View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Maastricht University Research Portal

Maastricht University

Fluid and stable

Citation for published version (APA):

Uitdewilligen, S., Rico, R., & Waller, M. J. (2018). Fluid and stable: Dynamics of team action patterns and adaptive outcomes. *Journal of Organizational Behavior*, *39*(9), 1113-1128. https://doi.org/10.1002/job.2267

Document status and date:
Published: 01/11/2018

DOI:
10.1002/job.2267

Document Version:
Publisher's PDF, also known as Version of record

Document license:
Taverne

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy
If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

Download date: 02 Nov. 2021

Received: 1 October 2016 | Revised: 1 January 2018 | Accepted: 6 January 2018
DOI: 10.1002/job.2267

SPECIAL ISSUE ARTICLE

WILEY Journal of Organizational Behavior

Fluid and stable: Dynamics of team action patterns and adaptive outcomes

Sjir Uitdewilligen[1] | Ramón Rico[2,3] | Mary J. Waller[4]

[1] Department of Work and Social Psychology, Maastricht University, Maastricht, The Netherlands

[2] Department of Social Psychology and Methodology, Universidad Autónoma de Madrid, Madrid, Spain

[3] Management and Organizations, The University of Western Australia, Perth, WA, Australia

[4] Neeley School of Business, Texas Christian University, Fort Worth, Texas, U.S.A.

Correspondence
Sjir Uitdewilligen, Department of Work and Social Psychology, Maastricht University, Maastricht, The Netherlands.
Email: sjir.uitdewilligen@maastrichtuniversity.nl

Summary

The current study draws on work in the areas of team adaptation, team compilation, and small groups as complex systems to predict and test relationships between time, taskwork team mental models, team action patterns, and team effectiveness. Three-person teams performed 9 scenarios of a firefighting simulation distributed over 3 days with discontinuous task changes introduced in the fourth and seventh scenarios (N = 41 teams; 123 individuals). We applied pattern detection algorithm software to the behavioral data to identify emergent performative patterns in the team members' task-oriented actions. We also used discontinuous growth modeling to track the development of these team action patterns and their dynamic relation to team effectiveness. The results indicate that pattern emergence increased over time. This was particularly true for teams with similar taskwork mental models, and these teams also showed a more acute decrease in action patterns after a task change. In addition, team action patterns became increasingly positively related to team effectiveness over time, but this effect was reset after the occurrence of a task change. Overall, our research provides practical guidance to managers by illustrating the value of teams having highly shared taskwork team mental models and of enhancing the effects of teams' action patterns on team adaptive outcomes.

KEYWORDS

growth modeling, interaction patterns, shared mental models, team adaptation, team dynamics

1 | INTRODUCTION

In order to effectively function in a dynamic work environment, teams must find a balance between stability and change. This balancing act is clearly visible in the extent to which team members perform recurring patterns of activity in their collective task-oriented work (Zellmer-Bruhn, Waller, & Ancona, 2004). We define these team action patterns in concordance with existing work (e.g., LePine, 2003; Zellmer-Bruhn et al., 2004) as recurring sets of actions performed for coordination and taskwork. As such, action patterns in teams differ from the information-laden and chiefly verbal interaction patterns explored in previous work (e.g., Stachowski, Kaplan, & Waller, 2009; Zijlstra, Waller, & Phillips, 2012). Instead, team action patterns are emergent performative patterns "created through practice" (Feldman, 2000, p. 622) and composed of task-directed actions engaged in by team members. These patterns differ from routines, however, as they are not "bound by rules and customs" (Feldman, 2000, p. 622). For instance, if a production team receives a customer order, a logistics worker may gather the required materials, hand these over to two production workers who will prepare the subcomponent of the order, after which a third worker will assemble the separate components. If this same sequence of actions is repeatedly performed over time and with very little or no variation, it becomes a stable action pattern within the team.

On one hand, it is important that teams quickly develop such action patterns, as this creates stability through predictability and efficiency (Cohen & Bacdayan, 1994). When team members know what actions they can expect from each other, they can easily adjust and anticipate their own actions to match those of their team members, becoming coordinated in an implicit way (Rico, Sanchez-Manzanares, Gil, & Gibson, 2008). On the other hand, stability can become detrimental when teams are faced with novel situations that significantly differ from situations for which stable action patterns within the teams exist (e.g., Stachowski et al., 2009; Uitdewilligen, Waller, & Pitariu, 2013). In such cases, relying on stable action patterns may lead to the rigidity that limits teams' ability to adapt to novel situations (LePine, 2003).

Related previous research on verbal interaction patterns suggests that there is a strong situational influence on the relationship between

 © 2018 John Wiley & Sons, Ltd.

team effectiveness and the extent to which team interaction occurs according to stable patterns. Zijlstra et al. (2012) found that teams with communication that fell into patterns early in team formation subsequently outperformed those teams with comparatively less communication that composed patterns during team formation. Stachowski et al. (2009) found that during critical nonroutine situations, teams with less complex interaction patterns outperformed teams with more complex patterns. In a study with 12 flight crews working in a flight simulator, Lei, Waller, Hagen, and Kaplan (2016) found that pattern length (measured as the amount of time within which a pattern unfolded), pattern complexity (measured as the number of hierarchical levels within a pattern containing smaller, embedded subpatterns), and actor switches (or turn-taking among team members) interacted with environmental volatility to predict team effectiveness. In routine environments, these interaction pattern characteristics were positively related to effectiveness; however, in nonroutine environments, the relationship was negative.

Although these previous studies have focused on verbalized interaction patterns, little is known about the recurring performative patterns of behaviors that emerge in teams as structured ways of doing when teams perform coordinated tasks. Moreover, although the temporal elements of pattern development and change have been implicit in these studies, an analysis of the antecedents, development, and changes in patterns, as well as of the dynamic relationship between patterns and team effectiveness, is missing. How do patterns of teams' actions develop and emerge over time, and how does the nature of this development influence team outcomes? In this study, we take a dynamic perspective on team development and effectiveness (Collins, Gibson, Quigley, & Parker, 2016), and we take a team adaptation perspective (Baard, Rench, & Kozlowski, 2014; LePine, 2005) to assess the effect of unexpected task changes on team action pattern development; additionally, we build on Kozlowski, Gully, Nason, and Smith's (1999) model of team compilation by predicting the development of team action patterns over time. We suggest that taskwork team mental models (TMMs)—a similar understanding among the team members about the central aspects of the task (Mohammed, Ferzandi, & Hamilton, 2010) —function as a key antecedent of team action pattern development and change. We focus on TMMs as they are the most advanced and frequently studied form of team cognition and due to their consistent relationship with the capacity of team members to articulate their interactions in a way that improves both coordination and outcomes (Mohammed, Hamilton, Sanchez-Manzanares, & Rico, 2017). Finally, we propose a dynamic relationship between these action patterns and team effectiveness. In this regard, we address how repeated changes in the task over time influence the relationship between team action patterns and team effectiveness.

This study thus tests key theoretical propositions to advance the study of team dynamics in four important ways. First, responding to calls for studies on the dynamics of team effectiveness (Ballard, Tschan, & Waller, 2008; Collins et al., 2016; Cronin, Weingart, & Todorova, 2011; Roe, 2008; Waller, Okhuysen, & Saghafian, 2016), we do not treat our focal constructs as static; instead, we model and track the development and change of team effectiveness and action patterns over time. Second, the literature on team interaction patterns shows contrasting findings regarding the influence of interaction patterns on team effectiveness (Kanki, Folk, & Irwin, 1991; Stachowski et al., 2009; Uitdewilligen et al., 2013); by applying our temporal design, we show that patterns are not good or bad per se but that their influence depends on the timing within the team's trajectory. Third, we contribute to the team literature by identifying shared mental models (Mohammed et al., 2010) as an important antecedent of team action pattern development and change. Finally, because task changes over time are a central issue in this research, we contribute to the burgeoning literature of team adaptation in two main ways: (a) by revealing the role of TMMs and team action patterns in transition and reacquisition adaptation, thus addressing recent calls in the field to characterize what is being changed in the team when adaptation occurs (Maynard, Kennedy, & Sommers, 2015); and (b) by testing central postulates from Kozlowski's et al. (1999) team compilation model that remained unexplored.

2 | THEORETICAL FRAMEWORK AND HYPOTHESES

2.1 | Team adaptation and the development of action patterns

In general, research on teams postulates that adaptation may be motivated by a decrement (or expected decrement) in team effectiveness, and some scholars have provided conceptual approaches portraying how teams cope with and adapt to the changes believed responsible for these decrements. In this regard, it is suggested that team adaptation occurs through an emergent and recursive multilevel process combining situation assessment, plan formulation, plan execution, and team learning (Burke, Stagl, Salas, Pierce, & Kendall, 2006; Kozlowski et al., 1999). However, team adaptation scholars are still struggling to properly characterize the specific underlying mechanisms that drive team adaptation and, in particular, the measurement and characterization of the behaviors that constitute team adaptation (Maynard et al., 2015).

In looking for a response to this particular issue, we submit that the behavioral manifestation of the team adaptation process can be observed in the moment-to-moment manifestations of team functioning, indicated by the observable patterns occurring among the team members' actions (Kozlowski et al., 1999). Here, following work specifically in the team dynamics literature, we consider team action patterns as the recurring sequences of performative task-oriented actions executed by team members (LePine, 2003; Zellmer-Bruhn et al., 2004). As such, the notion of action patterns is closely related to the concept of collective routines, which are also characterized by repeatedly exhibited similar patterns of behavior (Cohen & Bacdayan, 1994; Gersick & Hackman, 1990). In addition to not being bound by rules and customs (Feldman, 2000), a central distinction between routines and action patterns is that routines are often associated with unconscious or nondeliberate behavior, whereas action patterns refer purely to the behavioral aspects without inferences about the extent to which these behaviors are consciously developed or executed (Schulz, 2008). Cohen and Bacdayan (1994) provide a compelling account of how collective routines are stored as situation-action linkages in the procedural memory of individual members. Collective routine execution emerges when team members, primed by situation cues or the actions of others, enact their parts in the behavioral sequence and thereby trigger the concordant actions of their co-workers. In this way, actions of different team members are likely to co-occur at a higher-than-chance frequency, resulting in repeated sequences of collective behaviors (Stachowski et al., 2009).

