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Patterns of team adaptation: The effects of behavioural interaction patterns on team adaptation and the antecedent effect of empowering versus directive leadership

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Abstract

In this study, we analysed the effects of team leadership style and magnitude of change on team behavioural interaction patterns (TBIPs) and performance in teams coping with unexpected task changes. Sixty-seven 3-person teams took part in a computer-based fire-fighting simulation task and were randomly assigned to one of the four conditions resulting from our 2 (leadership style: directive vs. empowering) × 2 (magnitude of change: high vs. low) longitudinal factorial design. Our results showed that empowering-led teams tend to display more TBIPs than directive-led teams. Through discontinuous random coefficient growth modelling, we observed that prechange TBIPs negatively affect teams' transition adaptation. However, postchange TBIPs were beneficial for teams' reacquisition adaptation. Implications for theory and practice are discussed.

KEYWORDS
directive leadership, empowering leadership, magnitude of change, team adaptation, team behavioural interaction patterns

1 | INTRODUCTION

More than ever teams are ongoingly facing external and internal crises and changes derived from the unpredictability and dynamism of the context in which they operate (Christian et al., 2017; French et al., 2020). Recent COVID-19 pandemic has highlighted even more, our need for understanding how teams respond to events and effectively recover from them (Uitdewilligen et al., 2021). Fortunately, there is an incremental interest in the study of team adaptation (defined as modifications made by team members in response to new situations—Baard et al., 2014) as a crucial element leveraging organisational effectiveness (Rico et al., 2019; Rosen et al., 2011). Along the last 15 years, research has transitioned from focusing over team adaptation antecedents, the nature of changes triggering adaptation and the outcomes of team adaptation, to an emphasis on the adaptive process itself (Baard et al., 2014; Rico et al.,

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2020). Such efforts in unpacking the team adaptation process are mainly centred in discerning the cues for team adaptation stemming from the way task changes are understood, how teams coordinate in light of their perceptions, and how the negative and positive team adaptation outcomes occur over time (Rico et al., 2019).

One of the central elements of inquiry in unpacking the team adaptation process are the so-called team behavioural interaction patterns (TBIPs, defined as recurrent sequences of verbal and non-verbal interactions performed by team members—Zellmer-Bruhn et al., 2004). These patterns are task-directed activities which team members create through practice (Feldman, 2000); such as for example, the way in which a firefighting team through training and practice develops an efficient routine for preparing and setting up equipment, and confronting a fire. TBIPs increase team's efficiency because their recurrent nature increases team members' action predictability (Zellmer-Bruhn et al., 2004); thus, team members could coordinate implicitly each time they encounter a situation suited for their use (Rico et al., 2008). The relevance of TBIPs for team adaptation has been already discussed in extant research revealing that to be effective teams performing in stable or routine task settings require longer and complex interaction patterns (e.g., Hoogeboom & Wilderom, 2020; Lei et al., 2016); while teams performing under nonroutine task settings, require simpler interaction patterns (e.g., Stachowski et al., 2009). Thus, the central role of TBIPs for team adaptation is clear (Uitdewilligen et al., 2013), but we still need to better understand the factors enabling teams to make the most of their interaction patterns when unexpected task changes occur.

In this regard, the minor role given to leadership in studying team adaptation is surprising. Particularly if we consider the role team leaders exert in the emergence of team processes required for team adaptation, such as shared cognition and coordination (e.g., Burke et al., 2006a; Marks et al., 2000; Rico et al., 2019) and in the creation of TBIPs. Whether team members are led in a directive or participative way has been differentially related to adaptive performance (Sánchez-Manzanares et al., 2020). Thus, because leaders have the capability to help teams in establishing and changing their TBIPs in response to situational demands (Zaccaro et al., 2001), directive or empowering leadership styles are likely to impact how TBIPs enable teams in coping with unexpected changes. However, there is no empirical evidence supporting this assertion yet. In addressing this gap, we first analyse the extent to which TBIPs are affected by the main relevant leadership styles in extant team leadership research: directive and empowering leadership (Lorinkova et al., 2013).

In addition to analysing leadership styles effects on TBIP's, current developments in team adaptation emphasize the need to incorporate change characteristics to fully understand how teams cope with unexpected situations (Christian et al., 2017; Maynard et al., 2015). In this regard, different TBIPs may differentially support team adaptation depending on the magnitude of change (defined as the severity of the task-based trigger requiring adaptation—Maynard et al., 2015) teams experience. Thus, under low-magnitude changes teams may still be able to perform, though at suboptimal levels, relying on pre-existing TBIPs. In contrast, under high-magnitude changes, team problems will be more severe and require either developing new TBIPs or a recombination of existing ones to ensure team performance. However, this question also remains to be addressed. Accordingly, our second research question examines direct and moderating effects of magnitude of change over TBIPs, and over the links between leadership style, TBIPs and team adaptive performance.

Team processes in general, and team adaptation in particular, shall be approached longitudinally to capture their dynamic nature (Kozlowski et al., 1999). Accordingly, we adopted the two-phase framework proposed by Lang and Bliese (2009) that articulates team adaptation in: a transition phase (i.e., the immediate decrease in team performance after facing the change), and a reacquisition phase (i.e., the gradual team performance recovery after facing the change). Because these two adaptation phases capture distinct forms of adaptive performance, we dissect how TBIPs developed in the prechange period affect teams' transition adaptation, and how TBIPs developed in the postchange period impact teams' reacquisition adaptation.

In sum, as Figure 1 shows, we analyse both direct and interactive effects of leadership style and magnitude of change over pre- and postchange TBIPs and team transition and reacquisition adaptation respectively. To do so, we designed a longitudinal experimental study and used discontinuous random coefficient growth modelling to test for TBIPs differences that may benefit postchange team performance during both transition and reacquisition phases.

Our study contributes to theory, research and practice on team adaptation, TBIPs and leadership in several ways. First, by uncovering the relationships between leadership styles, TBIPs and team adaptive performance, we better understand how leaders promote TBIPs that enable teams to handle task changes of different magnitude and progressively recover their performance. Furthermore, analysing the moderating role of the magnitude of change help us to disentangle the extent to which team leadership shall adaptively respond to changes of different magnitude. Concomitantly, this improves our understanding of the role that the magnitude of change has over leaders and TBIPs when responding adaptively. In addition, adopting a longitudinal design better position us to explore how TBIPs trajectories support both transition and reacquisition adaptation, under different leadership styles and changes of different magnitude. Finally, from a practical stance, this study increases both leaders and team members awareness regarding how different leadership styles and TBIPs are optimally adaptive at different moments (i.e., right after the change or while recovering from it) and under different magnitudes of change. This information is of paramount relevance both for team and leadership adaptive training and development.

