figure 1. The sources, components, and role of coordinating knowledge.

Structured Coordination Mechanisms

Previous research has characterized coordination into dichotomous pairs, such as programmed vs. unprogrammed (Argote, 1982; March & Simon, 1958; van de Ven, 1976; Willem et al., 2006), standardized vs. mutual adjustment/feedback (Adler, 1995; Malone & Crowston, 1994; Orlikowski, 1996; Thompson, 1967), formal vs. informal (Brown, 1999; Sherif et al., 2006; Tsai, 2002), and mechanistic vs. organic (Andres & Zmud, 2001). The distinction between these pairs is similar; one side favors a structured plan of coordination while the other favors an unstructured, somewhat impromptu coordination style (Claggett & Karahanna, 2018).

Structured coordination is often implemented by organizations through coordination mechanisms (Simon, 1957). Coordination mechanisms are the "organizational arrangements that allow individuals to realize a collective performance" (Okhuysen & Bechky, 2009, p. 472) and seek to address the structured means (Mintzberg, 1979) or formal organizational arrangements (Okhuysen & Bechky, 2009) that allow individuals to coordinate. While coordination mechanisms have been operationalized broadly in the literature, some common examples include routines or procedures (Gittell, 2002; Mintzberg, 1979; Okhuysen & Bechky, 2009; Simon, 1957; Thompson, 1967), rules (Argote, 1982; Okhuysen & Bechky, 2009), and meetings (Argote, 1982; Gittell, 2002). These provide an actionable mechanism that can guide individual episodes of coordination by

offering coordinating knowledge. For example, if a rule states that the physician must be notified if a patient's fever exceeds a specific temperature, that provides the trigger (the fever threshold), the actor (the physician on duty), the content (the patient's fever condition), but not necessarily the method (must the physician be told in person? a note in the hospital software? a text message or page?). Therefore, we understand coordination mechanisms to provide (often partial) blueprints of how to enact a coordination episode.

Structured coordination mechanisms are a source of coordinating knowledge where coordination episodes have been, at least partially, routinized. However, it is important to note that structured coordination mechanisms do not necessarily define all the components of coordinating knowledge for an episode. An episode of coordination may inherit some structured components from a routine or process, but other components may be left unstructured and be decided via some other source of coordinating knowledge (Claggett & Karahanna, 2018). This reexamination of coordination mechanisms from a coordinating knowledge vantage point elucidates that the original dichotomization of "structured vs. unstructured" coordination breaks down and may not accurately describe how coordination is achieved.

Domain Expertise

Managers have long since known that the presence of expertise on a team usually leads to performance improvements. There are two aspects involved in realizing these performance improvements: the inherent value of the expertise in completing the goal and the degree to which the expertise is fully accessed and coordinated (Gardner et al., 2012; Wegner, 1986). Certainly, the inherent value of expertise is greatly tied to the ability of that actor to perform the tasks necessary to realize the shared goal. A heart surgeon has the expertise necessary to perform heart surgery, which is of paramount importance to taking care of a patient that needs heart surgery. However, the authors suggest that another benefit of domain expertise is that it can manifest as coordinating knowledge—it provides additional information in deciding when and what is important to coordinate. Perhaps a heart surgeon's domain expertise allows him to recognize a subtle patient symptom that demands an immediate consult with a nephrologist, sparking important coordination between the nephrologist and the heart surgeon. Superior information improves decision-making (March, 1991), and coordination is often reliant on individual actors making decisions about when, how, and with whom to enact a coordination episode.

Team Familiarity and Transactive Memory Systems

Another aspect of leveraging expertise is summarized by work in transactive memory systems (TMS)—the importance of knowing where to go in the group for certain types of expertise (Kanawattanachai & Yoo, 2007; Lewis, 2003; Wegner, 1986). Recognition of specific areas of expertise is an important part of teamwork (Grant, 1996) and personal experience with individuals helps build knowledge about what expertise each individual possesses, especially as

teams develop (Jarvenpaa & Majchrzak, 2008; Pearsall et al., 2010). The existence of TMSs is known to enhance coordination and the coordinating knowledge framework provides a lens to understand how that benefit might be realized.

In addition to having expertise and knowing where it exists in the network, the relationships between the team members may have profound effects on coordination. Team familiarity is the understanding that team members have of one another and has been shown to improve general team performance (Espinosa et al., 2007b; Goodman & Leyden, 1991; Reagans et al., 2005). The knowledge that informs a team member about the nuanced expertise, habits, and preferences of another team member can inform coordination and it usually enhances over time spent together in a team. In fact, length of time spent working with one another is assumed to affect performance so much so that "team longevity" is a common control variable in team performance studies (Jansen et al., 2005; Zhang et al., 2007). The importance of the relationship and communication style is also found in relational coordination, which looks at the mediating effect of relationships among team members on coordination quality (Gittell, 2002). In some situations, familiarity enables an actor to anticipate other team members' needs and task demands (informing the when, what, and how to coordinate) and dynamically adjust his or her own behavior in order to implicitly coordinate (Rico et al., 2008).

These streams of research show convincing evidence that structured coordination, domain expertise, and team familiarity (including TMS) are important to coordination. The authors suggest that their importance derives at least to some extent because they serve as salient sources of coordinating knowledge. Coordinating knowledge for a coordination episode can be the result of one or more of these sources and different components of coordinating knowledge for an episode can each be derived from a different source.

