DEPARTAMENTO PSICOLOGIA SOCIAL Y METODOLOGIA

DOCTORADO EN PSICOLOGIA

A LONGITUDINAL APPROACH TO TEAM ADAPTATION THROUGH THE TWO-PHASE FRAMEWORK: THE ROLE OF TEAM LEADERSHIP, COORDINATION, BEHAVIORAL INTERACTION PATTERNS AND TEAM COGNITION ON TEAM ADAPTION WHEN FACING CHANGES OF DIFFERENT MAGNITUDE

TESIS DOCTORAL

DANIEL DORTA AFONSO

Director: Ramón Rico Muñoz

Madrid, 2019

A LONGITUDINAL APPROACH TO TEAM ADAPTATION THROUGH THE TWO-PHASE FRAMEWORK: THE ROLE OF TEAM LEADERSHIP, COORDINATION, BEHAVIORAL INTERACTION PATTERNS AND TEAM COGNITION ON TEAM ADAPTION WHEN FACING CHANGES OF DIFFERENT MAGNITUDE

Daniel Dorta Afonso

Supervisor:

Dr. Ramón Rico

This dissertation leads to the award of a doctoral degree in Psychology in the Autonomous University of Madrid. The Spanish National Plan for R&D, Ministry of Economy and Competitiveness (PSI2012-31135, R. Rico, Principal Investigator; and BES-2013-063820, D. Dorta-Afonso, PhD Grant) has financially supported the present dissertation.

For my team

Contents

CHAPTER 1

INTRODUCTION

1. Abstract

In this doctoral dissertation we built on recent developments on team adaptation, team cognition, team coordination and team behavioral interaction patterns literatures to analyze team characteristics that positively impact team adaptive outcomes. We carried out three experimental studies in the laboratory and through discontinuous random coefficient growth modeling (RCGM) we identified team variables that positively (or negatively) impacted teams' transition adaptation (i.e., teams ability to minimize team performance decrease after a task-change) and teams' reacquisition adaptation (i.e., teams ability to recover post-change team performance). Sixty-seven teams took part in a computer-based fire-fighting simulation task in which we manipulated team leadership (directive vs. empowering) and magnitude of change (high vs. low) for studies one and three. Seventy teams took part in the "gazogle" building task in which we manipulated magnitude of change (high vs. low) for study two. In the first study, we identified team leadership and context as predictors of team behavioral interaction patterns and their differential effects on team adaptive outcomes in different moments of the team adaptation process. In the second study, we investigated team mental models (TMMs) and team coordination effects on teams' transition and reacquisition adaptation. In the third study, we identified team leadership and the accuracy of TMMs as predictors of the accuracy of team situation models (TSMs) and its positive effects on reacquisition adaptation. The findings reported in this doctoral dissertation have important theoretical as well as managerial implications and open interesting lines of inquiry for the team adaptation literature

Keywords: team adaptation, team leadership, team coordination, team cognition, behavioral interaction patterns, magnitude of change.

2. Relevance of this Doctoral Dissertation

"Our marketing strategy radically changed excluding some exceptions. Today, most of our marketing campaigns are carried out on the Internet. In order to communicate our content to our target audience we have to be there. Indeed, social networks and online communities allow a constant increase of the knowledge we have of our clients, and we target them directly. We have almost completely abandoned offline advertising concerning leaflets, TV, etc. Information and Communication Technologies have completely changed the way we work today". Head of the Marketing Department in a Tourism Destination Management Organization.

The testimony above reflects a clear example of team adaptation, showing how behavioral modifications positively impacted adaptive outcomes of a marketing team dealing with changes derived from the irruption of new technologies (Rosen, et al., 2011; Baard, Rench, & Kozlowski, 2014; Maynard, Kennedy & Sommer, 2015). To this concern, managing changing situations is the daily challenge of all kind of teams, from police and film crews, to nuclear plants crews, anesthesia teams, airline crews, firefighting teams and even software development teams (Toups & Kerne, 2007; Stachowski, Kaplan, & Waller, 2009; Burtscher, Kolbe, Wacker & Manser, 2011; Bechky & Okhuysen, 2011; Lei, Waller, Hagen, & Kaplan, 2015; Bolici, Howison & Crowston, 2016). Reflecting interest in this topic, research on team adaptation has proliferated over the years to better understand how teams can improve their team adaptive outcomes, such as their team performance after facing a task change (e.g., Kozlowski, Gully, Nason & Smith, 1999; Pulakos, Arad, Donovan, & Plamondon, 2000).