2 | THEORETICAL FRAMEWORK AND HYPOTHESES

2.1 | Team leadership styles effects on TBIPs

When teams work in unpredictable contexts, leaders may use different leadership styles to enable TBIPs establishing or adjustment

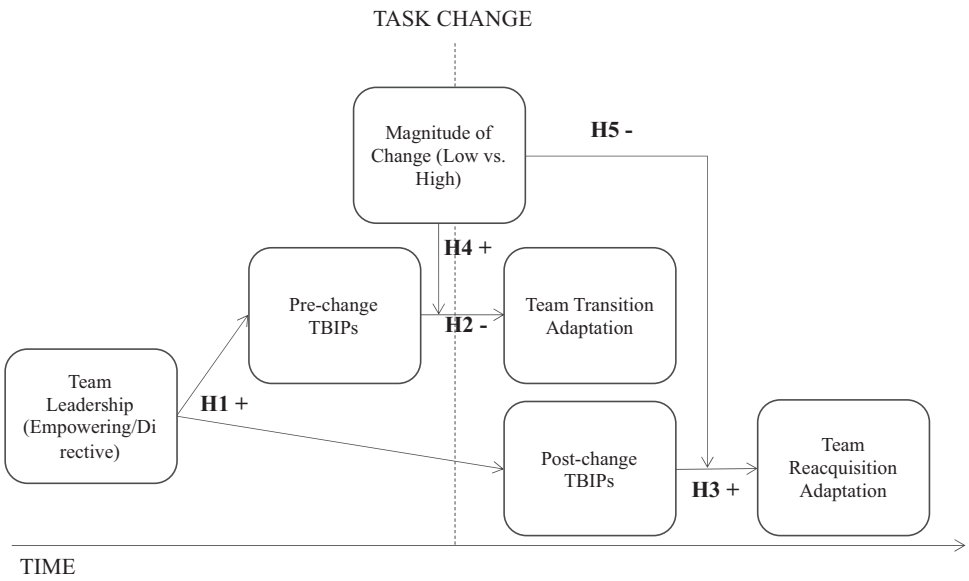

FIGURE 1 Research model

in response to situational demands (Zaccaro et al., 2001). Whereas directive leaders tend to make decisions and give instructions to the team (Sims et al., 2009), empowering leaders to increase team members' autonomy and responsibility (Srivastava et al., 2006). In this line, recent research revealed that empowering-led teams showed higher levels of team learning and team behavioural coordination (Lorinkova et al., 2013). Thus, empowering and directive leadership styles can differentially affect TBIPs in two main ways.

First, directive leaders restrain and control team members' behaviours by providing them with guidance in terms of task assignment and performance goals (House, 1996). Because directive leaders restrain interactions, team members focus on their own tasks in directive-led teams (Pearce & Sims, 2002). In terms of TBIPs, this entails directive-led teams displaying lower variety of TBIPs, and more unipersonal behavioural patterns instead (Kozlowski et al., 1999). For example, in hotels' housekeeping departments, directive supervisors monitor room cleaning needs according to check-ins/outs, and occupancy rate (Behaviour A), supervisors plan housekeepers' cleaning room distribution (Behaviour B) and assign tasks to them (Behaviour C). This behavioural sequence makes housekeepers engage in their own cleaning task, with restricted interaction between them. Thus, few TBIPs may occur.

Second, empowering leaders encourage frequent team member interactions, information interexchange and participative decision-making (Arnold et al., 2000). Following with our example above, in hotels' front-office departments, empowering leaders ask receptionists about shift incidents (Behaviour A), receptionists warn other front-office team members about shift issues (Behaviour B), and the desk-clerk offers help for problem solving (Behaviour C). This will become a stable TBIP as team members repeatedly perform it under the encouragement of an empowering leader. Thus, the amount of TBIPs is expected to be high. Given, that in general empowering leaders invite more input and encourage more interaction among team members than directive leaders (Cheong et al., 2016), we expect this effect to hold both before and after a task change. Based on the rationalities above, we hypothesize that:

Hypothesis 1 – *Empowering-led teams will show more TBIPs than directive-led teams.*

2.2 | Effects of TBIPs on team adaptation

Research on team adaptation has adopted a cross-sectional task-change approach (Baard et al., 2014) and although some efforts have been made to longitudinally analyse postchange performance (LePine, 2003) few studies assessed postchange performance trajectories (e.g., Lang & Bliese, 2009; LePine, 2005; Sánchez-Manzanares et al., 2020). Lang and Bliese's (2009) development allows studying team adaptation distinguishing three task performance phases: the initial skill acquisition or prechange phase (where teams begin their tasks, develop prechange TBIPs and increase their performance) and two postchange phases of team adaptation (i.e., transition and reacquisition). Adopting this approach, we can study the effects of prechange TBIPs on the transition phase and the effects of postchange TBIPs on the reacquisition phase. Thus, we overcome previous studies neglecting postchange team performance trajectories (Stachowski et al., 2009; Zijlstra et al., 2012).

Teams develop TBIPs early in their formation to increase efficiency (Zijlstra et al., 2012). TBIPs are established during the initial skill acquisition phase as team members interact and repeatedly perform behavioural sequences (Uitdewilligen et al., 2018). However, research suggests that prechange TBIPs obstruct task changes identification and hinder teams' transition adaptation (Stachowski et al., 2009). Extant studies focused on behaviours displayed when facing a disruption, and not along the prechange stage. Thus, the available

empirical evidence does not allow to firmly state that prechange TBIPs ease teams' transition adaptation. Further, studies suggest that effective prechange TBIPs are difficult to abandon and may become a liability when they are not appropriate after the change (Cohen & Bacdayan, 1994; Uitdewilligen et al., 2018), as postchange situation would require other behaviours (Kozlowski et al., 1999). Consequently, we follow Gersick and Hackman's (1990) proposition that prechange TBIPs increase teams' difficulty to adapt to changes and impair teams' transition adaptation making postchange team performance decline more acute. Thus, we submit that:

Hypothesis 2 – *Prechange TBIPs negatively impact teams' transition adaptation. The initial postchange team performance decline after facing a task change will be higher for teams displaying higher prechange TBIPs.*

To counteract the transition phase's performance decline, teams shall engage in acquiring new skills and gradually recover their performance (Lang & Bliese, 2009). Thus, during the postchange stage, teams establish TBIPs that will smooth coordination and free team resources to better perform the task (Gersick & Hackman, 1990; Uitdewilligen et al., 2018). However, extant empirical research is inconclusive on the effects of TBIPs on team performance along the post-change stage. Whereas Uitdewilligen et al. (2013) found that TBIPs positively predicted postchange team performance, other field studies suggest that TBIPs are indeed negative when managing disruptions (e.g., Stachowski et al., 2009).