Coordinating Knowledge Components and Types

We now elaborate the coordinating knowledge framework by describing each of its four components (trigger, actor, content, and method) and identifying the various types of coordinating knowledge for each. These 14 specific components are summarized in Table 1.

Table 1. Coordinating Knowledge Types and Definitions

Component	Specific Types (Source)	Definition: Coordinating Knowledge . . .
Triggers (when): refers to knowledge indicating a need to initiate a coordination episode	Time-schedule triggers (S)	. . .about a temporal plan that informs when to initiate an exchange of information
	Event-sequence triggers (S)	. . .about the order of related activities that informs when to initiate an exchange of information

Component	Specific Types (Source)	Definition: Coordinating Knowledge . . .
	Emergent triggers (D)	. . .that allows an actor to recognize novel and previously unpredicted needs to initiate an exchange of information
Actors (who): refers to knowledge that helps select with whom to coordinate	Role (D)	. . .about the functional position and the skills and abilities that this position implies of an actor that informs the selection of an actor with whom to exchange information
	Assignment (S)	. . .about a person's designated task, case, or post that informs the selection of an actor with whom to exchange information
	Individual (T/M)	. . .about a particular person's skills, capabilities, traits, or situation that informs the selection of an actor with whom to exchange information
Content (what): refers to knowledge that either helps select or present the content shared during the coordination episode	Predetermined content selection (S)	. . .about preexisting routines that guide the selection of specific pieces of information to include during the exchange of information
	Emergent content selection (D)	. . .that allows an actor to recognize novel and previously unpredicted pieces of information to include during the exchange of information
	Predetermined content selection (S)	. . .about other team members that allows an actor to anticipate pieces of information to include during the exchange of information
	Emergent content selection (D)	. . .about preexisting routines that informs the presentation of information during the exchange of information
	Predetermined content selection (S)	. . .about shared norms and mental models that informs the presentation of information during the exchange of information
Method (how): refers to knowledge that helps select the appropriate medium of communication for a coordination episode	Predetermined method selection (S)	. . .about preexisting routines that informs the selection of a medium of communication to use during the exchange of information

Component	Specific Types (Source)	Definition: Coordinating Knowledge . . .
	Media-fit method selection (D)	. . .about the situation and the media capabilities that informs the selection of a medium of communication to use during the exchange of information by matching the media capabilities with the needs of the situation
	Recipient-tailored method selection (T)	. . .about a team member's media style preferences or situation that informs the selection of a medium of communication to use during the exchange of information

Note: Source codes are (S) for structured mechanism, (D) for domain expertise, (T) for team familiarity, and (M) for TMS.

Coordinating Knowledge About When: Triggers to Coordination

Before a coordination episode occurs, something must cause an actor to start the process. Little attention has been paid to the circumstances that surround and prompt coordination (Faraj & Sproull, 2000; Faraj & Xiao, 2006), but it is important to understand the coordinating knowledge needed to initiate coordination. Coordinating knowledge about triggers refers to knowledge indicating a need to initiate a coordination episode. Previous literature has recognized the distinction between scheduled and unscheduled meetings (Hage, 1974; Hage et al., 1971; van de Ven, 1976) and the importance and limitations of spontaneous, emergent communications (Massey et al., 2003). These previous findings suggest there can be predictable triggers (i.e., structured) and emergent triggers that initiate coordination.

Within the predictable trigger category are time-triggers and event-triggers (Broekhuis & van Donk, 2011). Coordination episodes can be scheduled to occur at a specific time, such that their occurrence is expected and anticipated. The knowledge regarding a temporal plan that informs when to initiate an exchange of information is known as coordinating knowledge about time-schedule triggers. For example, a team may always have a meeting to discuss current patients every morning at 8 o'clock. An alternative predictable trigger type is when coordination always occurs as part of a larger business process, such that the sequence of events triggers the coordination. For example, suppose a hospital's procedure for transferring a patient between departments always includes a form that the releasing physician must fill out and send to the accepting department. In these cases, knowledge about the sequence of events triggers the coordination in a predictable way; if X occurs then Y coordination follows. The authors define coordinating knowledge about event-sequence triggers as knowledge regarding the order of related activities that informs when to initiate an exchange of information.

However, there may be triggers that materialize due to situational circumstances that are not explained by predictable, structured triggers. These coordination episodes occur due to judgment calls and team interactions of the experts involved and are related to what others have observed as spontaneous communication opportunities that improve team coordination (Espinosa et al., 2007b; Hinds & Mortensen, 2005; Massey et al., 2003). For example, suppose a nurse recognizes that a patient's subtle change in appetite and energy may indicate a more serious health concern given the patient's other health conditions. The nurse decides to contact a physician about the situation, even though it is not part of a scheduled or routine communication. The interpretation of the unusual symptoms by the nurse served as an emergent coordination trigger derived from domain expertise. The authors define coordinating knowledge about emergent triggers as knowledge that allows an actor to recognize novel and previously unpredicted needs to initiate an exchange of information.