Although previous research shows that teams rapidly develop stable patterns upon team formation (e.g., Bettenhausen & Murnighan, 1985; Zijlstra et al., 2012), patterns are likely to be continuously developed as team members accumulate experience in working with each other (Edmondson, Winslow, Bohmer, & Pisano, 2003; Reagans, Argote, & Brooks, 2005). In the role compilation phase, team members shift their focus from individual level skill development to the dyadic interactions between team members (Kozlowski et al., 1999). Team members learn who requires their output and from whom they require input (Huber & Lewis, 2010; Marks, Sabella, Burke, & Zaccaro, 2002), they learn what specific expectations they have regarding actions from each other, and they learn when these actions should be performed to ensure coordination. As these sequences are repeated, procedural memory for these cue-action linkages is strengthened (Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001; Cohen & Bacdayan, 1994), and the likelihood that similar sequences will re-occur increases (Gersick & Hackman, 1990; Tushman & Romanelli, 1985). With this ongoing automatization of basic interactions, team members can shift their attention from simple dyadic to more complex multimember action sequences (Kozlowski et al., 1999). In their theory of small groups as complex systems, Arrow, McGrath, and Berdahl (2000, p. 55) refer to this process as coordination or the "ongoing pattern of interaction among the group's constituent elements as the group pursues its function." Consistent with this theory, we argue that the number and variety of action patterns in teams is likely to increase over time as team members pursue interdependent work together. Therefore, we hypothesize that

> **Hypothesis 1.** *Increasing amounts of team actions will fall into patterns over time.*

From a team adaptation standpoint, the fact that team actions become increasingly patterned over time shall be also considered in light of potential task changes. Accordingly, as we explain in the next section, task changes will subsequently affect the extent to which such action patterns become more or less frequent.

2.2 | The effect of task changes on team action patterns

Task changes and disruptions are a central element in the existing research on adaptation, collective routines, and behavioral patterns in teams (Baard et al., 2014; Cohen & Bacdayan, 1994; Edmondson et al., 2003; Stachowski et al., 2009), and a number of different perspectives exist on how such patterns are affected by task disruptions. Threat-rigidity theory maintains that when teams are confronted with an external environmental change, this can pose a perceived threat that leads to a reduction in information processing activities and a constriction or centralization of control (Staw, Sandelands, & Dutton, 1981). As a result, the team responds by using well-learned or dominant responses. This suggests that teams would defer to highly patterned modes of action when faced with a sudden change. Such rigid responses would result in positive outcomes if the change is incremental and negative outcomes if the change is discontinuous. However, empirical evidence for the threat-rigidity effect in teams is limited (e.g., Gladstein & Reilly, 1985), leading Turner and Horvitz (2001) to conclude that "responses to threat may be more varied than the threat-rigidity model might predict" (p. 450).

An alternative perspective considers discontinuous task changes as disruptive events that temporally lead to instability in coordination (Arrow et al., 2000). Many of the team behavioral patterns that were effective for task execution in the prechange period suddenly become obsolete and cannot be meaningfully applied to the new task situation. Due to previously established associations between behavioral patterns and team effectiveness, teams may initially aim to use old patterns (Audia, Locke, & Smith, 2000), but they will eventually realize that these have become ineffective or impossible to execute. With the abandonment of obsolete patterns, team members' ability to predict and anticipate the behaviors of other members is momentarily compromised (Rico, Gibson, Sánchez-Manzanares, & Clark, 2014). As a result, the initial phase of adaptation is characterized by disruption (Hale, Ployhart, & Shepherd, 2015) and coordination flux (Summers, Humphrey, & Ferris, 2012). Therefore, we expect that the use of team action patterns is likely to decrease directly after a discontinuous task change before teams regain their coordinative composure again.

> **Hypothesis 2.** *The occurrence of team action patterns will decrease immediately after a discontinuous task change.*

2.3 | TMMs and team action pattern development

The beginnings of the team lifecycle are pivotal in understanding the underpinnings of how team members build a common representation of both the team and its task. According to the team compilation model, the initial formation phase is crucial for team members to develop shared goals and norms, to acquire knowledge about the other team members, and to develop a sense of how their individual roles and goals align with the team goals (Kozlowski et al., 1999). For instance, Santos, Uitdewilligen, and Passos (2015) found that shared mental structures (e.g., TMMs) at the start of the team lifecycle are crucial for teams in translating learning behaviors into actual improvements of team effectiveness over time. Thus, in this initial phase, team members start developing cognitive structures that allow them to understand and cope with the main aspects of their task and how they work together in the team.

As mentioned previously, the teamwork literature has predominantly identified such cognitive structures as TMMs. TMMs are team members' mental representations of knowledge about key elements of the team-relevant environment—such as the task, the equipment, or the teamwork strategies—that allow them to understand it (Klimoski & Mohammed, 1994). TMMs tend to be stable and long-term, and according to the team compilation model, they will be continuously refined and increasingly shared as team's progress toward task, role, and team compilation phases. Accordingly, TMMs progressively develop by including a broader range of cognitive content, including both taskwork (individual and team task goals and performance requirements) and teamwork (i.e., team members' interpersonal interaction requirements) domains (Mohammed et al., 2010). Although TMMs include other types of content such as strategic, temporal, or situational information, the taskwork and teamwork categories are dominant in existing research in the field (Mohammed et al., 2017). Although we acknowledge that team members have multiple TMMs simultaneously, we opted in this research for focusing only on taskwork TMMs for two main reasons. First, given that task changes are a central issue in dynamic teamwork environments, taskwork TMMs will better capture variations in the team cognitive structures concerned with the task itself. Second, in existing studies that examine different TMM content (i.e., teamwork and taskwork), taskwork TMMs are typically postulated to generate the outcomes under study (e.g., Gorman & Cooke, 2011; Santos & Passos, 2013; Zhou & Wang, 2010).

As taskwork TMMs are developed through team member interaction and interchange of information, they can be characterized by two main properties: (a) the degree to which members' TMMs are similar, referred as sharedness and (2) the degree to which members' TMMs are correct, referred to as accuracy. Extant literature has shown team effectiveness benefits are derived when highly shared TMMs are also accurate (Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2005). The fact that team members share a common and accurate representation of the common task being carried out increases their ability to anticipate the needs and actions of other team members and develop team action patterns that improve team coordination and effectiveness (Cannon-Bowers, Salas, & Converse, 1993; Rico et al., 2008).

Following the team compilation model postulates, it could be argued that taskwork TMM development will include different elements during the different developmental phases. Thus, although social interaction and communication processes shape the way TMMs emerge (e.g., Mohammed et al., 2010), because they are primarily held in the mind of team members, TMMs include idiosyncratic information that may or may not be shared by the whole team. In fact, during the first two phases (i.e., team formation and task compilation phases), it has been predicted that teamwork TMMs will be developed first, as team members must gain interpersonal knowledge about their teammates and orient themselves to the team before they can attend to task performance and acquire the individual task knowledge, self-efficacy, and self-regulatory skills necessary to develop taskwork TMMs (Kozlowski et al., 1999). Subsequently developed taskwork TMMs will allow team members to understand team effectiveness and further develop both team and task team mental models as a dyadic and network of roles, respectively (Kozlowski et al., 1999). Accordingly, the quicker the team develops and shares taskwork TMMs in early stages of their development, the quicker the team action patterns will develop (captured on the slope of team action pattern development), fueling predictability and team effectiveness (Zijlstra et al., 2012). Thus, we hypothesize that

Hypothesis 3. *Shared taskwork TMMs in early stages of team development will be positively related to both the emergence of and to the subsequent increase of team interaction pattern development over time.*

2.4 | Taskwork TMMs sharedness and team action pattern change

The key assumption in TMMs research is that when team members share the necessary team knowledge to perform, they are on a more solid footing to anticipate the actions and demands of other teammates, thereby fostering team coordination processes that yield improved effectiveness (Cannon-Bowers et al., 1993). In particular, taskwork TMM sharedness facilitates one kind of coordination identified as implicit coordination (Rico et al., 2008).

Team coordination is an emergent process integrating the actions, knowledge, and goals of interdependent team members aiming for common goals (Malone & Crowston, 1994). Two kinds of coordination have been identified in previous research: explicit and implicit (Rico et al., 2008). Both are alternative and complementary processes that align team member actions as the team performs. In so doing, explicit coordination requires team members to communicate (e.g., orally, written, and visually) to articulate plans, define responsibilities, negotiate deadlines, and seek information (Espinosa, Lerch, & Kraut, 2004), whereas implicit coordination is a more indirect process, mainly tacit and derived from shared team representational structures (i.e., TMMs) that allow members to integrate their interdependencies by anticipating other team members' actions and needs and future task demands (Rico et al., 2008). In addition, and particularly important for our rationale here regarding team adaptation, implicit coordination is associated with the dynamic adjustment of team members' behaviors, based on the anticipated demands enacted in shared knowledge structures (i.e., taskwork TMMs). Thus, action patterns are inextricably related with implicit coordination processes, and it could easily be argued that when a team is performing based on implicit coordination, there will be a high frequency of action patterns.

Thus, the question remains as to the extent to which such well-oiled action patterns yielding efficient implicit coordination processes will also serve the team well when the team faces a change in its task. According to the team compilation model, during the team compilation phase, if the team has a repertoire of functioning networks (i.e., alternative configurations of team roles and work transactions between them), then the team may decide on an alternative network and cope with the situation. In this regard, when team members have a shared understanding of how they work together in the team and of how the main task elements are related (i.e., high taskwork TMM sharedness), the team will continue working in a coordinated fashion after an unexpected task change. However, there are changes that a team cannot address with a network selection strategy—namely, cases in which, due the magnitude of the change, the team must invent a new network to perform. Network invention involves the ability of team members to quickly create and communicate new networks of functioning (Kozlowski et al., 1999), implying that the team must abandon previous action patterns as well as reconfigure its role structure by building new action patterns.