Along postchange stages, teams shall identify new situational requirements to cope with the situation and increase performance. To do so, team members engage in behaviours implying frequent interactions (information sharing and planning), that create TBIPs when they are repeatedly performed (Rico et al., 2008). Accordingly, creating TBIPs might be initially detrimental facing a task disruption, because they might distract the team from fast task completion (Stachowski et al., 2009). However, the benefits of these new TBIPs will pay-off later enabling further identification of situational demands requiring adaptation, and gradually increasing postchange team performance (Abrantes et al., 2018). Hence, we expect that postchange TBIPs ease teams' reacquisition adaptation and improve team performance recovery after change.

Hypothesis 3 – *Postchange TBIPs positively relate with teams' reacquisition adaptation. The rate of recovery in postchange team performance after facing a task change will be higher for teams that display more postchange TBIPs.*

2.3 | The moderating role of magnitude of change on the effects of TBIPs on team adaptation

Whereas some studies found that high-magnitude changes facilitate team adaptation more than low-magnitude changes because they are easier to recognize (DeRue et al., 2008), other studies found that teams were more able to adapt to low-magnitude changes (Hollenbeck et al., 2011). This evidence highlights the importance of characterising the magnitude of change when examining both pre- and postchange TBIPs effects on teams' transition and reacquisition adaptation (Gersick & Hackman, 1990; Jundt et al., 2015).

In particular, previous theoretically driven propositions propose that the negative impact of prechange TBIPs on teams' transition adaptation is particularly acute for those teams facing high-magnitude changes (Gersick & Hackman, 1990). When teams face low-magnitude changes, prechange TBIPs may remain their usability to some extent in the new situation. In practical terms, this would mean that patterned behaviours that were useful in the prechange situation either could be directly transferred or would only require minor alterations, to remain effective in the postchange situation. In contrast, under high-magnitude changes, the task structure is substantially altered to render previously established patterns ineffective or even detrimental to performance (Stachowski et al., 2009). This suggests that patterns 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). Instead, team members need to actively overrule tendencies to engage in old patterns and novel TBIPs to deal with the new situation. Therefore, prechange TBIPs will increasingly impair teams' transition adaptation when facing changes of high magnitude. Therefore, we formally state that:

Hypothesis 4 – *Magnitude of change moderates the relationship between prechange TBIPs and teams' transition adaptation. The negative effect of prechange TBIPs on the initial postchange team performance decline after facing a task change will be higher when the magnitude of change is high.*

Similarly, postchange TBIPs may not be as beneficial during the reacquisition phase when dealing with high-magnitude changes compared to low-magnitude changes. In this sense, effective teams are expected to establish TBIPs according to the new postchange situation demands to increase team effectiveness (Uitdewilligen et al., 2018). However, the effect of TBIPs on postchange team performance may depend also on the magnitude of change faced.

The main reason for that moderation effect is that TBIPs are likely to be more beneficial for teams working in more predictable situations (Stachowski et al., 2009). Under high-magnitude change conditions, the complexity of the situation for the team is likely to be high (Hærem et al., 2015), requiring less standardized solutions, and more flexibility to cope with situational demands (Stachowski et al., 2009). Considering previous studies revealing that interaction patterns are less effective, or even detrimental to performance, in nonroutine situations (Hoogeboom & Wilderom, 2020; Lei et al., 2016), we expect that teams facing low-magnitude changes would benefit more from rapidly building novel sets of interaction patterns than teams with high-magnitude changes. Stated formally we predict that:

Hypothesis 5 – *Magnitude of change moderates the relationship between postchange TBIPs and teams' reacquisition adaptation. The positive*

effect of postchange TBIPs on the rate of recovery of postchange team performance after facing a task change will be higher when magnitude of change is low.

3 | METHODS

3.1 | Research participants

A total of 201 students (64% females) aged between 18 and 35 years old ($M = 20.93$, SD = 3.02) enroled at a major University in Southern Europe, were randomly assigned to sixty-seven 3-person teams that took part in a 3-h computer simulation (two 90-min sessions). Teams were assigned to one of the four conditions resulting from our 2 (magnitude of change: high vs. low) × 2 (leadership style: directive vs. empowering) factorial design[1]. All participants provided informed consent and were given 10€ in exchange for their participation.

3.2 | Task

Three participants played a total of nine missions on the Networked Fire Chief (NFC) wildfire simulator (Omodei et al., 2003) with networked computers located in three different cubicles. The purpose of the teams is to collectively extinguish fires programmed to appear over different locations using appliances to drop water or create control lines. Communication via headphones among team members as well as the audio recording of the sessions was possible using the software Ventrilo. Besides, the NFC simulation automatically generates files with the visual recording of the sessions.

Simulation environment: In each scenario participants were provided with seven vehicles to fight fires: three firetrucks, two helicopters which use water to extinguish larger fires and two bulldozers which can create barriers that prevent fire from spreading. Vehicles have different resource requirements (water and fuel) and travelling speed. Fires are programmed to appear and spread over different locations.

Team members' roles: Each participant could execute different actions depending on their roles. The leader of the team was only able to move and use the firetrucks. The second member could move and use the firetrucks, move and use bulldozers, move helicopters and refill water. The third member could move and use firetrucks, move and use helicopters, move bulldozers and refill fuel.