Coordinating Knowledge About Who: Selecting the Actors Involved

The next set of coordinating knowledge the authors explore is coordinating knowledge about actors, that is, knowledge that helps an actor know with whom to coordinate. Although there is substantial evidence that knowing who holds specific expertise and relevant knowledge to the task at hand leads to better coordination (and ultimately performance) (Kogut & Zander, 1996; Lewis & Herndon, 2011; Wegner, 1986), this literature has not clearly explicated the types of knowledge that allow for this advantage. The authors suggest that there are three types of coordinating knowledge that aid an actor in knowing who holds relevant expertise and knowledge: coordinating knowledge about (a) role, (b) assignment, and (c) individual.

The growing complexity of organizations forces division of labor and a logical way of dividing labor is by specialties or roles (Kogut & Zander, 1996). A role describes the functional group the actor is part of and helps signal to other actors what knowledge the actor has and what functions he can perform (Bechky, 2006; Lewis & Herndon, 2011). Consider a situation where a nurse recognizes a patient's loss of appetite and knows the appropriate role (perhaps a nutritionist) with whom to coordinate. This can be seen as a form of domain expertise to understand the relevant roles and when to seek them out. This coordinating knowledge about role is defined as knowledge regarding the functional position and the skills and abilities that this position implies of an actor that informs the selection of an actor with whom to exchange information.

Another important circumstance that occurs within many team contexts is that of functional assignment to specific cases (Cummings, 2004). In early work on the problem of coordination, it was recognized that dependencies may arise from the assignment of activities to actors (Crowston, 1997). A common situation in hospitals is that each patient will have an assigned nurse and an assigned hospitalist during each shift. Consider the situation where a physician needs to coordinate with a nurse about a patient's medication. That type of coordination needs to involve not just any nurse (role), but the nurse assigned to the patient in question (assigned role). The first condition for assignment-based selection is for an actor to know that assignments exist in the situation. Second, in order to use these assignments in coordination episodes, an actor must know the relevant assignment at the moment of a coordination episode (e.g., Nurse Collins

is assigned to patient Jim Blake). Assignments are a form of structure and help plan coordination needs a priori. The authors refer to this type of coordinating knowledge as coordinating knowledge about assignment and it is defined as knowledge regarding a person's designated task, case, or post that informs the selection of an actor with whom to exchange information.

Prior literature, most notably work in TMS, has discussed the necessity of knowing the location of specific expertise in a team beyond typical role or assignment categories (Hollingshead, 2001; Jarvenpaa & Majchrzak, 2008; Kanawattanachai & Yoo, 2007; Majchrzak et al., 2007; Ren & Argote, 2011). Initial work described the process of building a TMS as encoding the location of knowledge by memorizing what each team member might know (Wegner, 1986), which is a form of team familiarity. Actors can also be chosen because a person knows something about that individual actor, not necessarily related to their role or assignment. The recognition of individual knowledge domains is an important tool of teamwork (Grant, 1996) and social ties between members help an individual know "where to go" in the network for knowledge (Hansen, 1999). For example, suppose a hospitalist sees a concerning heart problem in an elderly patient and decides coordination with a cardiologist (role) is necessary. However, when enacting this coordination episode he selects cardiologist Patel over cardiologist Singh, because he knows that cardiologist Patel (individual) is particularly knowledgeable about heart conditions in older patients. Or perhaps he selects cardiologist Singh because he knows that Patel is tied up in surgery all day (individual). Knowing about individualized team member areas of expertise, experience, availability, situation, and preferences is an example of coordinating knowledge that may be used in addition to selection based on role, or on its own, and is informed by team familiarity and the presence of TMSs. Coordinating knowledge about individuals is defined as knowledge regarding a particular person's skills, capabilities, traits, or situation that informs the selection of an actor with whom to exchange information.

Coordinating Knowledge About What: Selecting and Formatting the Content

At the heart of each coordination episode is content that must be shared between two or more team members. There are two groups of decisions that must be made regarding the content that necessitate coordinating knowledge: the selection of the content and the presentation of the content. Therefore, the authors define coordinating knowledge about content as knowledge that either helps select or present the content shared during the coordination episode. Both decisions can be informed by coordinating knowledge derived from predetermined routines and procedures (i.e., structured coordination) (e.g., Argote, 1982; March & Simon, 1958; Willem et al., 2006).

For example, suppose a normal routine is for a nurse ending a shift to meet with the nurse taking over his or her patients during the next shift. Part of this routine is for the exiting nurse to record the information and then generate a report from the hospital software that lists which medications were administered and when. The format of the report is that the information is grouped by patient name and the medicine and name, quantity, and timestamp of administration are printed. The medication information (the content) and the format (the report layout) has been predetermined and the nurses know to (and expect to) share that content in that specific way. In this example we see that coordinating knowledge about predetermined content refers to

knowledge regarding preexisting routines that guide the selection of specific pieces of information to include during the exchange of information. We also see evidence of coordinating knowledge about predetermined presentation and define it as knowledge regarding preexisting routines that informs the presentation of information during the exchange of information.

Coordinating knowledge informing content selection and presentation can also result from experience working with the team and customizing content with the intended recipient in mind (Gardner et al., 2012; Rico et al., 2008). For example, the actor selects content because he or she knows something about the work preferences of that particular expert (e.g., Dr. Xui always wants the last three blood pressure readings, even though the form asks only for the last one). It can also occur if the actor anticipates what a person will need because of the type of expertise that person has (e.g., urologists will always want a copy of these particular lab results). Both of these examples utilize coordinating knowledge about recipient-tailored content, which the authors define as knowledge about other team members that allows an actor to anticipate pieces of information to include during the exchange of information.