Because taskwork TMM sharedness facilitates effective team communication and coordination, it is likely to facilitate this routine-abandonment process. Teams with highly shared taskwork TMMs will rapidly become aware of the misfit between their action patterns and the current altered task situation. In addition, teams with highly shared team TMMs will also quickly become aware of the effect of their action patterns on individual team members and become aware of this potential dysfunction. Moreover, both shared task and team TMMs are likely to facilitate communication among the team members regarding the relation between the task situation and team processes. Shared taskwork TMMs will ease sensemaking processes regarding members' actions and communications because team members may interpret the task situation within the same frame of reference (Fussell & Krauss, 1989). All in all, such more intensive communication processes will help team members define new roles and new links between them, requiring a new set of action patterns to be established. Accordingly, we submit that having shared taskwork TMMs will enable team members to collectively realize a misfit is occurring and decide to abandon patterns that have been developed for situations that differ significantly from the current task situation. This will limit the coordination flux associated with developing a new team network of functioning that better fits the new task situation (Summers et al., 2012). Thus, we hypothesize that

> **Hypothesis 4.** *Taskwork TMM sharedness will interact with the effect of a task change on teams' use of action patterns. The decrease in the occurrence of team action patterns after a task change will be more acute the more shared the taskwork TMM.*

2.5 | The dynamic relationship between action patterns and team effectiveness

The effect of action patterns on team outcomes is likely to differ over time. The positive influence of action patterns on team effectiveness depends on aspects of internal alignment—how well the actions of different members fit together to produce a meaningful coherent pattern—as well as on external fit, or the extent to which the patterns enable the team to perform given the specific characteristics of the team's task environment (Arrow et al., 2000). We expect that in a relatively stable context, due to microfeedback from other team members and from the task environment, both internal alignment and external fit are likely to improve over time.

Previous research suggests that patterns are formed rapidly as soon as team members start working together (Bettenhausen & Murnighan, 1985; Feldman, 1984; Ginnett, 1987). In the initial moments of team formation, patterns may be shaped by a variety of factors that may not be directly relevant for team functioning in the specific task setting. Team members may have preconceptions about the capabilities and requirements of the other team members, and they may use scripts developed in previous team settings to initiate patterns in the current situation (Abelson, 1981; Bettenhausen & Murnighan, 1985). As a result, many of these initial patterns are not explicitly developed to optimally fit the requirements of the task. Hence, the initial relationship between patterned action and team effectiveness is likely to be weak.

As team members repeatedly work together, they may monitor the effects of their actions on other team members, or they may directly provide each other with feedback on the effectiveness of their actions (Arrow et al., 2000). As the patterns become increasingly tailored to the idiosyncratic needs of the team members and the requirements of the roles they fulfill within the team, the internal alignment of their action patterns increases (Pearsall, Ellis, & Bell, 2010). In addition, as team members repeatedly execute action patterns, they accumulate feedback about the effectiveness of these patterns, which either by triggering conscious reflection or through basic reinforcement processes, is likely to result in a pruning of the action structure as teams abandon some inefficient patterns and replace these with better alternatives (Arrow et al., 2000; Gersick & Hackman, 1990). Although previous research shows that some patterns are likely to be retained independent of their relation to goal attainment (Feldman, 1984; Ginnett, 1987), it is likely that, overall, the patterns will become increasingly attuned to the characteristics of the task.

> **Hypothesis 5.** *Action patterns will be increasingly positively related to team effectiveness over time.*

After a discontinuous change in the task, the fitness landscape of action patterns shifts; where some patterns will remain efficient, others may no longer be functional. Hence, in order to successfully adapt, teams must alter their action patterns to realign them with the shifting situation (Gersick & Hackman, 1990). Stachowski and colleagues found that in nonroutine situations, higher performing nuclear power plant crews exhibited fewer, shorter, and less complex interaction patterns. Similarly, Lei, Waller, Hagen, and Kaplan (2016) found that crews with patterns that were shorter, simpler, and involved lower reciprocity outperformed other crews during a nonroutine situation. This suggests that patterns established that were effective in the prechange situation may actually become a liability as teams may have difficulty abandoning patterns that have been previously experienced as successful (Audia et al., 2000; Cohen & Bacdayan, 1994). For example, this effect is frequently observed in sports teams that try to immediately cope with an important task change such as an adverse score situation by persisting in the same interaction patterns that seemed to be effective before the change, resulting in subsequent additional adverse outcomes due to the misalignment of old interaction patterns and an inability to cope with the new situation at hand.

Therefore, in the period immediately after the task change, adaptive teams avoid falling back on pre-established action structures and reevaluate their strategies given the new task requirements (Arrow & McGrath, 1993). After this initial period of flux (Summers et al., 2012), the team can again begin to optimize the internal alignment and external fit (LePine, 2003; Uitdewilligen et al., 2013) of action patterns to the new task circumstances. Therefore, we hypothesize that

> **Hypothesis 6.** *The positive relationship between action patterns and effectiveness over time will be reset after a discontinuous task change, in such a way that action*

patterns will be related to a greater reduction in effectiveness immediately after the task change and effectiveness after the change will recover at a slower rate when teams engage in many action patterns.

3 | METHOD

3.1 | Participants and design

Participants included 123 undergraduate students from two European universities. Students were randomly assigned to 41 three-person teams. Fourteen teams were tested at one location and 27 at the other university. Teams performed in a laboratory on a computer-based real-time firefighting simulation over nine consecutive scenarios distributed over three sessions in three different days. On the first day, teams were familiarized with the task and performed three basic simulation scenarios. On the second and third days, after a training round in which the teams performed the training scenario used in the first day, task changes were introduced in the fourth (second day) and seventh scenario (third day), respectively, requiring the teams to adapt their strategies.

3.1.1 | Simulation

The task scenarios were created using Networked Fire Chief (NFC; Omodei, Taranto, & Wearing, 2003). NFC is a computerized dynamic command-and-control simulation requiring members to monitor an area for the occurrence of fires and contain or extinguish the fires using three types of vehicles. Team members were collocated and worked on separate networked computers. The objective of the simulation is to limit the amount of points lost due to land burned by the fires. Land areas differed in how flammable they were and how many points they would cost when burned; for example, fires occurring in hay spread much faster than fires in forests, and burned houses cost more points than burned forests or hay. All team members had the possibility to zoom out to an overview map of the area, enabling them to locate fires and warning signs indicating where fires were likely to occur. Teams were given control over helicopters and fire engines that could extinguish fires and over bulldozers that could be used to treat land, preventing fires from spreading. Task roles were distributed in such a way that only one team member could use the helicopters to extinguish the fires, and only one team member could use the bulldozers to treat land. Vehicles required two types of resources to operate: water and fuel. One team member could reload vehicles with fuel and one team member could reload vehicles with water. In this way, team members were highly interdependent, as they required each other's input for executing their actions.

Task changes were introduced by varying the number, size, and location of fires as well as the wind speed and direction. During the first three scenarios, teams were faced with a large number of small fires. The optimal strategy for the teams under these circumstances would be to have one team member use the overview map to spot fires and move vehicles toward the location, whereas the other two members would use the fire trucks and helicopters to rapidly extinguish the fires. In the fourth through sixth scenarios, the number of fires was dramatically reduced, but fires were larger, often occurring in hayfields and threatening houses. Now fires could be spotted more easily, and all three team members would be needed to contain the fires by using fire trucks, bulldozers, and helicopters. In the seventh through ninth scenarios, the number of fires remained constant but wind speed and direction changes significantly increased, making it impossible for team members to extinguish the fires as soon as they occurred. Now the optimal strategy for the teams would be to spot warning signs of where fires were likely to occur and use bulldozers before the actual start of the fire to ensure that fires could not spread beyond a limited area. Because only one team member could treat land with the bulldozers, the other team members should have assumed supportive roles enabling this team member to operate the bulldozers.

3.2 | Procedure

Participants were recruited via advertisements on campus and student participant recruitment systems and were randomly assigned to teams. Before the first session, participants first received 20 min of individual training to familiarize them with their role and with operating the simulation. Participants worked through a training sheet detailing all the actions they could take and prompting them to try these out on their computers. Participants also received a handout of the value of the different types of land and information on how to use each vehicle, which they could check during the simulation. Participants then performed a 10-min practice task as a team. In the practice task, teams were presented with an easy scenario and were instructed to practice extinguishing the fires and communicating with each other. Team members did not receive information about individuals' area of specialization, so they could use this session to familiarize themselves with each other's roles and to hand over vehicles for having them refilled by other team members. A research assistant was present during the training session for answering questions and clarifying misunderstandings.

After the training task, teams performed on the first scenario. They then completed the mental model measures, after which they completed the second and third scenario. On the second and third day of the experiment, participants returned to the lab and, after a short refresher training session, completed the fourth through sixth and seventh through ninth scenarios composed of, respectively, the first and second adaptation periods. To this regard, changes occurred at Trials 4 and 7. In order to prevent fatigue effects, teams completed the nine scenarios during three consecutive days in a week.

3.3 | Measures

3.3.1 | Team action patterns

In order to assess team action patterns, we used the action history file automatically generated by the NFC simulation that captures all actions that have been executed by each of the individual players and the exact time moment at which the actions were executed (Uitdewilligen et al., 2013). Due to technical errors, the action history of all nine scenarios was missing completely for one team, and for 10 teams, action information was missing for one scenario, resulting in information from 340 scenarios of 40 teams. With these action history files, we created temporally ordered strings of actions containing information about the actions that were executed by the team members, the vehicle with which the action was executed, and the team member who executed the action.

Consistent with previous studies on interaction patterns in teams (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012), we used THEME (Magnusson, 2000), a pattern recognition software algorithm, to identify recurrent sequences of actions in the sequential behavioral data. The THEME algorithm uses a stepwise hierarchical procedure to identify patterns. First, simple patterns of two behaviors are identified based on their co-occurrence above a specific chance level. Second, the simple patterns are added to the sequence of events data and the program searches the data again to identify additional co-occurrences that include the initial single events as well as the simple patterns. This process is repeated, identifying increasingly complex patterns, until no additional patterns are found. Finally, in order to avoid duplication, the algorithm deletes patterns that are less complete versions of other patterns. Consistent with previous studies, we set the minimum number of 3 times for a pattern to be occurring, and we set the confidence interval to derive patterns at 0.05, indicating that patterns were only retained if they occurred at a less than 5% probability level. We derived indicators for the number of unique action patterns occurring among team members and the amount of times these patterns occurred. A typical example of a pattern is team member #1 moves a helicopter to the fire location, team member #2 uses it to extinguish the fire, and team member #3 refills it with fuel. Given the high correlation between these factors (r = 0.95), we took the z-score of each measure and averaged them into a single measure of action patterns.