3.3 | Procedure

About 4–5 weeks before the experimental sessions, participants were sent an online questionnaire that assessed their demographic data, their neuroticism and their natural tendency leadership tendencies, which we used to select the team leaders. Team leaders were assigned to their corresponding leadership condition and randomly assigned to the magnitude of change (high vs. low) experimental conditions. The rest of the participants were randomly assigned to the teams. Selected team leaders were asked to arrive earlier in the laboratory to be trained immediately before the session, so that they would show the desired directive or empowering behaviours. The entire team was trained during 10 min on how to use the simulation with a training protocol that explained them how to operate in the simulation. After the training, each team performed four rounds of the task. Then the simulation was paused until the next day. The second day, each team performed five additional rounds. After the fifth round, that task change was introduced. After the end of the simulation, participants were asked to fill in a short survey.

3.4 | Manipulations and measures

3.4.1 | Leadership manipulation

Following extant studies, we manipulated team leadership through a strategy consisting of selection and training of leaders (Durham et al., 1997; Lorinkova et al., 2013). Using the Directive Leadership Scale (Durham et al., 1997) and the Empowering Leadership Questionnaire (Arnold et al., 2000) we selected those individuals as leaders who reported a natural tendency to act as a directive or empowering leaders in the initial questionnaire. Participants considered for leadership training were selected based on two criteria: (1) having a score in the top fifth of the Directive or Empowering Leadership Scale and (2) having a low level of neuroticism. The second criterion was incorporated because there was evidence from a pilot study that some individual leaders found it difficult to lead a team of nonfamiliar people. Consequently, we decided to measure participants' neuroticism, which refers to the ability to remain calm when confronted with difficult, stressful or changing situations.

3.4.2 | Training

Team leaders were first exposed to a 2-min verbal presentation explaining the behaviours they should show during the simulation consistent with their experimental condition. Directive leaders were then shown a 6-min clip from Apollo 13 (Howard et al., 1995) whereas empowering leaders were shown a 6-min clip from The Cube (Natali, 1997) emphasising the desired behaviours performed by a team leader. After this, they listened to a 4-min audio-recording leaders displaying either directive or empowering behaviours.

The magnitude of change manipulation: We manipulated the magnitude of change after the fifth scenario by increasing the effects of the wind on the fire spreading, increasing the size of the fires and reducing the amount of the available resources. In the high magnitude of change condition, some fires had longer warnings, were located in critical places, and spread faster depending on the wind intensity and direction. There was no possibility of successfully fighting those fires only with firetrucks or helicopters. The use of bulldozer was crucial to prevent fire spreading as well as prioritising

important over less important fires. In addition, the amount of resources provided was reduced to half. In the low magnitude of change condition some fires appeared in critical places, but they spread slower than in the high magnitude of change condition. Consequently, fighting fires with trucks and helicopters was possible and the use of bulldozer was not a priority. In this condition, the amount of resources provided remained the same as in the prechange scenarios.

3.4.3 | Team behavioural interaction patterns

TBIPs concern actions that are both verbal and nonverbal (Zellmer-Bruhn et al., 2004). Consequently, we developed an observational system that captures communications and actions based on (1) a review of observational systems developed in previous studies and (2) discussion with expert researchers in the topic. The categories from the literature review (Kolbe et al., 2013; Manser et al., 2008) were complemented through discussion with behaviours repeatedly shown by participants during the simulation. Two different raters coded participants' behaviours. Behaviours coded by the raters and examples are presented in the Appendix. Both raters coded the audiovisual material of 10 teams and achieved an inter-coder reliability of 0.76 (Cohen's κ) demonstrating substantial agreement. Next, each rater coded the half of the remaining material. Raters obtained information about the team member who executed the behaviour and the time in which the behaviour was executed. Cohen's κ was calculated again at the middle of the process using data of five teams showing substantial agreement (0.73). The coded material in the prechange period consisted of behaviours performed during tasks 1, 3 and 5 and the coded material in the postchange period consisted of behaviours performed during tasks 6, 8 and 9. Due to technical errors, the audiovisual material for three teams was missing for the whole simulation, for two teams this information was missing for the postchange period, and for one team this information was missing for the prechange period.

The coded material was used as input for identifying TBIPs. We used THEME, a pattern recognition software algorithm (Magnusson, 2000) that detect patterns in temporally ordered data. Similar to other research in the field, we set the minimum number of times a pattern should occur to three and we required a 95% probability that patterns occurred above and beyond chance (Lei et al., 2016; Zijlstra et al., 2012). We obtained two indicators of TBIP relating to (1) the total number of unique TBIPs and (2) the total occurrence of TBIPs. Following similar research (Uitdewilligen et al., 2013), and given the high correlation between these measures ($r = .92$ for prechange TBIPs and $r = .93$ for postchange TBIPs) we aggregated both indicators by averaging their z scores into a single measure.

3.4.4 | Team performance

Team performance was an index representing the percentage of landscape saved from the total that the team could have saved. The index ranges from 0 to 1, where 0 means the team did not save any piece of land and 1 means that the team performed the best possible.

4 | RESULTS

4.1 | Manipulation checks

4.1.1 | Leadership manipulation check

At the end of the simulation, we measured the extent to which team members perceived their leaders to behave in a directive (Durham et al., 1997) or empowering way (Arnold et al., 2000) with a 6-item test (using a 5-point Likert scale: 1 = *strongly disagree* and 5 = *strongly agree*). Three items were adapted from the directive leadership scale to measure perceived directive leadership ($\alpha = .70$; e.g. "The leader of my team makes decisions and establish performance goals alone"), and three items were adapted from the ELQ (Arnold et al., 2000) to measure perceived empowering leadership ($\alpha = .90$; e.g. "The leader of my team encourage team members to express their ideas"). Within group reliability was estimated with the Rwg (James et al. 1984). The mean R_{wg} was .86 and .87 concerning the perception of empowering and directive leadership behaviours which means strong agreement (LeBreton & Senter, 2008).

Participants in the directive condition perceived their leaders to be significantly more directive ($M = 4{,}03$, $SD = 0.45$) than those in the empowering condition ($M = 3.14$, $SD = 0.52$, $t(65) = -7.98$, $p < .01$). Participants in the empowering condition, perceived their leaders to be significantly more empowering ($M = 4.28$, $SD = 0.59$) than those in the directive condition ($M = 3.51$, $SD = 0.83$, $t(65) = 3.72$, $p < .01$). From these results we claim that our leadership manipulation was effective.