Team familiarity can also result in coordinating knowledge about how to present information during coordination, due to shared understanding and vocabulary (Clark & Marshall, 1981; Gardner et al., 2012; Krauss & Fussell, 1991). Groups establish communication norms that are used when presenting content during coordination (Gittell, 2002). These communication norms occur when actors share common mental models. Mental models are held internal images about how the world works, that in turn influence how new information is processed and how previously stored information might be relevant to a particular situation (Kim, 1993). Mental models are different from static memory because they provide the context by which the world is viewed. Individuals operating in similar contexts (i.e., the healthcare industry) or in the same organization (i.e., a certain hospital) are likely to have shared mental models, meaning that there are significant similarities between individuals' mental models (Cannon-Bowers et al., 1993; Kim, 1993; Klimoski & Mohammed, 1994). This lets them interpret information in a similar way. Shared mental models allow for shared language, taken-for-granted understandings and implications, and nuances in vocabulary (Madhavan & Grover, 1998).

For example, vitals of a patient could be presented as "James Jones, in ICU room 5, was found to have especially high blood pressure this morning. I took a reading at 8 a.m. and found his systolic pressure to be 160 mmHG and his diastolic pressure to be 110 mmHG." However, in a team used to coordinating patient blood pressure, and familiar with blood pressure ranges, measurement units, etc., this same information might be presented in abbreviated form as, "ICU #5—8 a.m.—BP: 160/110." In our example, due to shared understanding, the actor chooses to present the blood pressure information in a very succinct format and use abbreviations like "BP" that he believes will be understood by the receiving actor. The authors refer to this type as coordinating knowledge about shared understanding and define it as knowledge regarding shared norms and mental models that informs the presentation of information during the exchange of information.

The final type of coordinating knowledge the authors consider pertaining to the content is emergent content. Sometimes actors utilize this type of coordinating knowledge to select additional, ad-hoc information to share during coordination. For example, the added content might be an anomaly in a patient's behavior a nurse believes merits further observation. An actor

can possess domain expertise that allows him or her to recognize content that is relevant and useful as it emerges from the situation. When actors make decisions about the selection of content in this manner, the authors refer to it as coordinating knowledge about emergent content and define it as knowledge that allows an actor to recognize novel and previously unpredicted pieces of information to include during the exchange of information.

Coordinating Knowledge About How: Choosing the Method

Coordination transmits information between two or more actors in order to manage interdependencies (Broekhuis & van Donk, 2011; Malone & Crowston, 1994), but the methods that the actors select to transmit the information can vary greatly. A method can be thought of as the vehicle which transmits the information between the two actors. In a healthcare setting, just like most organizations, there are often multiple ways for team members to communicate. E-mail, phone calls, in-person conversations, text messages, and specialized industry software (e.g., Electronic Health Records solutions in hospitals) all offer ways for two actors to coordinate. The authors define coordinating knowledge about method as knowledge that helps select the appropriate medium of communication for a coordination episode. The authors identify three types of coordinating knowledge related to selecting the coordination method: (a) coordinating knowledge about predetermined method, (b) coordinating knowledge about media-fit method, and (c) coordinating knowledge about recipient-tailored method.

Coordinating knowledge about predetermined method is often embedded in a structured coordination mechanism. It is similar to the previous two types of predetermined coordinating knowledge. For example, a coordination routine may exist that dictates a weekly, in-person meeting occurs between the ICU nurses. Within this routine is the implicit decision that the method of coordination will be verbal communication. The authors refer to this as coordinating knowledge about predetermined method and define it as knowledge regarding preexisting routines that informs the selection of a medium of communication to use during the exchange of information.

The second type of coordinating knowledge that may guide the selection of the coordination method involves the understanding of what media best fit the nature of the coordination from the choices available. There is a rich body of literature that studies media choice (Carlson & Zmud, 1999; Daft & Lengel, 1986; Dennis et al., 2008; Straub & Karahanna, 1998; Te'eni, 2001; Watson-Manheim & Bélanger, 2007). Performance gains are expected when the communication media capabilities match the requirements of the task. For example, media richness refers to the capacity of the medium to overcome diverse frames of reference in order to support communication across channels and allow actors to coordinate (Daft & Lengel, 1986). When selecting a method to coordinate, actors are thus likely to consider the equivocality of the information to exchange and select a medium that matches the information requirements of the communication (Daft & Lengel, 1986). Actors are also likely to consider both urgency of the communication and availability of the recipient in order to achieve task closure (Straub & Karahanna, 1998) as well as five key media capabilities: transmission velocity (speed the content is shared at), parallelism (amount of messages from amount of participants at a given time),

symbol sets (different ways the medium allows the content to be encoded), rehearsability (amount the medium allows the sender to craft and recraft the message before sending), and reprocessability (how many times the receiver can process or replay the message) (Dennis et al., 2008). This is coordinating knowledge about media-fit method and is defined as knowledge regarding the situation and the media capabilities that informs the selection of a medium of communication to use during the exchange of information by matching the media capabilities with the needs of the situation.