3.3.2 | Team effectiveness

Team effectiveness was calculated by the simulation separately over each scenario. The effectiveness scores indicate the value of the land that has not burned relative to the total value of all land in the scenario. Mean scores were 99.18 (SD = 0.23) over Scenarios 1 through 3, 96.86 (SD = 1.23) over Scenarios 4 through 6, and 93.91 (SD = 2.079) over Scenarios 7 through 9. Because of the considerable increase in standard deviations over the sessions, we controlled for heteroscedasticity in the longitudinal analyses.

3.3.3 | Taskwork TMM sharedness

Taskwork TMMs were each assessed with paired comparison ratings between seven pairs of concepts identified through an analysis of the task and with the help of people who were experts in the simulation (e.g., Edwards, Day, Arthur, & Bell, 2006; Mathieu et al., 2005). Concepts for the taskwork TMMs referred to aspects that were critical for understanding the task, including (a) mastering task procedures (refueling and water loading), (b) prioritizing different land types (field, hay, and houses), (c) prioritizing which fires to deal with first, (d) the ability to use vehicles appropriately, (e) understanding how fires spread, and (f) having a clear understanding of the instructions and goals of the mission. Participants filled in relatedness ratings regarding all possible pairs of these concepts between them and with team effectiveness, resulting in 42 ratings for each measure. The measure consisted of a matrix with the respective concepts along the top and the side of the grid. Following extant measurements on this regard, team effectiveness was included on the top of the grid (Lim & Klein, 2006). For each pair of concepts, participants were asked to indicate the extent to which they were related on a 7-point scale ranging from a strong negative relationship (−3) to a strong positive relationship (+3). We used UCINET (Borgatti, Everett, & Freeman, 1992) to calculate the quadratic assignment proportion correlation between the mental models of the different team members (Mathieu et al., 2005).

3.3.4 | Control variables

Because previous research has indicated a relationship between TMM sharedness and TMM accuracy (e.g., Edwards et al., 2006), we controlled for TMM accuracy when testing the effects of TMM sharedness. TMM accuracy was calculated in UCINET by the average quadratic assignment proportion correlation of each team member's mental model with an expert taskwork TMM. The expert taskwork TMM was developed by the developer of the scenarios and subject matter experts with ample experience with the simulation.

In addition, because the sample consisted of two subsamples from different universities, independent sample t tests were conducted to check whether teams from the two samples differed on the main variables. Results show no significant differences between the samples for average team effectiveness, $t(39) = -1.61$, $p = .12$, interaction patterns, $t(38) = -0.63$, $p = .53$, TMM similarity, $t(39) = 1.06$, $p = .30$, and TMM accuracy, $t(39) = -1.45$, $p = .16$. However, to err on the conservative side, we controlled for sample location in all analyses.

3.4 | Statistical analyses

Because our hypotheses include effects that vary within teams over time, we used random coefficient modeling, following the procedures advised by Bliese and Ployhart (2002). In particular, because we were interested in the effect of change events on the development of team effectiveness and action patterns over time, we used discontinuous growth modeling. With discontinuous growth modeling, the time metric is scaled to represent the discontinuities in the trajectories of the variables at the change points (Ployhart & Vandenberg, 2010). Discontinuous growth modeling has been used previously for modeling individual level adaptation (Lang & Bliese, 2008) as well as group level adaptation (Hale, Ployhart, & Shepherd, 2015; Sander, van Doorn, van der Pal, & Zijlstra, 2015). All analyses used the nlme package (Pinheiro, Bates, DebRoy, & Sarkar, 2014) included in the open source software R and used restricted maximum likelihood.

Table 1 represents the scaling of the time metric used for modeling the discontinuous growth trajectories. The slope parameter represents the linear form of the trajectory, and the transition parameters represent the immediate impact of the first and the second task change event, respectively. The reacquisition parameters represent the differences in the linear growth in the postchange trials relative to the slope in the prechange trials. A significant reacquisition parameter indicates that the slope after the change event differs from the slope before the change event (Lang & Bliese, 2008).

TABLE 1 Coding of the time metric coefficients representing growth and change

	Measurement occasion								
Variable	1	2	3	4	5	6	7	8	9
Slope	0	1	2	3	4	5	6	7	8
Transition Adaptation 1 (TA1)	0	0	0	1	1	1	1	1	1
Transition Adaptation 2 (TA2)	0	0	0	0	0	0	1	1	1
Reacquisition Adaptation 1 (RA1)	0	0	0	0	1	2	2	2	2
Reacquisition Adaptation 2 (RA2)	0	0	0	0	0	0	0	1	2

3.5 | Level 1 analysis: Describing the trajectory of team action patterns over time

As a first step, we modeled the development trajectory of team action patterns over all teams using the time metric coefficients. Based on recommendations of Bliese and Ployhart (2002), we tested for autocorrelation and heteroscedasticity in the error structure. The analysis suggests no evidence for autocorrelation ($\phi = -0.06$, $\Delta 2LL = 0.51$, $p = .31$), and models accounting for heteroscedasticity ran into convergence problems, a problem that also occurred in previous studies (Lang & Bliese, 2008).

As can be seen in Table 3, Model 1, the slope coefficient positively predicts action pattern development, providing support for Hypothesis 1. Neither of the transition adaptation terms (TA1 and TA2) predicts pattern development, indicating that the experience of a change episode does not directly lead to an increase or decrease of action patterns, providing no support for Hypothesis 2. Finally, the second reacquisition adaptation term (RA2) is significantly negatively related to pattern development, indicating a decrease in action patterns after the second change. Figure 1 summarizes the combined effects of these temporal coefficients, thereby providing the estimated average development trajectory of team interaction patterns over time.

To test our hypotheses regarding the effect of TMM sharedness on action pattern development and change, we added interaction

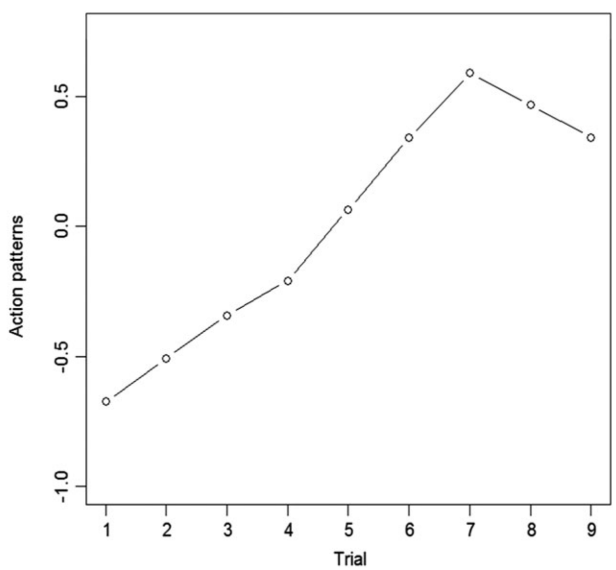

FIGURE 1 Average action pattern trajectory of all teams over time

terms of the linear growth term and the transition adaptation coefficients with the shared mental model variable. Because these tests involve cross level moderation effects with a Level 2 factor (TMM sharedness) moderating the Level 1 effects of time on pattern development, we specified the temporal coefficients to be random over teams (Bliese & Ployhart, 2002). Consistent with previous research (Santos et al., 2015), we controlled for TMM accuracy when testing the effects of TMM sharedness.

As can be seen in Table 2, Model 2, TMM accuracy was positively related to the overall level of action patterns. The interaction term of TMM sharedness with the slope coefficient was positive and significant, indicating that the development of action patterns picks up more rapidly for teams with highly shared TMMs than for those with less shared TMMs, providing support for Hypothesis 3. The significant interaction between the first transition adaptation term (TA1) and TMMs sharedness is negative, indicating that teams with highly shared taskwork TMMs have an immediate decrease in action patterns after the first change, whereas teams with less shared taskwork TMMs actually increase their use of action patterns immediately after the first change. However, the interaction term with the second transition adaptation (TA2) was not significant, indicating that this effect of TMMs only holds for the first of the two changes, thereby providing partial support for Hypothesis 4 (Figure 2).

3.6 | Level 1 analysis: Describing the trajectory of team effectiveness over time

Second, we modeled the average trajectory of team effectiveness over all teams using the time metric coefficients. Based on recommendations of Bliese and Ployhart (2002), we tested for autocorrelation and heteroscedasticity in the error structure. Autocorrelation indicates a correlation between observations close in time, which decreases with an increase in the temporal distance between the observation points. The analysis suggests no evidence for autocorrelation ($\phi = -0.10$, $\Delta 2LL = 1.06$, $p = .14$). Given the increase in task difficulty due to the task changes, we expected an increase in effectiveness variability over the adaptation episodes. The analysis indeed suggests evidence for heteroscedasticity over the two change episodes ($\Delta 2LL = 146.255$, $p < .001$). Consequently, in the subsequent models, we accounted for heteroscedasticity but not for autocorrelation in the error structures.

As can be seen in Table 3, Model 1, all temporal coefficients except Reacquisition 1 are significant, indicating that the expected trajectory models the data well. The linear trend positively predicts effectiveness, signaling a learning effect as team members improve effectiveness over time. As expected, both transition adaptation effects are negative, indicating drops in effectiveness directly after the task changes. Reacquisition Adaptation 1 is not significant, indicating that there is no significant additional linear growth after the transition relative to the linear growth before the transition; conversely, Reacquisition Adaption 2 is positive, signaling that the teams on average peak up effectiveness after the second transition faster than the average growth rate. Figure 3 summarizes the combined effects of these temporal coefficients, thereby providing the estimated average effectiveness trajectory over the teams over time.