4.1.2 | Magnitude of change manipulation check

We measured the extent to which team members perceived that the tasks in the postchange scenarios had changed relative to the prechange scenarios. We used a 2-item test on a 5-point Likert scale (1 = *nothing at all* and 5 = *to a great extent*). An example of the items used is 'To what extent have the tasks of this session changed compared to the tasks in the previous session?' The reliability coefficient for the scale was high ($\alpha = .90$). The mean R_{wg} was .79 and .51 for perceived high and low magnitude of change, respectively, which means strong and moderate agreement (LeBreton & Senter, 2008), and we consider this enough evidence to justify agreement from the individual level to the team level. Participants in the high magnitude of change condition perceived that tasks in the second session had changed more compared to those in the previous session ($M = 3.58$, $SD = 0.89$) than participants in the low magnitude of change condition ($M = 3.02$, $SD = 0.70$, $t(65) = 2.83$, $p < .01$). From these results, we claim that our magnitude of change manipulation worked well.

TABLE 1 Descriptive statistics and intercorrelations of study variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Team leadership condition (0 = Dir./1 = Emp.)	0.55	0.50	–						
2. Magnitude of change condition	0.54	0.50	−0.07	–					
3. Prechange team performance (tasks 1–5)	0.62	0.13	−0.30*	−0.19	–				
4. Transition team performance (task 6)	0.33	0.21	−0.09	−0.68**	0.36**	–			
5. Postchange team performance (tasks 7, 8 and 9)	0.59	0.24	−0.13	−0.68**	0.58**	0.69**	–		
6. Prechange TBIPs	0.00	0.98	0.24***	0.09	−0.01	−0.25*	0.00	–	
7. Postchange TBIPs	0.00	0.98	0.12	−0.15	0.19	0.02	0.24***	0.47**	–

Note: $N = 67$ teams.
Abbreviation: TBIP, team behavioural interaction pattern.
*$p < .05$; **$p < .01$; ***$p < .1$.

TABLE 2 Coding and interpretation of change variables in the discontinuous mixed-effects growth models recommended by Lang and Bliese (2009)

Change variable	Prechange					Postchange				
Trials	1	2	3	4	5	6	7	8	9	Meaning
Skill acquisition (SA)	0	1	2	3	4	5	6	7	8	Linear growth rate in the prechange period
Transition adaptation (TA)	0	0	0	0	0	1	1	1	1	Immediate performance drop due to task change
Reacquisition adaptation (RA)	0	0	0	0	0	0	1	2	3	Linear growth rate in the postchange period
Quadratic skill acquisition (SA^2)	0	1	4	9	16	16	16	16	16	Quadratic growth rate in the prechange period
Quadratic reacquisition adaptation (RA^2)	0	0	0	0	0	0	1	4	9	Quadratic growth rate in the postchange period

4.2 | Hypotheses testing

Means, standard deviations and intercorrelations among experimental conditions, prechange and postchange team performances as well as prechange and postchange TBIPs are shown in Table 1.

Hypothesis 1 poses that teams led by empowering leaders will show more TBIPs than teams led by directive leaders. In the empowering leadership condition ($N = 34$), teams showed higher indicators of TBIPs than in the directive leadership condition ($N = 29$) both during the prechange ($M = 0.21$, $SD = 1.19$ vs. $M = -0.25$, $SD = 0.56$) and the postchange periods ($M = 0.11$, $SD = 0.99$ vs. $M = -0.13$, SD = 0.97). We performed an independent samples *t*-test to test the hypothesis that both groups were associated with statistically significantly different values of TBIPs. The independent sample *t*-test showed a statistically significant effect, $t(48{,}45) = 2.02$, $p < .05$ concerning prechange TBIPs. The independent sample *t*-test did not show a statistically significant effect, $t(59) = 0.95$, $p = .34$ for postchange TBIPs. Therefore, our Hypothesis 1 was partially supported.

To test our remaining hypotheses, we analysed the effects of the task change on team performance over time using discontinuous random coefficient growth models. This technique allows studying teams' transition and reacquisition adaptation relative to a discontinuous event while controlling for skill acquisition and baseline performance (Lang & Bliese, 2009). Table 2 shows the coding of the time variables based on similar studies (Hale et al., 2016; Lang & Bliese, 2009).

We first established a baseline model of the development of team performance over time. This model showed a significant quadratic effect (SA^2, $\gamma = -0.014$, $SE = 0.006$, $p < .05$; RA^2, $\gamma = -0.119$, $SE = 0.011$, $p < .001$), indicating that the team performance trajectory shape is characterized by an early acceleration but that the rate of change declines with time. Following Lang and Bliese (2009) we also controlled for autocorrelation and heteroscedasticity in our model's error structure. Analysis provided evidence of autocorrelation ($\varphi = -0.12$; $\chi^2_{diff} = 3.71$, $p < .06$) but not of heteroscedasticity ($\varphi = -0.12$; $\chi^2_{diff} = 0.33$, $p = .85$).

After this, we included TBIPs as a Level-2 predictor to assess differences in the performance trajectories between groups derived from different amounts of TBIPs. As in previous research we controlled for the number of actions performed by team members (Uitdewilligen et al., 2013). In the second step, we included the magnitude of change as a Level-2 predictor to test for moderation effects of this variable on the relationships between TBIPs and team performance adaptation.

Hypothesis 2 submits that prechange TBIPs negatively affect teams' transition adaptation. As can be seen in Table 3 (Step 1), there is a significant negative relationship between teams' transition adaptation and prechange TBIPs. Those teams performing more prechange TBIPs have a more prominent immediate decrease in

TABLE 3 Discontinuous random coefficient growth models predicting teams' transition and reacquisition adaptation as a function of prechange TBIPs and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. SE	*t*	Coef.	Coef. SE	*t*
Fixed effects						
Final level 1 model						
Intercept	0.39	0.05	7.23[a,**]	0.35	0.06	6.31[b,**]
Skill acquisition (SA)	0.11	0.02	5.23[a,**]	0.11	0.02	5.22[b,**]
Transition adaptation (TA)	−0.48	0.05	−14.15[a,**]	−0.36	0.04	−9.30[b,**]
Reacquisition adaptation (RA)	0.28	0.03	7.08[a,**]	0.29	0.04	7.19[b,**]
Quadratic skill acquisition (SA^2)	−0.01	0.01	−2.38[a,*]	−0.01	0.01	−2.38[b,*]
Quadratic reacquisition adaptation (RA^2)	−0.12	0.01	−11.81[a,**]	−0.12	0.01	−11.81[b,**]
Final level 2 model						
Number of actions	0.00	0.00	2.94[c,**]	0.00	0.00	2.98[d,**]
Interaction patterns (IP)	−0.01	0.02	−0.57[c]	−0.01	0.03	−0.52[d]
Magnitude of change (MC)	−0.13	0.02	−4.49[c,**]	−0.05	0.03	−1.57[d]
TA × IP	−0.05	0.03	−2.03[a,*]	−0.06	0.03	−1.87[b,***]
TA × MC				−0.24	0.04	−5.93[b,**]
IP × MC				0.00	0.03	−0.02[b]
RA × IP	0.03	0.01	2.94[a,**]	0.03	0.02	1.75[b,***]
RA × MC				−0.02	0.02	−1.33[b]
TA × IP × MC				0.04	0.04	0.85[b]
RA × IP × MC				0.00	0.02	0.09[b]