The final type of coordinating knowledge that informs the selection of the coordination method is knowledge of recipient media style or preferences. Individuals have personal styles and use some media differently (e.g., more frequently) than others, in ways that are not attributable to task or organizational variation (Karahanna & Limayem, 2000). Knowing the habits and preferences of team members regarding technology media can influence the selection of the method of coordination. For example, perhaps one team member checks his email every five minutes whereas another checks it only a couple of times a shift. An actor may consider email a viable method in an urgent situation when coordinating with the first team member, but not the second. Also, knowing what they prefer and are more likely to respond to might make a certain method the better choice, above and beyond considering the technology traits. The authors refer to this instantiation of team familiarity as coordinating knowledge about recipient-tailored method and define it as knowledge regarding a team member's media style preferences or situation that informs the selection of a medium of communication to use during the exchange of information.

Coordinating Knowledge as a Profile Multidimensional Construct

We have identified and defined 14 specific types of coordinating knowledge. Given the four components of coordinating knowledge (trigger, actors, content, and method) and their various types, there are numerous combinations of coordinating knowledge that can be used to inform an episode. One coordination episode may leverage an emergent trigger, role-based actor selection, emergent content selection, and media-fit method selection, while another may use a time-schedule trigger, assignment actor selection, predetermined and emergent content selection, and predetermined method selection.

While multidimensional constructs can take many forms (see Law et al., 1998; Wong et al., 2008), the authors view coordinating knowledge as a profile construct. Its dimensions cannot be meaningfully algebraically combined. Rather, certain combinations of coordinating knowledge types exist and these combinations are likely contingent on the coordination dependency of the episode and have different impacts on the coordination process and outcomes. Identifying such coordinating knowledge profiles (e.g., qualitatively, through cluster analysis, through Qualitative Comparative Analysis [QCA]) opens a door to studying how coordination is enacted under different contingencies and its impacts, as well as how it is (and should be) embedded into technology.

Effects of Coordinating Knowledge on Coordination Episode Performance

We expect coordinating knowledge to be consequential to coordination episode performance with different types of coordinating knowledge varying in influence across different dimensions of performance. While previous work has considered team productivity and process satisfaction (Andres & Zmud, 2001; Hoegl & Gemuenden, 2001) or the quality of group decisions (Espinosa et al., 2007b; Gittell, 2002; Ren et al., 2006; Slaughter & Kirsch, 2006) as measures of coordination performance, these outcomes typically occur as a result of multiple coordination episodes. Our focus on the coordination episode makes it possible to consider measures that capture performance at a granular level: the efficiency and effectiveness of the coordination episode. These impacts are shown in Figure 2. The authors expect improvements in these at the episodic level to cascade into the broader measures of coordination success described in prior research such as team productivity, process satisfaction, quality of group decisions, and better overall performance. Further, as discussed in "Future Research Directions on Coordinating Knowledge," over time, the authors expect use of different types of coordinating knowledge to have effects on relational outcomes such as how team relationships form (Claggett & Karahanna, 2018).

Coordination Episode Efficiency

Efficiency involves minimizing the associated costs (time or effort) of completing a task (Evans & Davis, 2005). Therefore, the authors expect improved efficiency in a coordination episode to include a decrease in the cognitive effort expended by the involved actors or a decrease in the amount of follow-up coordination episodes that occur (Grant, 1996) (e.g., the receiver asks for information in additional coordination episodes that should have been included in the original episode).

Efficiency: Cognitive Ease

Coordinating knowledge that is embedded in a structured mechanism (e.g., standard procedure) allows actors to initiate coordination episodes efficiently by reducing the cognitive effort involved in performing aspects of the coordination episode. For example, a time-scheduled or event-sequenced trigger is a decision about when to coordinate that is provided to the actor and predetermined information about content selection provides the details about what information to gather and communicate without the actor needing to spend time and energy thinking about these. In other words, these are decisions made in advance and provided to the sending actor as a (partial) blueprint to follow during the coordination episode. Additionally, roles may provide a cognitively economical way for actors to identify the basic knowledge sets, capabilities, tasks, and responsibilities of each other. Roles bring standardization and efficiency to tasks which require coordination (Mintzberg, 1979; Okhuysen & Bechky, 2009; Simon, 1957) and reduce the need to know the specific identity of individuals with whom to coordinate.

Efficiency: Reduce Follow-Ups

If the coordination episode is missing some key pieces of coordinating knowledge, then additional coordination episodes may be required to complete an exchange that should have been completed in the original single episode. This performance aspect focuses on coordinating knowledge types that, when missing, may create additional or subsequent communication obstacles before the coordination process is completed. For example, if the sending actor does not know which physician has been assigned to a patient, then their initial communication with the wrong physician is likely to be met with a comment they should talk to someone else or they may have to seek out the assigned person before the actual coordination episode can occur. Including all of the appropriate content in the initial coordination episode will also mitigate the need for follow-up episodes. If the coordination needs are predictable, predetermined content selection can help make sure the complete set of information is included in the initial episode. Further, Rico et al. (2008) note the power of implicit coordination in teams that know each other's patterns well. Understood within the coordinating knowledge framework, implicit coordination involves anticipating what a team member will want to know, which can avoid additional coordination episodes. Similarly, knowing their preferred method of coordination can also help the sender and receiver to connect the first time and avoid channel switching (e.g., an email is ignored so a phone call must be made).