In this doctoral dissertation we focus on team leaders' role to enhance adaptive outcomes because of their direct relationship with team effectiveness (Zaccaro, Rittman,

& Marks, 2001) even under changing situations (Burke, Stagl, Salas, Pierce & Kendall, 2006), due to their ability to influence coordination and shared cognition processes required for adaptation (e.g., Marks, Zaccaro, & Mathieu, 2000; Burke et al., 2006b; Zaccaro, Heinen, & Shuffler, 2009). However, not all leaders follow the same strategy when leading a team, but their behaviors typically fall under directive or empowering categories (Fleishman et al., 1991). Whereas directive leaders focus on task completion with a top-down attitude by assigning tasks, distributing roles and restraining team members' participation (House, 1996; Martin, Liao, & Campbell, 2013), empowering leaders focus on exchanges of ideas and information among team members as well as participative decision-making processes (Arnold, Arad, Rhoades, & Drasgow, 2000; Amundsen & Martinsen, 2014). In this line, extant research suggests differential effects of leadership styles, on team processes and performance (e.g., Yun, Faraj, & Sims, 2005; Lorinkova et al., 2013). Concretely, Lorinkova and coauthors (2013) interestingly highlighted that greater improvements on performance of empowered-led compared to directive-led teams were due to higher levels of team coordination and shared cognition. Similarly, in this dissertation we propose that the enhancement of team adaptive outcomes is rooted on leaders' influence on both, coordinative behaviors (e.g., behavioral interaction patterns) and team cognition (e.g., team mental models –TMMs; and team situation models –TSMs) and their impacts on team performance.

As for team cognition, although studies relate TMMs (long-term shared mental representations among team members of relevant team and task elements –Klimoski & Mohammed, 1994) with team adaptation (e.g., Sander, van Doorn, van der Pal, & Ziljstra, 2015), recent advances in team cognition theory suggests moving the focus over TSMs (short-term shared understanding of a situation developed by team members moment by moment as they are engaged in a particular task –Rico, Sánchez-

Manzanares, Gil, & Gibson, 2008) because of their dynamic and situational nature. As TSMs are formed relating knowledge stored in TMMs with specific information of the situation (Mohammed, Hamilton, Sánchez-Manzanares, & Rico, 2017), we believe that team leaders can contribute to their accurate generation by encouraging different kinds of interactions among team members. In this line, after facing a task-change, whereas TMMs incorporate stable knowledge acquired due to previous experience (e.g., marketing knowledge), TSMs incorporate relevant information of the new situation (e.g., understanding that information and communication technologies produced that our target audience cannot be reached offline anymore) and consequently are more likely to impact team adaptive outcomes.

Apart from team cognition, we bear in mind team leaders' inherent competence to directly impact the patterns of behaviors performed by team members within the team. Concretely, empowering-led teams will perform more behaviors involving interaction (i.e., exchange of information and ideas) than directive-led teams. These behaviors will fall into patterns over time as team members repeatedly perform them. Alternatively, directive-led teams will show more patterns involving only one person. In this regard, we focus on team behavioral interaction patterns, defined as recurrent sequences of verbal and non-verbal actions performed by more than one team member developed in teams to increase their efficiency (Zellmer-Bruhn, Waller, & Ancona, 2004; Zijlstra, Waller, & Phillips, 2012). In this sense, much of the ongoing debate on team behavioral interaction patterns has focused on whether they are beneficial or detrimental for teams when managing changing circumstances (Zellmer-Bruhn et al., 2004; Stachowski, Kaplan, & Waller, 2009; Uitdewilligen, Waller, & Pitariu, 2013). Indeed, the few empirical studies carried out to date have not been conclusive, as they support both benefits (Uitdewilligen et al., 2013) and disadvantages (Stachowski et al., 2009) of behavioral interaction patterns on team adaptive outcomes.