TABLE 2 Discontinuous growth model results for action patterns over time

Variable	Model 1 Coef.	Model 1 SE	Model 2 Coef.	Model 2 SE
Intercept	−0.71**	0.12	−0.87**	0.15
Sample	0.07	0.14	−0.04	0.13
Slope	0.17*	0.07	0.07	0.08
Transition Adaptation 1 (TA1)	−0.03	0.23	0.29	0.28
Transition Adaptation 2 (TA2)	0.08	0.21	0.34	0.28
Reacquisition Adaptation 1 (RA1)	0.11	0.07	0.11	0.07
Reacquisition Adaptation 2 (RA2)	−0.29*	0.13	−0.29*	0.13
Level 2 effects				
Taskwork TMM accuracy			1.20*	0.46
Taskwork TMM sharedness			−0.35	0.40
Slope * taskwork TMM sharedness			0.49*	0.21
TA1 * taskwork TMM sharedness			−1.65*	0.78
TA2 * taskwork TMM sharedness			−1.25	0.85
AIC	943.31		949.12	
BIC	977.84		1,037.05	
LogLik	−462.65		−451.56	

Note. *N* = 41; k = 365. TMM = team mental model; *SE* = standard error; Coef. = coefficient.
$^{*}p < .05$, two-tailed. $^{**}p < .01$, two-tailed. $^{\dagger}p < .10$, two-tailed.

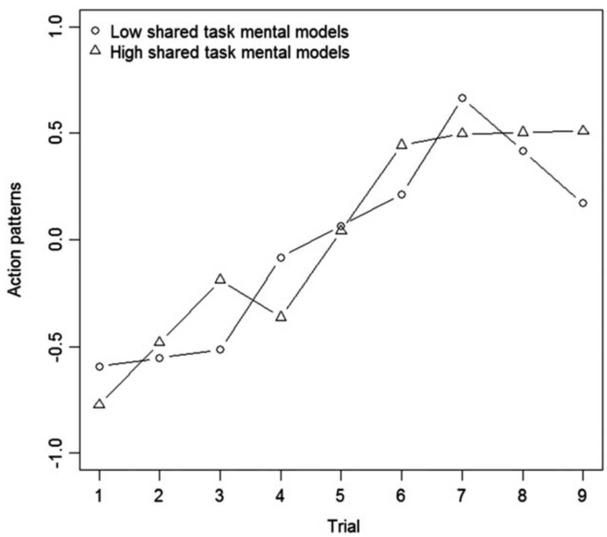

FIGURE 2 Effects of shared taskwork mental models on team action pattern development and change

To test our hypotheses regarding the time-specific effects of action patterns on team effectiveness, we added all interaction terms between the temporal coefficients and the team action pattern variable. As can be seen in Table 3, the interaction terms of action patterns with the slope coefficient was significant, indicating that the effect of action patterns on team effectiveness becomes increasingly positive over time, providing support for Hypothesis 5. However, the interactions between the reacquisition terms for both the first and the second change (RA1 and RA2) with action patterns were marginally significant and negative, indicating that this increase in the positive effect of action patterns on effectiveness only holds for the prechange period and diminishes or even reverses after the changes. Moreover, the interaction term with the first transition adaptation (TA1) was negative, indicating that the use of action patterns was related to a higher drop in team effectiveness directly after a change event. However, the interaction term with the second transition adaptation (TA2) was not significant, indicating that this transition effect of action patterns only holds for the first of the two changes, thereby providing partial support for Hypothesis 6. These results are most clearly summarized in Figure 4, which shows the effect of high versus low levels of action patterns on team effectiveness over time.

Finally, we ran additional analyses to test whether the performance trajectory differed between teams with low and high shared task mental models. The results show no significant interaction effects of shared mental models and transition adaptation (TA1: $\beta = 1.25$, $t = 0.63$, $p > .05$; TA2: $\beta = -0.33$, $t = -0.19$, $p > .05$) or reacquisition adaptation (RA1: $\beta = -1.05$, $t = -0.99$, $p > .05$; RA2: $\beta = -1.83$, $t = -1.17$, $p > .05$). This indicates that there are no direct effects of shared task mental models on adaptive performance, only indirect effects via interaction patterns.

4 | DISCUSSION

Our research overall revealed that the emergence of team action patterns increases over time, and this is particularly so for teams with similar taskwork mental models. However, and importantly, our research reveals that after a task change, teams sharing taskwork mental models also show a more acute decrease in action patterns. Further, when we related team action patterns with team effectiveness, we found a positive relationship over time; nevertheless, this effect is reset after the occurrence of a task change, uncovering an

TABLE 3 Discontinuous growth model results for baseline model of performance and action patterns

	Model 1		Model 2	
Variable	Coef.	*SE*	Coef.	*SE*
Intercept	98.49**	0.29	98.87**	0.09
Sample	0.550	0.33	0.20*	0.08
Slope	0.47**	0.17	0.22**	0.06
Transition Adaptation 1 (TA1)	−3.77**	0.54	−2.64**	0.19
Transition Adaptation 2 (TA2)	−5.43**	0.48	−4.89**	0.68
Reacquisition Adaptation 1 (RA1)	0.05	0.15	0.01	0.07
Reacquisition Adaptation 2 (RA2)	1.12**	0.30	1.42**	0.49
Action patterns			−0.11	0.09
Slope * action patterns			0.18**	0.06
TA1 * action patterns			−0.63**	0.18
TA2 * action patterns			−0.11	0.35
RA1 * action patterns			−0.11†	0.06
RA2 * action patterns			−0.72†	0.42
AIC	1,592.61		1,290.80	
BIC	1,631.42		1,500.25	
LogLik	−786.30		−590.40	

Note. N = 41; k = 365. *SE* = standard error; Coef. = coefficient.
**p* < .05, two-tailed. ***p* < .01, two-tailed. †*p* < .10, two-tailed.

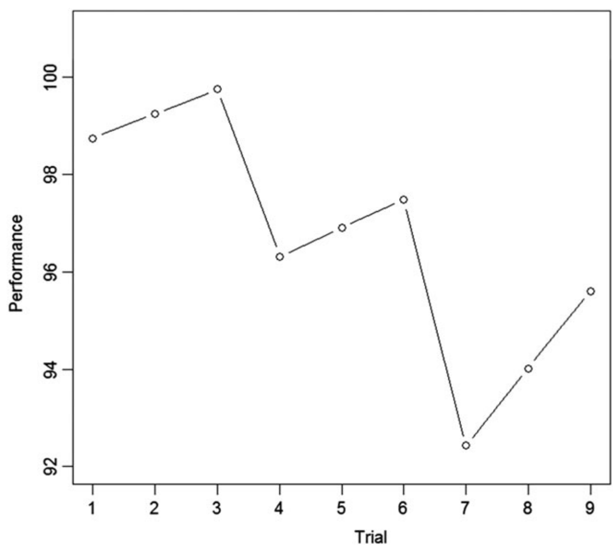

FIGURE 3 Average performance trajectory of all teams over time

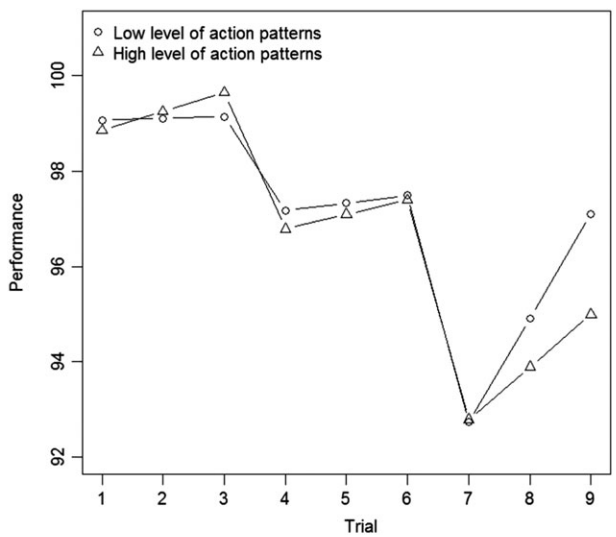

FIGURE 4 Temporal effects of high versus low level of action patterns on team performance

inverted pattern by means of which higher team effectiveness after a task change was achieved through fewer actions existing in patterns. Thus, the current study provides new theoretical and practical implications regarding both work team dynamics and team adaptation that deserve to be considered.

4.1 | Implications for theory

There is a small but growing stream of empirical literature on emergent patterns in teams (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012). We contribute to this literature by elucidating the nonlinear, complex, and dynamic nature of team action patterns and their influence on effectiveness in a work environment changing over time. By doing so, we provide a detailed examination of the emergence of action patterns as teams struggle to adapt to unexpected changes in their primary tasks, thus answering calls for research that explicates adaptive behavioral trajectories over time (e.g., Waller et al., 2016). We also offer empirical evidence that corroborates two temporal theories of group development and change that have substantially influenced the field of team dynamics (Arrow et al., 2000; Kozlowski et al., 1999). In this regard, our finding that team action patterns increase over time is consistent with both the postulates of team compilation model (Kozlowski et al., 1999) and the dynamics of elaboration (Arrow et al., 2000). Apart from negative slope after the final change event, action patterns linearly increase over time among the team members. Kozlowski's et al. (1999) model of team compilation proposes that team development occurs through a number of phases. In the initial formation phase, team members develop shared goals and norms, acquire knowledge about the other team members, and develop a sense of how their individual roles and goals align with the team goals. In the second task compilation phase, team members start developing the ability to fulfill their individual tasks within the team. In the third role compilation phase, the emphasis is switched from individual task mastery to the coordination of their actions with the other team members. Finally, in the team compilation phase, the focus shifts from the dyad to the team as team members develop more indirect and distal linkages and develop an understanding of the team as a network of task interdependencies. So, as teams progress through these phases, they shift their focus from individual level skill development to the dyadic interactions between team members to more complex multimember interaction sequences. Although we did not explicitly assess the underlying development of role network understanding of the team members, our study serves to illustrate this increasing complexity in the interaction among the team members as it becomes visible in the increased use of multimember action patterns over time.

Similarly, Arrow and colleagues' (2000) conceptualization of small groups as complex systems poses that groups assemble a network of connections that allow them to operate and that increase in complexity over time. According to this model, through the local dynamics of everyday activities, members establish an initial coordination network. By repeatedly enacting this coordination network through coordinated patterns of activity, its structure becomes stabilized and maintained. Finally, feedback is used to modify ties in the coordination network to align the network closer to the team goals. Our findings indeed suggest that teams not only increasingly make use of collective action patterns over time but also that, under stable circumstances, these patterns become increasingly effective for performance.