Coordination Episode Effectiveness

Effectiveness of a coordination episode is increased when the communication empowers actors to achieve the objective by bringing their expertise to bear. It involves sharing the right information, with the right people, at the right time to manage task interdependencies. The authors see two categories of coordination episode effectiveness drivers to consider. The first is apt selection, where the ideal person is selected, and the right information is shared with them, at the most opportune time, in order to bring expertise to bear and achieve their shared goals. The second is that the recipient of the information is provided the means to uptake the information being conveyed in a meaningful way.

Effectiveness: Apt Selection

Coordinating knowledge may impact performance by enabling selection of the right actors, coordination at the right time, and conveyance of the right information. The authors term this apt selection. Research streams such as TMS have focused on the importance of bringing the right team member into coordination to leverage their expertise (Lewis & Herndon, 2011; Ren & Argote, 2011) and research on information quality suggests that the provision of information that is complete, relevant, accurate, timely, and appropriately detailed relative to the specific task improves performance (Bailey & Pearson, 1983; DeLone & McLean, 2003; Wixom & Todd, 2005). Therefore, apt selection is likely to enhance coordination effectiveness by improving the timeliness of the coordination episode, team member utilization, and the quality of the information exchanged.

If the coordination context is predictable in nature, then types of coordinating knowledge that aid in apt selection are likely derived from structured mechanisms. For example, event-sequenced triggers help move information from one actor to another during key business processes (i.e., right time), predetermined content selection may make information complete (i.e., right information and appropriately detailed), and actor selection based on role and assignments help select the right skill set or assignment of a recipient (i.e., right person). Practically, this provides a way to embed best practices within the coordination process.

However, coordination needs are often emergent and not predictable. For example, an unusual set of symptoms may present in a patient that does not trigger any rules or procedures to coordinate, but an experienced nurse knows something is wrong and consults with a physician anyway (emergent trigger). Or a medical team with a strong TMS may know that a particular nurse is especially great at placing intravenous tubes in young children and calls that nurse in for a special case (individual actor selection). Or experience dictates that another piece of information not normally called for is relevant and should be included in a coordination episode (emergent content). These examples demonstrate coordinating knowledge that is important to coordination in dynamic environments, but also indicate possible antecedents to coordination failures. Coordination is more likely to fail in dynamic and unpredictable environments (Faraj & Xiao, 2006; Majchrzak et al., 2007; Ren et al., 2008) and the authors posit this is due to missing coordinating knowledge that derives from domain expertise and to some extent team familiarity and TMS, which would have helped to make a more apt selection.

Effectiveness: Conveyance of the Information

Even after the right person, the right content, and the right time are selected, a coordination episode is only successful if the receiving actor uptakes the intended information. For example, many medical coordination errors are the result of a healthcare professional failing to notice a key piece of coordinated information (e.g., overlooking something that was in the patient's chart) (Makary & Daniel, 2016). The second effectiveness consideration is that of conveyance—how coordinating knowledge can help ensure the information is successfully received. Shared understanding is a way for information to be efficiently delivered, which can improve cognitive ease, but it can also be a tool to succinctly convey meaning (Cannon-Bowers et al., 1993). Predetermined content presentation can also help format and display information in ways that make it easier for recipients to interpret. For example, a sender may enter raw data into a system, but the receiving actor receives a report that shows the data in graphical format, aiding in the understanding of the data. Finally, selecting the ideal media-fit method based on the information is another way to help the conveyance of the information between sender and receiver, because the channel will offer traits that help the conveyance of information (Dennis et al., 2008).