We argue that the aforementioned opposing findings are due to the generally followed cross-sectional approach focusing on behavioral patterns and team performance in the specific moment of facing the disruption neglecting the whole trajectory of team performance and behaviors performed both along the pre-change and post-change stage. In order to solve this problem and bearing in mind the temporal nature of team processes (Marks, Mathieu, & Zaccaro, 2001; Collins, Gibson, Quigley, & Parker, 2016), we follow Lang & Bliese (2009) proposed conceptual and methodological framework that examines team adaptation in different post-change moments (i.e., transition and reacquisition phases) bearing in mind pre-change levels of team performance (i.e., basal performance and skill acquisition).

Under the particular approach of Lang & Bliese (2009), the most interesting contribution to the field of team adaptation is to find out which differences in team allow them to foster their levels of transition and reacquisition adaptation. To this concern, whereas teams' transition adaptation refers to teams' ability to minimize the decrease in team performance right after a disruption takes place (i.e., the transition phase), teams' reacquisition adaptation captures teams' capability to increase their recovery rates of team performance along the post-change stage (i.e., the reacquisition phase) (Sander et al., 2015). In this dissertation, we argue that behavioral interaction patterns performed along the pre-change stage are detrimental for team adaptive outcomes in the moment of facing the disruption, but those performed along the post-change stage benefit the latter reacquisition of team adaptive outcomes (Gersick & Hackman, 1990; Uitdewilligen, Rico, & Waller, 2018).

Apart from patterns of behaviors we consider team coordination behaviors that are not performed repeatedly forming patterns but that can happen in isolation and directly impact team adaptive outcomes. Concretely, we follow recent theoretical developments on team coordination (Rico et al., 2008) that proposes two different and complementary ways of team coordination: explicit coordination and implicit coordination. Whereas the former refers to explicit verbalizations taking place in teams to distribute roles, communicate effectively and negotiate performance objectives and deadlines, implicit coordination happens imperceptibly among team members as they perform their tasks (Rico et al., 2008). In this dissertation, we argue that explicit and implicit coordination differentially impact team adaptive outcomes in different moments of the adaptation process (i.e., transition phase and reacquisition phase).

In addition, we align with extant studies suggesting that the relationship between team cognition and behavioral interaction patterns with team adaptive outcomes depend on the change characteristics (Gersick & Hackman, 1990; Baard et al., 2014; Christian, Christian, Pearsall, & Long, 2017). Concretely, we believe that the proposed effects of TMMs, team coordination, TSMs and team behavioral interaction patterns on adaptive outcomes depend on magnitude of change (defined as the severity of the trigger causing the disruption to which teams need to adapt –Maynard et al., 2015). With respect to magnitude of change, when teams face changes of low magnitude the pre-change and post-change situations share several elements that make the new context somehow predictable. Alternatively, when magnitude of change is high, the post-change situation will be less defined and predictable (Hærem, Pentland & Miller, 2015).

Bearing in mind the reasoning before, we have carried out three studies to examine team characteristics that foster (or hinder) teams' transition and reacquisition adaptation using discontinuous random coefficient growth modeling (RCGM).

Concretely, with the first study we identified team leadership style and team context as predictors of team behavioral interaction patterns and we put this variable as key because of its differential effects on team adaptive outcomes in different moments of the team adaptation process. With the second study, we analyzed the effects of long-term team cognition and both kinds of team coordination on team performance during the transition phase and the reacquisition phase. In the third study, we identified team leadership and the accuracy of TMMs as predictors of the accuracy of TSMs. In addition, we found a direct positive relationship between TSMs and team adaptive outcomes that only reached significance under changes of low magnitude.

With this doctoral dissertation that examines team adaptive outcomes we provide the field with relevant and valuable theoretical as well as managerial contributions. First, we contribute to the research stream that longitudinally analyzes team adaptive outcomes with the two-phase framework (e.g., Sander et al., 2015; Hale, Ployhart, & Shepherd, 2016). Second, we shed light on why previous studies on patterned interaction have not yet been conclusive about their effects on adaptive outcomes (e.g., Stachowski et al., 2009; Uitdewilligen et al., 2013). We provide empirical evidence that support both their detrimental effects during the transition phase and their positive effects during the reacquisition phase. Third, we are pioneer on generalizing the positive role of TSMs on team performance (e.g., Hamilton, 2009) to teams dealing with changing circumstances. Fourth, we provide support on the differential effects of team leadership styles on processes and performance (e.g., Lorinkova et al., 2013). In doing so, we also respond to several calls highlighting the need to analyze predictors of both TSMs (e.g., van der Haar et al., 2015) and team behavioral interaction patterns (e.g., Stachowski et al., 2009). In addition, we provide support to the benefits of TMMs similarity and accuracy as well as explicit and implicit coordination for team adaptation. Last but not least, we impulse the debate on incorporating change characteristics when examining team adaptive outcomes (e.g., Baard et al., 2014; Christian et al., 2017) as we prove its moderating role on many of the relationships between processes and outcomes found in the studies of this dissertation.