Abbreviation: TBIP, team behavioural interaction pattern.
[a]*df* = 497.
[b]*df* = 493.
[c]*df* = 59.
[d]*df* = 58.
**$p < .01$; *$p < .05$; ***$p < .1$.

postchange team performance (Figure 2a). This provides enough evidence to support our Hypothesis 2. Interestingly, the results in Table 3 show that prechange interaction patterns do not only lead to a higher drop (transition adaptation) immediately after the change but are also positively related to reacquisition adaptation.

Hypothesis 3 poses that postchange TBIPs positively affect teams' reacquisition adaptation. As Table 4 (Step 1) shows, there is a significant positive relationship between teams' reacquisition adaptation and postchange TBIPs. Those teams that show more postchange TBIPs have higher postchange team performance recovery rates (Figure 2b). Therefore, Hypothesis 3 is supported.

Hypothesis 4 proposed that magnitude of change would moderate the relationship between prechange TBIPs and teams' transition adaptation. As can be seen in Table 3 (Step 2), there is no significant interaction among prechange TBIPs, teams' transition adaptation and magnitude of change. This means that the negative effects of prechange TBIPs on teams' transition adaptation occurs in both magnitude of change experimental conditions (Figure 2c). Therefore, Hypothesis 4 is not supported.

Hypothesis 5 proposed that magnitude of change would moderate the relationship between postchange TBIPs and teams' reacquisition adaptation. As Table 4 (Step 2) shows, there is no significant interaction among postchange TBIPs, reacquisition adaptation and magnitude of change. This means that postchange TBIPs were positively related to reacquisition in both the high and the low magnitude of change experimental conditions (Figure 2d). Therefore, Hypothesis 5 is not supported.

5 | DISCUSSION

We examined how directive and empowering leadership styles under high- and low-magnitude changes influence TBIPs and their effects on team performance, during transition and reacquisition adaptation

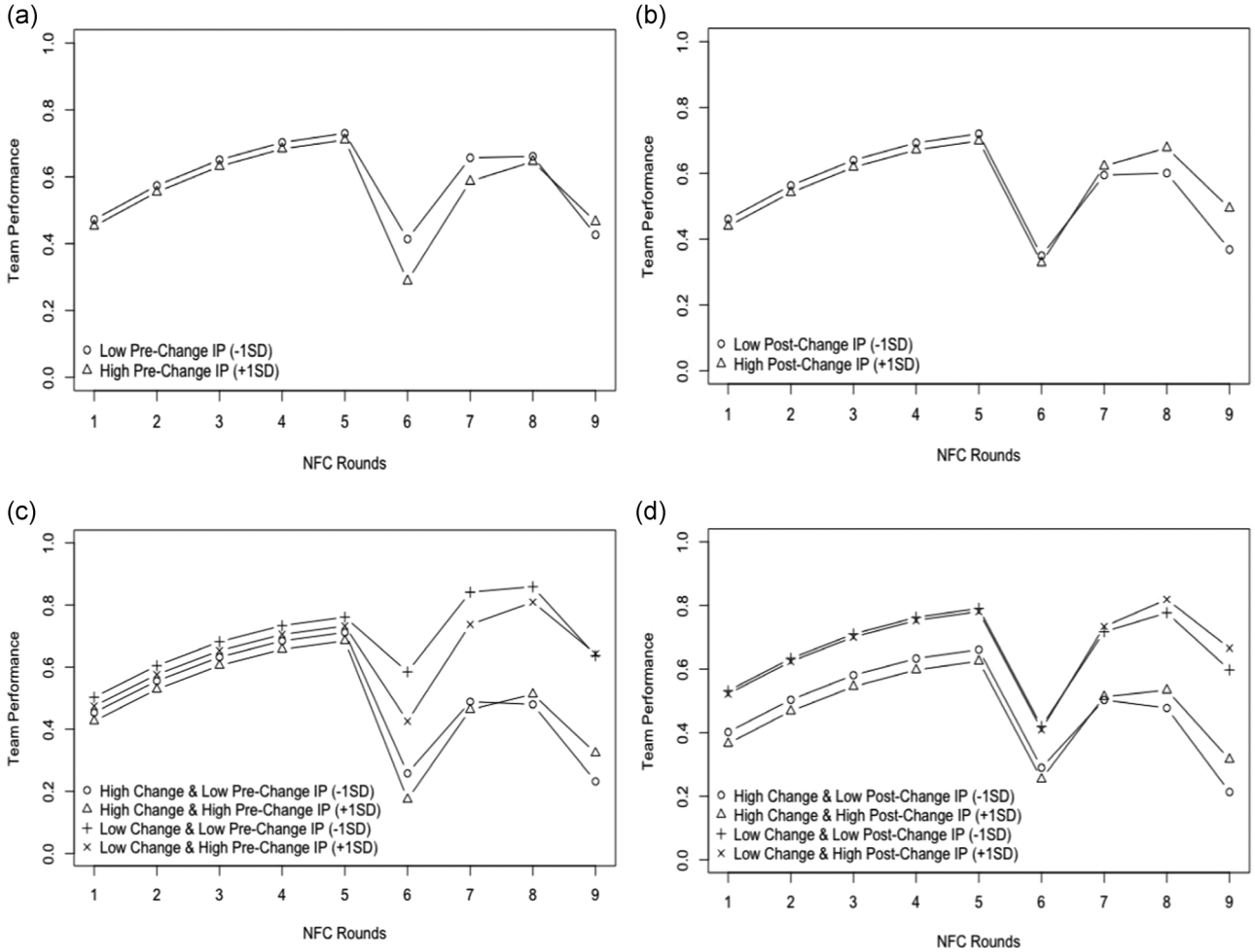

FIGURE 2 Team performance as a function of time (horizontal axes) and prechange TBIPs (Graph a), postchange TBIPs (Graph b), the magnitude of change and prechange TBIPs (Graph c) and magnitude of change and postchange TBIPs (Graph d). IP = TBIPs; Change = magnitude of change (experimental condition). TBIP, team behavioural interaction pattern