Although we hypothesized task changes to temporarily decrease the presence of action patterns, the results did not show a decline in action patterns over all teams. It appears that at least on average, the teams retained some action patterns after the changes. This could be related to the nature of the task changes we introduced; although the changes had a substantial effect on effectiveness, it is possible that they functioned as evolutionary rather than purely radical changes (Gersick, 1991). This implies that some of the action patterns that teams established in the prechange period may have remained effective in the postchange period. Another explanation with important implications for the study of team adaptation could be that although some teams may have reacted to the task changes by using well-learned responses, others may have quickly abandoned such previously established action patterns. This explanation is corroborated by our findings on the effects of action patterns on adaptive outcomes, which suggests that those teams that did shed their action patterns immediately after a change exhibited higher adaptive effectiveness than those that did not.

Accordingly, our results contribute to the existing literature on team adaptation by taking an important step toward addressing a renewed call in the field (Baard et al., 2014; Maynard et al., 2015) for empirical specificity regarding how team adaptation occurs. The finding that action patterns positively relate to effectiveness in stable situations but negatively after situations change is congruent with extant adaptation literature that suggests team adaptation to task changes is associated with team role reconfigurations (LePine, 2005). The inadequacy of team action patterns in changing situations helps explain the flux in coordination identified by Summers et al. (2012) when characterizing the team state resulting after a change in its task environment. When faced with a task change, teams need to realize that their previously established patterns have become ineffective, and they need to experiment with new action sequences in order to find new optimal patterns for the new situation.

Further on this topic, the fact that we focused on the role of taskwork TMMs in our work also gives us further insights as to how adaptation processes unfold. We highlight the fact that shared taskwork TMMs did not predict the initial onset of action patterns but instead positively predicted the slope of action pattern development. This finding is consistent with previous research suggesting that shared cognition can help teams adapt when confronted with unexpected change events (Burke et al., 2006; Marks, Zaccaro, & Mathieu, 2000). It appears that a shared task mental model helps teams rapidly become aware of the misfit between their action patterns and the current altered task situation and thereby sets in motion the pattern-abandonment process. In any case, the fact that we measure TMMs after teams complete the first scenario calls for caution in the way we relate TMMs with the initial onset of action patterns. Thus, we cannot infer a predictive relationship between TMMs and the very first action patterns occurring in the first scenario.

Finally, our results describing trajectories of team action patterns over time allow us to connect with extant literature concerning the relevance of coordination processes when teams adapt to task changes (Arrow et al., 2000; Rico et al., 2014). In this regard, team action processes are a clear indicator of implicit team coordination, with the team integrating its activities mainly through a series of well-oiled patterns of action. Thus, our findings confirm the pivotal role of shared knowledge structures in implicit team coordination, as predicted by Rico et al. (2008). The finding that after the first task change (i.e., TA1), teams with highly shared taskwork TMMs exhibit a decrease in action patterns (in other words, a decrease in implicit coordination processes) provides empirical support of the prediction that TMMs also play a key role in allowing the team to cycle between implicit and explicit coordination process when teams adapt to changes (Rico et al., 2014). In this sense, and complementing the process approach to adaptation (Baard et al., 2014), we provide further empirical input on how the adaptation process unfolds over time. The observed action pattern dynamics suggest an increase in explicit coordination to cope with the severity of the disruptive effect of the changes (Rico et al., 2014). Thus, although in stable circumstances teams may be effective through an increase of their action patterns reflecting the predictability of team members' actions (i.e., implicit coordination), when changes arise, the team may still be effective by decreasing their action patterns and openly discussing which new action patterns may be required to cope with the new situation (i.e., explicit coordination). In any case, the dynamics we report here regarding team action patterns before and after changes help in addressing the need to better characterize the specific underlying mechanisms involved in team adaptation—a need so often emphasized in the field (Maynard et al., 2015).

Our work here also contributes to the literature on team behavioral patterns by identifying the antecedent role of taskwork TMM sharedness which, at the outset of the trajectory, influences the development and change of action patterns over time. Shared taskwork TMMs did not predict the onset of action patterns occurring in the initial stages of team development but positively predicted the slope of action pattern development. This finding supports Kozlowski's et al. (1999) emphasis on the importance of the initial formation phase (during which team members develop interpersonal knowledge and a shared understanding) for the development of subsequent dyadic and team level interaction structures. A shared understanding of the task enables team members to anticipate the needs and actions of the other team members, thereby increasing predictability and enabling team members to adjust their actions to be compatible with those of others (Rico et al., 2008). In addition, we find that TMM similarity is negatively related to the level of action patterns in the first transition period, meaning that teams with similar mental models were able to shed their action patterns more easily after a discontinuous task change.

A number of authors have recently renewed the call for more in-depth examinations of temporal processes involved in the emergence of group level constructs (Cronin et al., 2011; Kozlowski & Chao, 2012; Waller et al., 2016). Emergence has been defined as "the process by which lower level system elements interact and through those dynamics create phenomena that manifest at a higher level of the system" (Kozlowski & Chao, 2012, p. 335). Central to the notion of emergence is its conceptualization as a process that occurs over time through the interaction of the individual level elements (Cronin et al., 2011), and more specifically, that emergent team phenomena emanate from behaviors of members and include emergent states, behavioral patterns, and structures (Waller et al., 2016).

The above-mentioned works uniformly lament that although most team constructs are essentially emergent constructs, most studies treat these constructs as static elements, neither measuring nor explicating the emergent processes through which lower level elements give rise to higher level constructs. In this regard, we contribute to a deeper understanding of team construct emergence by identifying stable team action patterns as emerging from the discrete actions of the individual team members, operationalized as actions taken during the simulation. In so doing, we illustrate how this emergent construct develops over time as team members repeatedly interact with each other to continuously build on and refine their action patterns. Moreover, we investigate how discontinuous team changes influence the process of emergence and how the trajectory of emergence can differ depending on individual knowledge at the outset of the team lifecycle. Thus, we provide a truly dynamic account of the emergence of team action patterns as team members struggle to cope with a changing and unpredictable work environment.

Kozlowski and Chao (2012) argued that one of the reasons why there is still so little empirical research on emergence is that most research in organizational behavior relies on perceptual survey measures to capture our main constructs. This limits the ability to gather many repeated measures of the same construct and often evokes questions about the construct validity of emergence measures. In this study, we were able to avoid these pitfalls by making use of an automatically recorded behavioral measure as the input for our data analyses. Researchers conducting laboratory studies are increasingly using such automatically captured behavioral data to attain rich and objective data (e.g., Grand, Braun, Kuljanin, Kozlowski, & Chao, 2016). This technique may not be limited to laboratory settings, however, as several scholars have been able to tap existing data sources to gather rich and objective data (e.g., Pentland, Haerem, & Hillison, 2010).

4.2 | Practical implications

The current study offers practical implications for training team leaders and members to become aware of and leverage their action patterns for improving effectiveness in dynamic environments. Action patterns are often extremely difficult to detect when simply observing sequences of behavior (Magnusson, 2000). Therefore, it is likely that team members are not explicitly aware of the action patterns in which they engage and the effect these patterns have on their coordination and team functioning. Training team members and leaders in meta-skills that involve becoming aware of action patterns occurring within their teams, giving them tools to both identify these patterns and assess their effectiveness for team functioning would be a powerful way to facilitate team learning. Although in some contexts, this may entail direct observation of behaviors to identify action patterns, increasing technical possibilities is likely to make it possible in the near future to automate this process. For instance, tools that combine automatic speech recognition software with algorithms for pattern recognition may be used to provide feedback that can be used as input for team reflection during debriefings of verbal interactions (Vashdi, Bamberger, Erez, & Weiss-Meilik, 2007). It could be feasible to use similar tools to provide the team with real-time live feedback during actual task performance. Particularly in high-stakes environments, the use of such tools could potentially increase team action pattern quality and thereby improve safety.

Additionally, our findings stress the importance for teams to develop shared mental models of the task early on in the team lifecycle. This suggests that teams may benefit from transition episodes early on—episodes during which team members share their knowledge, assumptions, and expectations on the execution of the task. This may help team members to rapidly learn to anticipate the actions and demands of other teammates and, as suggested by our work here, could thereby foster the development of effective action patterns.

4.3 | Limitations and future directions

In spite of the contributions noted above, our research presents several potential limitations that are worth considering, as they will help future research endeavors to better characterize the relationships of team action patterns and effectiveness adaptation.

First, we acknowledge the fact that we used a synthetic task in a laboratory setting with teams formed for a very short duration task (even considering that our teams came together to work three separate times—more than the average, we would suggest, for laboratory research on similar topics). This setting thus imposes certain limitations to team actions that may constrain the emergence of team action patterns. We expect that in real life settings, team action patterns would exert stronger effects on teams due to higher levels of repeated interaction and more profound consequences for team members. Although we could argue in favor of the robustness of our findings precisely for the same reasons we are referring to above, we ask for future research replicating our findings in more naturalistic settings. Additionally, teams in real organizational settings would likely present some team action patterns that have additional social and emotional value, therefore making them less amenable to change.

The above limitation relates to a second drawback of our study regarding the type of teams we used. In this regard, our teams could be identified as action teams, which are characterized by clearly specified and highly interdependent roles (see Hollenbeck, Beersma, & Schouten, 2012); consequentially, our results should be translated with caution to other type of teams. Other types of teams may exhibit different types of action patterns due to the necessity to negotiate both the roles and the resources each role controls within the team. Additional differences between other types of teams and action teams could be due to different types of interdependence arrangements for their work; the action teams we studied were reciprocal by design, but teams using, for example, a pooled interdependence structure could exhibit different types of action patterns. In addition, to test our findings in more naturalistic settings, future research efforts should also be trained toward considering how the type of teams will influence the pattern of results.

Further, recent work on team adaptation emphasizes that the effectiveness of processes and emergent states may differ depending on the nature of the changes with which the teams are faced (Christian, Christian, Pearsall, & Long, 2017; Maynard et al., 2015). The kind of changes that our teams faced were mainly task-based, and we only focused on task TMMs to untangle their relationship with team action patterns. However, the role of team TMMs should also be elucidated in further research incorporating changes triggered by team-based issues. In this regard, recent theoretical developments in the field offer a good start in constructing empirically testable hypotheses (e.g., Maynard et al., 2015). For example, it could be inferred that if interpersonal conflict arising in a team triggers team adaptation, team TMMs will require a change (resulting temporarily in less shared team TMMs) to support the new required team interaction patterns guaranteeing team effectiveness. Moreover, consistent with previous adaptation research, we introduced changes that increased the complexity of the task (Baard et al., 2014), making it impossible to separate effects of task novelty from increases in complexity. Recent literature on the operationalization of task complexity (Hærem, Pentland, & Miller, 2015) may serve as a basis to assess or manipulate task complexity independently from task changes, enabling future studies to disentangle these effects.