The relevance for the industry relies on our practical recommendations aiming to help teams dealing with changing situations. Concretely, we suggest several ways on how teams can improve their levels of transition and reacquisition adaptation depending on the nature of the changes they face. Specifically, we propose to adopt empowering behaviors to positively impact team behavioral interaction patterns as well as the accuracy of TSMs because of their positive effects on team adaptive outcomes. In addition, we recommend enhancing both task- and team- TMMs accuracy as we empirically relate them with team adaptive outcomes but also with the generation of accurate TSMs. Besides, task- and team- TMMs similarity was also related with post-change team performance and therefore, teams should focus efforts on enhancing levels of TMMs similarity through, for instance, cross-trainings.

(BIS) CAPÍTULO 1

INTRODUCCIÓN

1. Resumen

En esta tesis doctoral nos basamos en literatura sobre adaptación de equipos, cognición, coordinación y patrones de interacción para analizar características que impacten positivamente en el rendimiento adaptativo de equipos. Diseñamos tres estudios experimentales en laboratorio y por medio de modelos de coeficientes aleatorios de crecimiento discontinuo (RCGM) identificamos variables del equipo que impactaron positivamente (o negativamente) en la adaptación durante la transición (habilidad de los equipos de minimizar la caída del rendimiento después de un cambio) y la adaptación durante la readquisición (habilidad de los equipos de recuperar el rendimiento después del cambio). Sesenta y siete equipos participaron en una simulación de incendios manipulando el liderazgo del equipo (directivo vs participativo) y la magnitud del cambio (alta vs baja) para los estudios uno y tres. Setenta equipos participaron en una tarea gazogle de construcción donde manipulamos la magnitud del cambio (alta vs baja). En el primer estudio, identificamos el liderazgo y el contexto como predictores de los patrones de interacción de equipo y sus efectos diferenciales sobre el rendimiento adaptativo en diferentes momentos del proceso de adaptación. En el segundo estudio, investigamos los efectos de los modelos mentales de equipo (TMMs) y la coordinación en la adaptación durante la transición y la readquisición. En el tercer estudio, identificamos el liderazgo del equipo y la precisión de los TMMs como predictores de la precisión de los modelos de situación (TSMs) y sus efectos positivos sobre la adaptación durante la readquisición. Los resultados encontrados tienen importantes implicaciones teóricas y de gestión y abren interesantes líneas de investigación en el campo de la adaptación de equipos.

Palabras clave: adaptación de equipos , liderazgo de equipos, coordinación de equipo, cognición de equipos, patrones de interacción, magnitud del cambio.

2. Relevancia de esta Tesis Doctoral

"Nuestra estrategia de marketing ha cambiado radicalmente excluyendo algunas excepciones. A día de hoy, la mayoría de nuestras campañas de marketing se llevan a cabo en Internet. Para comunicar nuestro contenido a nuestro público objetivo tenemos que estar ahí. En realidad, las redes sociales y las comunidades virtuales permiten un incremento constante del conocimiento que tenemos sobre nuestros clientes y enfocarnos en ellos directamente. Hemos abandonado casi completamente la publicidad offline en lo que se refiere a folletos, TV, etc. Las Tecnologías de la Información y la Comunicación han cambiado completamente la manera en la que trabajamos hoy" Directora del Departamento de Marketing de una Organización Gestora de un Destino Turístico.