phases; and found that empowered-led teams show more TBIPs than directive-led teams, despite all teams show more TBIPs when adapting to low-magnitude changes than to high-magnitude changes. Additionally, we discover that prechange TBIPs hinder transition adaptation but facilitate reacquisition adaptation, and postchange TBIPs are beneficial during the reacquisition of postchange team performance. These findings have theoretical and managerial implications that we address below.

5.1 | Theoretical implications

Our findings advance team leadership, TBIPs and team adaptation literature; first, by connecting research on team processes and behaviours fostering team adaptation (Burke et al., 2006a; Maynard et al., 2015), with recent studies resolving conflicting evidence on the effects of different leadership styles on teams (Lorinkova et al., 2013; Martin et al., 2013), and research about TBIPs (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012).

We extended previous research comparing the differential effects of empowering and directive leadership styles on team processes and team effectiveness (Lorinkova et al., 2013; Martin et al., 2013) under changing circumstances, by revealing the antecedent role of leadership styles on TBIPs. Thus, we address recent calls regarding the need to better understand TBIPs antecedents (Zijlstra et al., 2012). Specifically, we identified empowering leadership as an antecedent of TBIPs, as these leaders encourage team members to frequently interact, sharing information and participatively making decisions (Srivastava et al., 2006). This effect was significant during the prechange period but not along the postchange stage. A plausible reason for this finding may be that although team leaders showed the desired behaviours according to our manipulations, effective leaders could have performed other behaviours driven by situational demands. Therefore, directive leaders may have also shown empowering behaviours responding to changes.

These findings underscore the importance of examining main team performance phases to understand the differential effectiveness of directive and empowering leadership (Lorinkova et al., 2013),

TABLE 4 Discontinuous random coefficient growth models predicting teams' transition and reacquisition adaptation as a function of postchange TBIPs and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. SE	*t*	Coef.	Coef. SE	*t*
Fixed effects						
Final level 1 model						
Intercept	0.41	0.06	7.06[a,**]	0.41	0.06	6.96[b,**]
Skill acquisition (SA)	0.11	0.02	5.05[a,**]	0.11	0.02	4.97[a,**]
Transition adaptation (TA)	−0.37	0.05	−13.86[a,**]	−0.48	0.04	−13.81[a,**]
Reacquisition adaptation (RA)	0.27	0.04	6.83[a,**]	0.31	0.04	7.63[a,**]
Quadratic skill acquisition (SA^2)	−0.01	0.01	−2.28[a,*]	−0.01	0.01	−2.24[a,*]
Quadratic reacquisition adaptation (RA^2)	−0.12	0.01	−11.41[a,**]	−0.12	0.01	−11.33[a,**]
Final level 2 model						
Number of actions	0.00	0.00	2.38[c,*]	0.00	0.00	2.28[d,*]
Interaction patterns (IP)	−0.01	0.02	−0.63[c]	0.00	0.02	−0.22[d]
Magnitude of change (MC)	−0.16	0.03	−4.84[c,*]	−0.14	0.03	−4.52[d,**]
IP × MC				−0.01	0.03	−0.40[d]
RA × IP	0.02	0.01	2.84[a,**]	0.01	0.01	1.36[b]
RA x MC				−0.07	0.02	−4.96[b,**]
RA × IP × MC				0.01	0.02	0.62[b]

Abbreviation: TBIP, team behavioural interaction pattern.

[a]*df* = 482.

[b]*df* = 480.

[c]*df* = 57.

[d]*df* = 56.

**$p < .01$; *$p < .05$.

and match Burke et al. (2006a) proposal connecting team leadership with team adaptation. Thus, we complement the general assumption that empowering leadership behaviours are beneficial for enhancing team processes (Lorinkova et al., 2013; Srivastava et al., 2006), revealing that such effect occurs through promoting TBIPs, despite they only seem benefiting reacquisition adaptation, and not for transition adaptation.

In this line, our results show when TBIPs seem more detrimental for teams managing disruptions, providing an interesting nuance over former research on this regard (Stachowski et al., 2009). Thus, our findings partially match Gersick and Hackman's (1990) proposal by revealing the negative effects of prechange TBIPs for teams' transition adaptation, but open for further study the question of when TBIPs benefit more team adaptation. The positive effects we found for both pre- and postchange TBIPs on team reacquisition adaptation is a good departing point for addressing such a question.

Although we attended recent calls to incorporate magnitude of change when analysing team adaptation (Baard et al., 2014; Maynard et al., 2015; Uitdewilligen et al., 2013), we did not find any moderating effects of it on the TBIPs–team adaptation link. Consequently, our evidence is not consistent with previous research suggesting that teams would experience more performance problems when facing high rather than low-magnitude changes (Gersick & Hackman, 1990; Hollenbeck et al., 2011). Despite the effectiveness of our manipulations, it is possible that the changes implemented in the study were perceived as radical rather than incremental (Audia et al., 2000) even at low magnitudes. In such cases, TBIPs would be negative for teams' transition adaptation and positive for teams' reacquisition adaptation regardless of the magnitude of change. If low-magnitude changes were understood as radical changes, then teams may consider that extant TBIPs won't work in the new situation, and will likely engage in altering their coordination patterns to look for or build new TBIPs (Rico et al., 2019), which will increase the coordination flux and impair their performance (Summers et al., 2012). This finding, and the fact that when using a logarithm measure of the magnitude of change, the hypothesized moderating effects of magnitude of change tended to be significant, stresses the importance of considering how teams understand changes instead of merely characterising their origin or duration (Rico et al., 2019).