Additionally, because changes were always introduced on a new day, this could potentially present a confound in our design. It is possible that some of the changes in pattern use and effectiveness were due not to the task changes but to the fact that these new scenarios were introduced on another day, which could, for instance, be related to reduced fatigue or the forgetting of some action patterns. However, there is no reason to assume systematic between-team differences in how these day-level effects would impact team functioning. Moreover, our analyses show no intercept effects of new days on action pattern development. This indicates that the occurrence of team action patterns did not significantly increase or decrease on the first performance trial of the new day relative to the last performance trial of the previous day. This absence of a change in the occurrence of team action patterns on new days suggests that there was no "forgetting" effect; teams maintained the level of action patterns they had displayed in the end of the previous day. Nevertheless, future research on team adaptation could consider how the timing of changes can impact team adaptive responses. For instance, does it matter if a change is introduced between or within scenarios?

An additional limitation of our study concerns the assumption of team membership stability. Our design did not investigate the effects of pattern emergence for existing teams that experience attrition and/or the arrival of new team members, and future work could certainly investigate such effects. The trajectory of action pattern emergence given a partial membership change might well result in an outcome similar to that found by Lewis, Belliveau, Herndon, and Keller (2007) examination of transactive memory systems (TMSs) under a partial membership change situation. They found that teams simply followed "oldtimers'" TMSs when newcomers were added to the team, resulting in poor performance. However, once the oldtimers were asked to reflect upon and articulate their TMSs, performance improved. A similar effect could also hold for team action patterns, although the ability of team members to articulate behavioral patterns (without prompting or training) is questionable (see Magnusson, 2000).

Although we attempted to capture a dynamic account of the emergence of team action patterns, we did not capture the potential change in TMMs across different scenarios and how such change could influence subsequent behavioral patterns and team effectiveness evolution. TMMs are considered stable team-level, long-term stored knowledge representations (Mohammed et al., 2017); however, they must change in order to support team effectiveness if the team faces task changes. Our limitation illuminates a clear avenue for future research to ascertain if those teams shedding their action patterns immediately after a change exhibited higher adaptive effectiveness because their TMMs also changed (e.g., Uitdewilligen et al., 2013). For example, if TMMs become more accurate or more complex (i.e., increasing the amount of ready-to-use procedures with potential situation changes) over time, perhaps they provide a well-grounded knowledge-based to facilitate rapid transition to different action patterns, ultimately resulting in increased team effectiveness.

Finally, although our study focused on behavioral actions, we did not characterize the nature or characteristics (such as length or complexity) of such action patterns; instead, we focused our efforts first on quantitatively tracking the existence of action patterns. Thus, it is possible that although our results regarding task changes not producing an increase or decrease in team action patterns are clear, changes did occur in the characteristics of the patterns. Future studies should transcend the quantitative approach we followed regarding team action patterns and gain deeper understanding of their qualitative nature. That step is a necessary one to fully understand how team action patterns change over time and influence team effectiveness in changing task circumstances. On a related note, team communication interactions could be also taken into account. These interactions may have different dynamics and interact with other types of behavioral actions; pursing additional work in this area will offer a new perspective for understanding how explicit and implicit coordination mechanisms drive effective team adaptation.

4.4 | Conclusion

Based on the results generated by our work, we find that increasing emergence of team action patterns predicts team effectiveness over time, particularly when teams hold highly shared teamwork TMMs. By investigating how team action pattern emergence relates to team effectiveness in a dynamic environment, we show that the positive relationship between team action patterns and team effectiveness is reset after a task change; action patterns are associated with a larger drop in team effectiveness after an initial task change and with a slower reuptake in team effectiveness after a subsequent change. In addition, those teams with highly shared taskwork TMMs experience a keen decline in action patterns after a task change. The results of this study reveal how team adaptation processes manifest as variations of team action patterns, and how team cognitive structures provide considerable support in ensuring that teams coping with changing circumstances develop the action patterns that lead to improved outcomes.

ORCID

Sjir Uitdewilligen http://orcid.org/0000-0001-7815-1579
Ramón Rico http://orcid.org/0000-0002-1999-7694
Mary J. Waller http://orcid.org/0000-0003-0389-5332

REFERENCES

Abelson, R. P. (1981). Psychological status of the script concept. *American Psychologist*, *36*(7), 715–729.

Arrow, H., & McGrath, J. E. (1993). Membership matters how member change and continuity affect small group structure, process, and performance. *Small Group Research*, *24*(3), 334–361.

Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). *Small groups as complex systems*. Thousand Oaks, CA: Sage.

Audia, P. G., Locke, E. A., & Smith, K. G. (2000). The paradox of success: An archival and a laboratory study of strategic persistence. *Academy of Management Journal*, *4*, 837–853.

Baard, S. K., Rench, T. A., & Kozlowski, S. W. J. (2014). Performance adaptation: A theoretical integration and review. *Journal of Management*, *40*, 48–99. https://doi.org/10.1177/0149206313488210.

Ballard, D. I., Tschan, F., & Waller, M. J. (2008). All in the timing: Considering time at multiple stages of group research. *Small Group Research*, *39*, 328–351. https://doi.org/10.1177/1046496408317036.

Betsch, T., Haberstroh, S., Glöckner, A., Haar, T., & Fiedler, K. (2001). The effects of routine strength on adaptation and information search in recurrent decision making. *Organizational Behavior and Human Decision Processes*, *84*(1), 23–53.

Bettenhausen, K., & Murnighan, J. K. (1985). The emergence of norms in competitive decision-making groups. *Administrative Science Quarterly*, *30*, 350–372.

Bliese, P. D., & Ployhart, R. E. (2002). Growth modeling using random coefficient models: Model building, testing, and illustrations. *Organizational Research Methods*, *5*, 362–387. https://doi.org/10.1177/109442802237116.

Borgatti, S., Everett, M. G., & Freeman, L. C. (1992). *UCINET IV network analysis software*. Columbia, SC: Analytic Technologies.

Burke, C. S., Stagl, K. C., Salas, E., Pierce, L., & Kendall, D. (2006). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology*, *91*, 1189–1207. https://doi.org/10.1037/0021-9010.91.6.1189.

Cannon-Bowers, J. A., Salas, E., & Converse, S. (1993). Shared mental models in expert team decision making. In N. J. Castellan, Jr. (Ed.), *Individual and group decision making* (pp. 221–246). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Christian, J. S., Christian, M. S., Pearsall, M. J., & Long, E. C. (2017). Team adaptation in context: An integrated conceptual model and meta-analytic review. *Organizational Behavior and Human Decision Processes*, *140*, 62–89. https://doi.org/10.1016/j.obhdp.2017.01.003.

Cohen, M. D., & Bacdayan, P. (1994). Organizational routines are stored as procedural memory: Evidence from a laboratory study. *Organization Science*, *5*, 554–568. https://doi.org/10.1287/orsc.5.4.554.

Collins, C. G., Gibson, C. B., Quigley, N. R., & Parker, S. K. (2016). Unpacking team dynamics with growth modeling: An approach to test, refine, and integrate theory. *Organizational Psychology Review*, *6*(1), 63–91.

Cronin, M. A., Weingart, L. R., & Todorova, G. (2011). Dynamics in groups: Are we there yet? *The Academy of Management Annals*, *5*, 571–612. https://doi.org/10.1080/19416520.2011.590297.

Edmondson, A. C., Winslow, A. B., Bohmer, R. M., & Pisano, G. P. (2003). Learning how and learning what: Effects of tacit and codified knowledge on performance improvement following technology adoption. *Decision Sciences*, *34*(2), 197–224.

Edwards, B. D., Day, E. A., Arthur, W., & Bell, S. T. (2006). Relationships among team ability composition, team mental models, and team performance. *Journal of Applied Psychology*, *91*, 727–736. https://doi.org/10.1037/0021-9010.91.3.727.

Espinosa, J. A., Lerch, F. J., & Kraut, R. E. (2004). Explicit versus implicit coordination mechanisms and task dependencies: One size does not fit all. In E. Salas, & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 107–129). Washington, DC: American Psychological Association.

Feldman, D. C. (1984). The development and enforcement of group norms. *Academy of Management Review*, *9*(1), 47–53.

Feldman, M. S. (2000). Organizational routines as a source of continuous change. *Organization Science*, *11*(6), 611–629.

Fussell, S. R., & Krauss, R. M. (1989). The effects of intended audience on message production and comprehension: Reference in a common ground framework. *Journal of Experimental Social Psychology*, *25*, 203–219. https://doi.org/10.1016/0022-1031(89)90019-X.

Gersick, C. J. G. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of Management Review*, *16*, 10–36.

Gersick, C. J. G., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes*, *47*, 65–97. https://doi.org/10.1016/0749-5978(90)90047-D.

Ginnett, R. C. (1987). First encounters of the close kind: The formation process of airline flight crews (No. AFIT/CI/NR-87-138D). Air Force inst of tech Wright-Patterson afp oh School of System and Logistics.

Gladstein, D. L., & Reilly, N. P. (1985). Group decision making under threat: The tycoon game. *Academy of Management Journal*, *28*(3), 613–627.

Gorman, J. C., & Cooke, N. J. (2011). Changes in Team cognition after a retention interval: The benefits of mixing it up. *Journal of Experimental Psychology Applied*, *17*(4), 303–319. https://doi.org/10.1037/a0025149

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W., & Chao, G. T. (2016). The dynamics of team cognition: A process-oriented theory of knowledge emergence in teams. *Journal of Applied Psychology*, *101*(10), 1353.

Hærem, T., Pentland, B. T., & Miller, K. D. (2015). Task complexity: Extending a core concept. *Academy of Management Review*, *40*(3), 446–460.

Hale, D., Ployhart, R., & Shepherd, W. (2015). A two-phase longitudinal model of a turnover event: Disruption, recovery rates, and moderators of collective performance. *Academy of Management Journal*, *59*(3), 906–929.

Hollenbeck, J. R., Beersma, B., & Schouten, M. E. (2012). Beyond team types and taxonomies: A dimensional scaling conceptualization for team description. *Academy of Management Review*, *37*(1), 82–106.