El testimonio anterior refleja un claro ejemplo de adaptación de equipo, mostrando cómo las modificaciones comportamentales impactaron positivamente en los resultados adaptativos de un equipo de marketing afrontando cambios derivados de la irrupción de nuevas tecnologías (Rosen, et al., 2011; Baard, Rench, & Kozlowski, 2014; Maynard, Kennedy & Sommer, 2015). Así, enfrentarse a situaciones de cambio es el reto diario de todo tipo de equipos desde equipos de filmación y patrullas policiales, equipos en plantas nucleares, unidades médicas, tripulaciones aéreas, brigadas de bomberos y grupos de desarrollo de software (Toups & Kerne, 2007; Stachowski, Kaplan, & Waller, 2009; Burtscher, Kolbe, Wacker & Manser, 2011; Bechky & Okhuysen, 2011; Lei, Waller, Hagen, & Kaplan, 2015; Bolici, Howison & Crowston, 2016). Reflejando el interés en esta materia, la investigación en adaptación de equipos de trabajo ha proliferado en los últimos años para entender mejor cómo los equipos pueden mejorar su rendimiento adaptativo, como por ejemplo el rendimiento después de afrontar un cambio (p. ej., Kozlowski, Gully, Nason & Smith, 1999; Pulakos, Arad, Donovan, & Plamondon, 2000).

En esta tesis doctoral nos centramos en el rol de los líderes de equipos para mejorar los resultados de adaptación por su relación directa con la efectividad de los equipos de trabajo (Zaccaro, Rittman, & Marks, 2001) incluso ante situaciones de cambio (Burke, Stagl, Salas, Pierce & Kendall, 2006), debido a su capacidad para influenciar procesos de coordinación y de cognición que se requieren en la adaptación (p. ej., Marks, Zaccaro, & Mathieu, 2000; Burke et al., 2006b; Zaccaro, Heinen, & Shuffler, 2009). Sin embargo, no todos los líderes siguen la misma estrategia cuando lideran un equipo sino que sus comportamientos normalmente se enmarcan en la categoría de comportamientos directivos o participativos (Fleishman et al., 1991). Mientras que los líderes directivos se centran en completar la tarea con una actitud de arriba hacia abajo, asignando tareas, distribuyendo roles y restringiendo la participación de los miembros del equipo (House, 1996; Martin, Liao, & Campbell, 2013), los líderes participativos se centran en el intercambio de ideas y de información entre los miembros del equipo así como en procesos de toma de decisiones participativos (Arnold, Arad, Rhoades, & Drasgow, 2000; Amundsen & Martinsen, 2014). En esta línea, la investigación existente sugiere efectos diferenciales de los distintos tipos de liderazgo en el rendimiento y los procesos de equipo (p. ej., Yun, Faraj, & Sims, 2005; Lorinkova et al., 2013). En concreto, Lorinkova y su equipo (2013) descubrieron que la mayor mejora en el rendimiento de los equipos dirigidos por líderes participativos comparado con los dirigidos por líderes directivos era debido a un mayor nivel de coordinación y de cognición compartida. De igual forma, en esta tesis se propone que la mejora en el rendimiento adaptativo se fundamenta en la influencia de los líderes en comportamientos de coordinación (p. ej., los patrones de interacción de equipos) y de cognición (p. ej., modelos mentales de equipo –TMMs; y modelos de situación –TSMs) y su impacto en el rendimiento de equipo.

En cuanto a la cognición de equipos, aunque los estudios relacionan los TMMs (representaciones mentales estables a nivel de equipo de elementos relevantes del equipo y de la tarea –Klimoski & Mohammed, 1994) con la adaptación de equipos (p. ej., Sander, van Doorn, van der Pal, & Ziljstra, 2015), avances teóricos recientes en cognición de equipos sugieren que se mueva el foco sobre los TSMs (representaciones más dinámicas sobre la situación desarrolladas por los miembros el equipo cuando están realizando una determinada tarea –Rico, Sánchez-Manzanares, Gil & Gibson, 2008) por su naturaleza más dinámica y situacional. Como los TSMs se forman relacionando el conocimiento almacenado en los TMMs con la información específica de la situación (Mohammed, Hamilton, Sánchez-Manzanares, & Rico, 2017), creemos que los líderes de los equipos pueden contribuir a su generación fomentando diferentes comportamientos e interacciones entre los miembros del equipo. En esta línea, después de afrontar un cambio, mientras que los TMMs incorporan el conocimiento más estable adquirido por experiencia previa (p. ej., el conocimiento de marketing), los TSMs incorporan información relevante de la nueva situación (p. ej., el entendimiento de que las tecnologías de la información y la comunicación hayan producido que nuestro público objetivo no pueda ser alcanzado offline) y por lo tanto es más probable que impacten en el rendimiento adaptativo.