5.2 | Managerial implications

Our findings provide several useful insights for managers leading teams facing unforeseen situations. The time-sensitive nature of the relationship between TBIPs and team adaptation has important implications for leaders training. Given the critical role of TBIPs on team adaptation, leading teams to adapt shall enhance team members' interactions around the task. To do so, leaders may adopt empowering behaviours that foster team members' information and idea sharing and participative decision-making (Srivastava et al., 2006). However, as highlighted before, the more empowering behaviours is not always the better (Cheong et al., 2016), and our findings do not suggest that empowering is good across any changing situation. Thus, we recommend identifying the changing nature of the team environment to decide which strategy to follow. When teams are constantly facing new situations (i.e., ongoingly deal with transition adaptations) and/or have little time to cope with them (e.g., emergency teams), we recommend team leaders to focus on task completion instead on participative behaviours because less TBIPs seem to help teams to improve transition adaptation by concentrating efforts in minimising initial postchange performance decreases typical right after disruptions take place.

In contrast, if teams have time enough to adapt (i.e., the postchange team performance will not be truncated by new disruptions) team leaders shall encourage developing alternative TBIPs which will benefit team reacquisition adaptation, after the initial transition adaptation performance decrease. Thus, enabling teams to abandon old TBIPs and develop new ones increases team adaptability in the long run (Gorman et al., 2010), and empowering leadership styles provide a good support in such a task (Lorinkova et al., 2013).

These managerial recommendations are applicable to training emergency incident management teams and search and rescue teams (Hayes et al., 2021; Okita et al., 2021), but overall to enhance the effectiveness of leading frontline workers (i.e., frontline command—Groenendaal & Helsloot, 2016), such as firefighter teams. Our results globally suggest leading frontline teams in an empowering way that enables teams in self-managing their tasks, which extant research has related with improved frontline work performance (Groenendaal et al., 2013). However, our results also evidenced the cost of that empowering leadership has immediately after task changes. Hence, considering Groenendaal and Helsloot's (2016) five steps frontline command model, we suggest an adaptive use of both directive and participative leadership in frontline teams. Accordingly, a directive approach in implementing the frontline command model's five steps (i.e., Factfinding–Analysis–Decision-making–Communication–Monitoring) shall be adopted in ongoingly changing situations. Frontline leaders shall focus on task completion promoting less TBIPs and compensating team members limited attentional resources in gathering and processing information, to minimize transition adaptation drops. Alternatively, an empowering approach in implementing the frontline command model's five steps could be adopted in situations offering time enough to adapt. Following the five steps but emphasising teams alternative TBIPs development, will increase their behavioural repertoire and boost performance reacquisition to properly handling changes. This approach will free frontline leaders' cognitive resources compromised on the three first steps of the model and will alleviate the supervision burden of the last two steps. Empowering team members, ensures better knowledge sharing, which benefit the analysis of the situation, and the understanding of the decisions made and their autonomous regulation in following them (Srivastava et al., 2006).

5.3 | Limitations and directions for future research

Although this study constitutes the first one longitudinally analysing TBIPs effects on team adaptation, it has some limitations worth to discuss. First, we conducted the experiment using a sample of teams integrated by students, specifically composed for the purpose of this study. Accordingly, we should be cautious regarding the generalisability of our results, and future research is needed to see if our results hold in different types of teams, tasks or performance settings (e.g., Alcover et al., 2021).

Second, our team leadership examination by considering directive and empowering leadership styles as exclusive separate styles was somehow contradicted by our observation that team leaders in our sample sometimes exhibited both kinds of behaviours (e.g., directive leaders encouraging proactive team members participation). We connect this observation with adaptive leadership literature pointing that effective leaders could switch their behaviours contingently to situational requirements (Sims et al., 2009). Accordingly, we encourage future research to consider how adaptive leadership and related hybrid leadership styles impact on TBIPs development and team adaptation.

Also, although we identify team leadership as an antecedent of TBIPs, future research should further examine other antecedents (Zijlstra et al., 2012). In particular, because team cognition closely relates to team behavioural processes (Rico et al., 2019), future research may consider analysing the effects of team cognitive structures on TBIPs. Besides, recent research suggests that characterising team changes as internal (i.e., related to team composition alterations) or external (i.e., related to the task context) is crucial for analysing team processes effects on team adaptation (Christian et al., 2017). Because our change manipulation was exclusively external, future research on the TBIPs–team adaptation link shall analyse if our findings hold when teams cope with internal changes.

In addition, although we have a large sample incorporating quantitatively nonverbal behaviours to compute for TBIPs, we have neglected their content. So far, TBIPs literature paid attention to the amount, length and complexity of patterns but not to their composing specific behaviours (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012). Thus, in line with recent reviews, a valuable contribution would be to identify which specific behavioural patterns foster team adaptation, for teams to incorporate them in their behavioural repertoires (Hayes et al., 2021). Further, although we studied a bigger sample of teams than in previous studies (Stachowski et al., 2009; Zijlstra et al., 2012) and we considered more data for each team (60 min of audio-visual coded material), future studies shall address the generalisability of our findings.

Lastly, our study is limited regarding how we examined the perceived magnitude of change. Despite the novelty of including this variable into our team adaptation study, we characterized magnitude of change as simply high or low. However, recent developments on task complexity suggest that studies on team adaption should best characterize the magnitude of change through a logarithmic scale (Hærem et al., 2015). That approach overcomes variable dichotomisation limitations, offering a continuous measure of the magnitude of change, and increasing precision to unravel how to trigger severity impacts processes and team performance when teams adapt to changes.

6 | CONCLUSION

Empowering leadership foster TBIPs, which initially impair team performance during transition adaptation, although accelerate team performance recovery during reacquisition adaptation. Because team contexts are increasingly unpredictable and dynamic, we hope that our work stimulates further research to better understand and manage team adaptation.

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

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ENDNOTE

[1]Participants in this sample also participated in Sanchez-Manzanares et al.'s (2020) sample. Future meta-analyses should recognize the nonindependent nature of the measures in these samples.

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APPENDIX

Behavioural coding: Categories and examples	
Category	**Example**
Giving instructions and commands	'Air officer, please send two helicopters'
Directly stated information	'There is a new fire on the top left side of the map'
Reactive planning	'Ok, from now we come back to base when we extinguish a fire'
Monitoring	Every time a team member changes the view mode into the general zoom
Actively undertake a task as first mover	When actions are done without being asked
Provide assistance with other members' tasks	A player sends a vehicle to the fire where other team members already are located
Reaction to comments	Refilling after comments such as 'I think I'm running out of fuel'