Huber, G. P., & Lewis, K. (2010). Cross-understanding: Implications for group cognition and performance. *Academy of Management Review*, *35*(1), 6–26.

Kanki, B. G., Folk, V. G., & Irwin, C. M. (1991). Communication variations and aircrew performance. *International Journal of Aviation Psychology*, *1*, 149–162. https://doi.org/10.1207/s15327108ijap0102_5.

Klimoski, R., & Mohammed, S. (1994). Team mental model: Construct or metaphor? *Journal of Management*, *20*(2), 403–437.

Kozlowski, S. W., & Chao, G. T. (2012). The dynamics of emergence: Cognition and cohesion in work teams. *Managerial and Decision Economics*, *33*(5–6), 335–354.

Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen, & E. D. Pulakos (Eds.), *The changing nature of work performance: Implications for staffing, personnel actions, and development* (pp. 240–292). San Francisco: Jossey-Bass.

Lang, J. W. B., & Bliese, P. D. (2008). General mental ability and two types of adaptation to unforeseen change: Applying discontinuous growth models to the task-change paradigm. *Journal of Applied Psychology*, *94*, 411–428. https://doi.org/10.1037/a0013803.

Lei, Z., Waller, M. J., Hagen, J., & Kaplan, S. (2016). Team adaptiveness in dynamic contexts: Contextualizing the roles of interaction patterns and in-process planning. *Group & Organization Management*, *41*(4), 491–525.

LePine, J. A. (2003). Team adaptation and postchange performance: Effects of team composition in terms of members' cognitive ability and personality. *Journal of Applied Psychology*, *88*, 27–39. https://doi.org/10.1037/0021-9010.88.1.27.

LePine, J. A. (2005). Adaptation of teams in response to unforeseen change: Effects of goal difficulty and team composition in terms of cognitive ability and goal orientation. *Journal of Applied Psychology*, *90*, 1153–1167. https://doi.org/10.1037/0021-9010.90.6.1153.

Lewis, K., Belliveau, M., Herndon, B., & Keller, J. (2007). Group cognition, membership change, and performance: Investigating the benefits and detriments of collective knowledge. *Organizational Behavior and Human Decision Processes*, *103*(2), 159–178.

Lim, B. C., & Klein, K. J. (2006). Team mental models and team performance: A field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior*, *27*, 403–418.

Magnusson, M. S. (2000). Discovering hidden time patterns in behavior: T-patterns and their detection. *Behavior Research Methods, Instruments, & Computers*, *32*, 93–110. https://doi.org/10.3758/BF03200792.

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys (CSUR)*, *26*(1), 87–119.

Marks, M. A., Sabella, M. J., Burke, C. S., & Zaccaro, S. J. (2002). The impact of cross-training on team effectiveness. *Journal of Applied Psychology*, *87*(1), 3–13.

Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of Applied Psychology*, *85*, 971–986. https://doi.org/10.1037/0021-9010.85.6.971.

Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Cannon-Bowers, J. A., & Salas, E. (2005). Scaling the quality of teammates' mental models: Equifinality and normative comparisons. *Journal of Organizational Behavior*, *26*, 37–56. https://doi.org/10.1002/job.296.

Maynard, M. T., Kennedy, D. M., & Sommer, S. A. (2015). Team adaptation: A fifteen-year synthesis (1998–2013) and framework for how this literature needs to "adapt" going forward. *European Journal of Work and Organizational Psychology*, *24*(5), 652–677.

Mohammed, S., Ferzandi, L., & Hamilton, K. (2010). Metaphor no more: A 15-year review of the team mental model construct. *Journal of Management*, *36*, 876–910. https://doi.org/10.1177/0149206309356804.

Mohammed, S., Hamilton, K., Sanchez-Manzanares, M., & Rico, R. (2017). Team cognition: Team mental models and situation awareness. In E. Salas, R. Rico, & J. Passmore (Eds.), *The Wiley Blackwell handbook of the psychology of teamwork and collaborative team processes* (pp. 369–392). London: Wiley Blackwell.

Omodei, M. M., Taranto, P., & Wearing, A. J. (2003). *Networked Fire Chief (Version 1.33)* [computer program]. Melbourne: La Trobe University.

Pearsall, M. J., Ellis, A. P. J., & Bell, B. S. (2010). Building the infrastructure: The effects of role identification behaviors on team cognition development and performance. *Journal of Applied Psychology*, *95*, 192–200. https://doi.org/10.1037/a0017781.

Pentland, B. T., Haerem, T., & Hillison, D. (2010). Comparing organizational routines as recurrent patterns of action. *Organization Studies*, *31*, 917–940.

Pinheiro, J., Bates, D., DebRoy, S., & Sarkar, D. (2014). R core team (2014) nlme: Linear and nonlinear mixed effects models. R package version 3.1–117. See http://CRAN.R-project.org/package=nlme.

Ployhart, R. E., & Vandenberg, R. J. (2010). Longitudinal research: The theory, design, and analysis of change. *Journal of Management*, *36*, 94–120. https://doi.org/10.1177/0149206309352110.

Reagans, R., Argote, L., & Brooks, D. (2005). Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. *Management Science*, *51*(6), 869–881.

Rico, R., Gibson, C., Sánchez-Manzanares, M., & Clark, M. (2014). On the interplay of implicit and explicit team coordination: Understanding team adaptation. *Paper presented to the 2014* EAWOP Small Group Meeting Conference on Dynamics of Team Cognition and Team Adaptation, Lisbon: Portugal.

Rico, R., Sanchez-Manzanares, M., Gil, F., & Gibson, C. (2008). Team implicit coordination processes: A team knowledge-based approach. *Academy of Management Review*, *33*, 163–184.

Roe, R. A. (2008). Time in applied psychology. The study of "what happens" rather than "what is". *European Psychologist*, *13*, 37–52.

Sander, P. C., van Doorn, R. R., van der Pal, J., & Zijlstra, F. R. (2015). Team adaptation to an unforeseen system failure: Limits of the potential aids of shared knowledge and standardized communication. *European Journal of Work and Organizational Psychology*, *24*(5), 796–811.

Santos, M. C., & Passos, M. A. (2013). Team mental models, relationship conflict and effectiveness over time. *Team Performance Management: An International Journal*, *19*(7/8), 363–385. https://doi.org/10.1108/TPM-01-2013-0003

Santos, C. M., Uitdewilligen, S., & Passos, A. M. (2015). A temporal common ground for learning: The moderating effect of shared mental models on the relation between team learning behaviours and performance improvement. *European Journal of Work and Organizational Psychology*, *24*(5), 710–725.

Schulz, M. (2008). Staying on track: A voyage to the internal mechanisms of routine reproduction. In M. C. Becker (Ed.), *Handbook of organizational routines* (pp. 228–255). UK, Edward Elgar Publishing: Cheltenham.

Stachowski, A. A., Kaplan, S. A., & Waller, M. J. (2009). The benefits of flexible team interaction during crises. *Journal of Applied Psychology*, *94*, 1536–1543. https://doi.org/10.1037/a0016903.

Staw, B. M., Sandelands, L. E., & Dutton, J. E. (1981). Threat-rigidity effects in organizational behavior: A multilevel analysis. *Administrative Science Quarterly*, *26*, 501–524.

Summers, J. K., Humphrey, S. E., & Ferris, G. R. (2012). Team member change, flux in coordination, and performance: Effects of strategic core roles, information transfer, and cognitive ability. *Academy of Management Journal*, *55*, 314–338.

Turner, M. E., & Horvitz, T. (2001). The dilemma of threat: Group effectiveness and ineffectiveness under adversity. *Groups at work: Theory and research*, 445–470.

Tushman, M. L., & Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation. In L. L. Cummings, & B. M. Staw (Eds.), *Research in organizational behavior* (Vol. 7) (pp. 171–222). Greenwich, CT: JAI.

Uitdewilligen, S., Waller, M. J., & Pitariu, A. H. (2013). Mental model updating and team adaptation. *Small Group Research*, *44*, 127–158.

Vashdi, D. R., Bamberger, P. A., Erez, M., & Weiss-Meilik, A. (2007). Briefing-debriefing: Using a reflexive organizational learning model from the military to enhance the performance of surgical teams. *Human Resource Management*, *46*(1), 115–142.

Waller, M. J., Okhuysen, G. A., & Saghafian, M. (2016). Conceptualizing emergent states: A strategy to advance the study of group dynamics. *The Academy of Management Annals*, *10*(1), 561–598.

Zellmer-Bruhn, M., Waller, M. J., & Ancona, D. (2004). The effect of temporal entrainment on the ability of teams to change their routines. In E. Mannix, M. A. Neale, & S. Blount-Lyon (Eds.), *Time in groups* (6th ed.) (pp. 135–158). Bingley, UK: Emerald Group Publishing Limited.

Zhou, Y., & Wang, E. (2010). Shared mental models as moderators of team process-performance relationships. *Social Behavior and Personality*, *38*(4), 433–444. https://doi.org/10.2224/sbp.2010.38.4.433

Zijlstra, F. R. H., Waller, M. J., & Phillips, S. I. (2012). Setting the tone: Early interaction patterns in swift-starting teams as a predictor of effectiveness. *European Journal of Work and Organizational Psychology*, *21*, 1–29. https://doi.org/10.1080/1359432X.2012.690399.

Sjir Uitdewilligen, Ph.D., is an assistant professor of work and organizational psychology at Maastricht University, Netherlands. His research focuses on team communication and cognition, team adaptation to unexpected changes and nonroutine events, and multiteam systems.

Ramón Rico, Ph.D., is an associate professor at the University of Western Australia. His current research interests include shared cognition, team and leadership adaptation, team diversity, task design characteristics, multiteam systems, and team process and effectiveness.

Mary J. Waller, Ph.D., is M.J. Neeley Professor of Management at the Neeley School of Business, Texas Christian University. Her research focuses on emergent team dynamics and effectiveness during critical, nonroutine situations and includes studies of flight crews, nuclear power plant crews, health care teams, mine rescue teams, and many other types of teams as they face real or simulated unexpected events.

How to cite this article: Uitdewilligen S, Rico R, Waller MJ. Fluid and stable: Dynamics of team action patterns and adaptive outcomes. *J Organ Behav*. 2018;39:1113–1128. https://doi.org/10.1002/job.2267