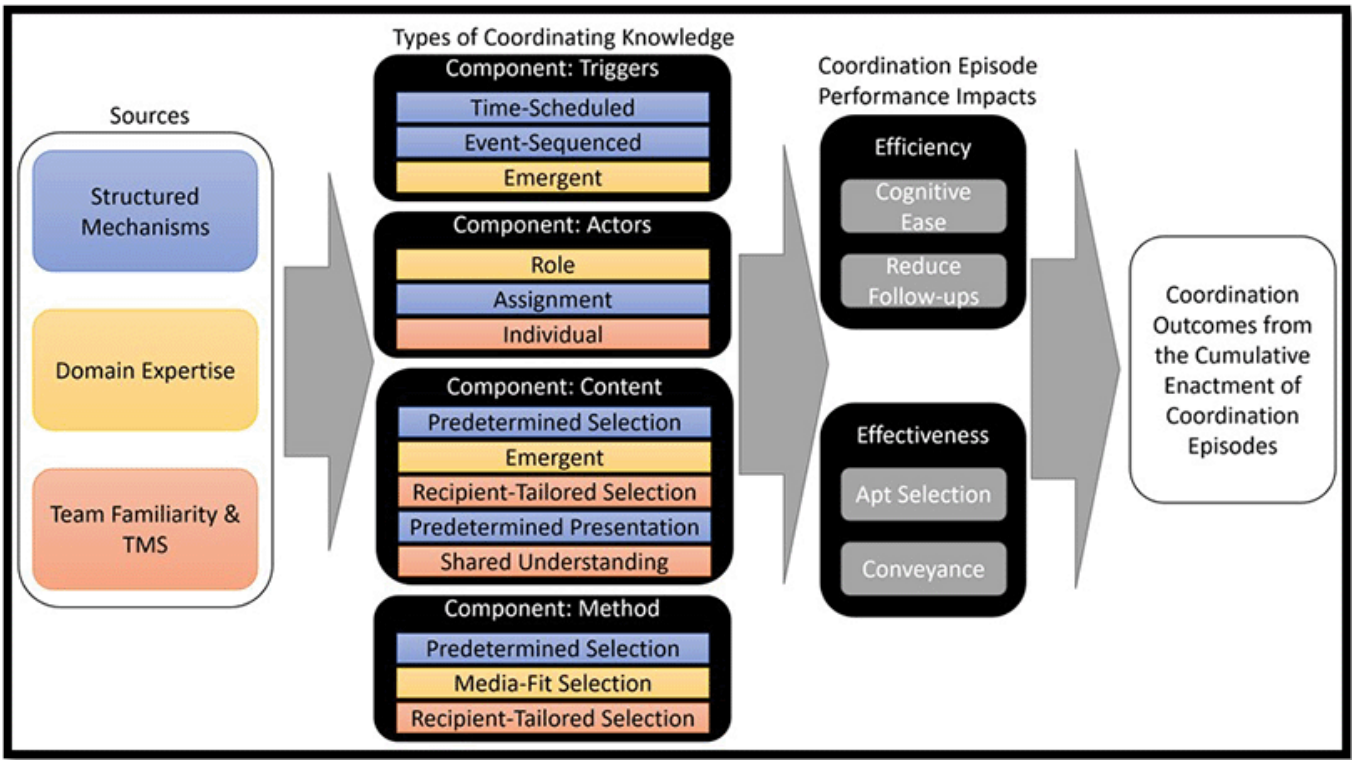

Figure 2. Sources and impacts of coordinating knowledge on coordination episode performance.

Future Research Directions on Coordinating Knowledge

Traditionally, research in coordination has considered the nature of coordination as being either structured or unstructured (Andres & Zmud, 2001; Argote, 1982; Willem et al., 2006), yet research examining structured vs. unstructured coordination yielded conflicting or weak empirical results (e.g., Argote, 1982; Broekhuis & van Donk, 2011; Havens et al., 2010). One possible reason for the conflicting results may be their monolithic, all-or-nothing view of structured and unstructured coordination (Claggett & Karahanna, 2018). The authors posit that while some components (i.e., actors, timing, content, method) of coordination may be structured, other components may be unstructured. For example, work examining how coordination mechanisms can have unstructured actor selection and structured content (or vice versa) provides promising lines of inquiry in how to describe and assess coordination (Claggett & Karahanna, 2018). Other streams of research have studied how teams of actors build relationships that support coordination (Gardner et al., 2012; Gittell, 2002; Lewis et al., 2005; Rico et al., 2008; Wegner, 1986). Given the various perspectives on coordination, each focusing on a distinct aspect of the phenomenon, the coordinating knowledge perspective provides a holistic framework that can help us integrate this research. It allows us to categorize theories based on the components of coordinating knowledge they inform and to comprehensively integrate these existing insights about the coordination process. Faraj and Xiao (2006) note that while much attention has been paid to *what* is being coordinated, we still know little about *when* and *how* coordination unfolds. The coordinating knowledge framework allows us to identify knowledge that not only guides the when and how,

but observe and understand how that interacts with knowledge guiding the what (and the who). Identifying and examining coordinating knowledge profiles provides a useful foray into achieving this.

Coordination is fundamentally about the management of dependencies (Mohr, 1971; Rico et al., 2008; Thompson, 1967). Prior work has identified pooled, sequential, and reciprocal dependencies, which refer to how tasks and activities among group members are related and consequently impact the type of coordination necessary (Thompson, 1967). Different components of coordinating knowledge, and different coordinating knowledge profiles, may be more or less useful to manage these different types of dependencies. For example, in dependencies that are less tightly coupled, such as pooled, role or assignment coordinating knowledge may be an ideal way to "hand off" information to another actor, but in tightly coupled situations, such as reciprocal dependencies, more intimate knowledge about individual team members may be beneficial to select the appropriate actor.

Past research in coordination provides additional contingency considerations and contextual attributes that may benefit from being revisited with the coordinating knowledge framework. Previous work has considered how performance might change when task uncertainty was present (Gittell, 2002; Ren et al., 2006; Weinberg et al., 2007), when team structure or group size varied (Crawford & Lepine, 2013; Espinosa et al., 2007a; Lewis & Herndon, 2011; Straus & McGrath, 1994), or when the type of task was fundamentally different (Adler, 1995; Watson-Manheim & Bélanger, 2007). The coordinating knowledge framework may help us make better predictions about how and why coordination is affected when these environmental and situational factors differ. The authors suggest that reexamining these research questions while using the coordinating knowledge framework may create new understanding about coordination and generate practical suggestions about how to maximize performance by attending to the metadata that informs the coordination process.

We discussed how using certain types of coordinating knowledge may impact the performance of coordination episodes by increasing the efficiency or effectiveness of that episode. However, the aggregate of enactments of coordination episodes may impact relational outcomes between the actors over time, such as, for example, improving an understanding of shared goals, shared knowledge, and mutual respect (Gittell, 2016). This use of relationship dimensions within the coordination process has been referred to as relational coordination (Gittell, 2002). A promising future direction of research is unpacking how the use (or avoidance) of certain types of coordinating knowledge may alter how relationships within coordinating groups of actors develop. Further, the presence of strong relational coordination is likely to impact the coordination episode performance (Claggett & Karahanna, 2018). For example, in coordination episodes lacking structured content delivery (e.g., no predetermined content selection), relational coordination may inform content selection by providing recipient-tailored content selection derived from knowledge about shared goals, shared knowledge, and mutual respect. Therefore, future research should consider both the impact relational coordination has on how coordinating knowledge is selected and used within the performance of a coordination episode and how the repeated performance of coordination episodes builds relational coordination.

Embedding Coordinating Knowledge in Technology

Prior work has noted the importance of technology to coordination processes in a variety of contexts. For example, large-scale collaborations benefit from a variety of affordances provided by technology over which they communicate to help the knowledge creation process (Malhotra et al., 2021) and open-source software projects have to adapt their coordination mechanisms when they find unexpected dependencies during development (Lindberg et al., 2016). Much of the work considering the role of technology in coordination has focused on virtual teams, noting the challenges (Cramton, 2001; Cummings et al., 2009; Kellogg et al., 2006; O'Leary & Mortensen, 2010; Olson & Olson, 2000) or benefits (Espinosa et al., 2007b; Kanawattanachai & Yoo, 2007; Kraut et al., 1999) of coordinating over electronic communication tools. These studies often leave the technology "black boxed," only distinguishing between groups that coordinate over technologies versus those that do not. Other work in coordination acknowledges the need to explore how technology interacts with the coordination process. Crowston's (1997) examination of coordination theory highlights how coordination can be studied as a decomposed process and recognizes that technology can play an integral role as a host for coordination mechanisms. Other work studying emergent practices around coordination acknowledges how specific artifacts are used to make peers aware of each other's activities or provide a medium to manage specific interdependencies (e.g., scheduling rooms and shifts in a hospital or managing code updates in software development) (Chua & Yeow, 2010; Faraj & Xiao, 2006; Xiao et al., 2001). This previous work on coordination provides important examples of technology shaping the coordination process, which the authors extend by providing a framework to more specifically understand how technology may impact coordination episodes.

Specifically, coordinating knowledge may be stored and even enacted upon via external artifacts. Disaggregating coordinating knowledge into distinct modular components enables us to decide which of these components to store externally. Technology is involved in many coordination episodes (e-mail, Enterprise Resource Planning systems, specialized industry software such as Electronic Health Records, cell phones, etc.). Various types of information technologies have been shown to change routines (Goh et al., 2011) and collaborative software tools improve performance (Banker et al., 2006). The authors believe altering coordination by embedding and acting upon coordinating knowledge may be one way that information systems impact coordination performance. The coordinating knowledge framework identifies specific types of coordinating knowledge that are needed for the enactment of coordination episodes and which can be embedded in information systems. Consider an EHR system that stores the identity and contact information of healthcare professionals involved with each patient (nurse on duty assigned to that patient, cardiologist of patient, etc.). When the lab technician has completed a blood test for the patient and has the results, he or she could record them in the EHR system and the system could automatically notify each of these actors. In this example, the coordinating knowledge about assignment, role, and an event-scheduled trigger has been entered into the information system. The lab technician does not have to possess this coordinating knowledge in order for the coordination episode to be performed successfully. Embedding coordinating knowledge in information systems, routines, and workflows will reduce the amount of coordinating knowledge actors must possess and is likely to increase the performance of coordination episodes. The

coordinating knowledge framework helps identify alternative types of coordinating knowledge for each component to be considered for embedding into the system and enables consideration of performance implications for each type.

In addition to storing and enacting coordinating knowledge, technological advances in machine learning make it possible to algorithmically generate coordinating knowledge. For example, instead of simply encoding individual actor coordinating knowledge about specialties (e.g., this cardiologist is known for expertise in this type of condition), algorithms can pattern match with cardiologists who have a high success rate with a particular condition and recommend them. These emerging uses of machine learning open up a world of possibilities of further technology aids to the automation or augmentation of the coordination process that can be better understood with the coordinating knowledge framework.

Conclusion

In order to better understand coordination, insights can be generated by recognizing that coordination occurs in a series of coordination episodes and understanding what people need to know in order to enact each episode. The framework of coordinating knowledge delineates the set of knowledge that enables coordination by informing who are the actors involved in the coordination, its timing, content, and method. This knowledge is derived from structured coordination mechanisms, domain expertise, team familiarity, and transactive memory systems. The authors explored each of the four components of coordinating knowledge and defined their specific types and their effects on the efficiency and/or effectiveness of a coordination episode. They suggest that coordinating knowledge should be viewed as a profile construct and encourage future research to identify and explore coordinating knowledge profiles and the conditions that favor them and impact their performance.

The primary goal of the authors is to present coordinating knowledge as a new lens in understanding coordination that brings together insights from multiple coordination research streams. The framework allows organizations insight into *how* experts know how to enact a coordination episode to manage dependencies. Organizations can influence coordinating knowledge by providing or encouraging cultivation of specific types of coordinating knowledge. Further, the authors believe this framework is useful in considering the design of coordination processes and especially the aspects that can be digitized by embedding coordinating knowledge into systems.

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