Aparte de la cognición de equipos, tenemos en cuenta la inherente capacidad de los líderes para influenciar directamente los patrones de comportamientos que se dan dentro del equipo. En concreto, los equipos dirigidos por líderes participativos mostrarán más comportamientos que impliquen interacción (p. ej., el intercambio de información y de ideas) que los equipos dirigidos por líderes directivos. Estos comportamientos se transformarán en patrones con el tiempo a medida de que sean repetidos por los miembros del equipo. Alternativamente, los equipos dirigidos por líderes directivos mostrarán más patrones comportamentales que envuelvan a una única persona. A este respecto, nos centramos en los patrones de interacción de equipo, definidos como secuencias recurrentes de comportamientos verbales y no verbales llevados a cabo por más de un miembro del equipo para incrementar la eficiencia (Zellmer-Bruhn, Waller, & Ancona, 2004; Zijlstra, Waller, & Phillips, 2012). En este sentido, gran parte del debate en torno a los patrones de interacción de equipos se ha centrado en si son beneficiosos o perjudiciales para los equipos cuando se enfrentan a situaciones de cambio (Zellmer-Bruhn et al., 2004; Stachowski, Kaplan, & Waller, 2009; Uitdewilligen, Waller, & Pitariu, 2013). En realidad, los pocos estudios empíricos que se han llevado a cabo no han sido concluyentes, ya que avalan tanto ventajas (Uitdewilligen et al., 2013) como desventajas (Stachowski et al., 2009) de los patrones de interacción en el rendimiento adaptativo.

Argumentamos que los mencionados resultados contradictorios se deben a la aproximación transversal que siguen los estudios empíricos y que se han centrado en los patrones de interacción y el rendimiento en el preciso momento de afrontar el cambio ignorando toda la trayectoria de rendimiento así como los comportamientos que se han llevado a cabo antes y después del cambio. Para resolver este problema y teniendo en cuenta la naturaleza longitudinal de los procesos de equipo (Marks, Mathieu, & Zaccaro, 2001; Collins, Gibson, Quigley, & Parker, 2016), seguimos la aproximación conceptual y metodológica de Lang y Bliese (2009) que propone el análisis de la adaptación en diferentes momentos después del cambio (la fase de transición y la fase de readquisición) teniendo en cuenta el rendimiento antes del cambio.

Bajo la propuesta de Lang y Bliese (2009), la contribución más relevante al campo de la adaptación de equipos consiste en encontrar diferencias en los equipos que les permita mejorar sus niveles de adaptación durante la transición y la readquisición. Mientras que la adaptación durante la transición se refiere a la habilidad de los equipos de minimizar la caída en el rendimiento después de que se produzca el cambio (fase de transición), la adaptación durante la readquisición se refiere a la capacidad de los equipos de mejorar la ratio de recuperación de rendimiento durante la fase después del cambio (fase de readquisición) (Sander et al., 2015). En esta tesis, argumentamos que los patrones de interacción que los equipos han llevado a cabo durante la fase previa al cambio son perjudiciales para el rendimiento en el momento de afrontar el cambio pero que aquellos patrones de interacción que se llevan a cabo durante la fase posterior al cambio, beneficia la readquisición de rendimiento (Gersick & Hackman, 1990; Uitdewilligen, Rico, & Waller, 2018).

Aparte de los patrones de interacción, consideramos comportamientos de coordinación de equipos que no son llevados a cabo de forma recurrente pero que ocurren de manera aislada y que impactan directamente en el rendimiento adaptativo. Concretamente, seguimos los avances recientes en coordinación de equipos (Rico et al., 2008) que propone dos formas complementarias de coordinación: la coordinación explícita y la coordinación implícita. Mientras que la primera se refiere a verbalizaciones que ocurren en el marco de los equipos para distribuir roles, comunicarse de manera efectiva y negociar objetivos de rendimientos y plazos de ejecución, la coordinación implícita ocurre de manera imperceptible mientras que los equipos desarrollan sus tareas (Rico et al., 2008). En esta tesis doctoral argumentamos que la coordinación explícita y la coordinación implícita impactan de forma diferencial en las diferentes fases de la adaptación (fase de transición y fase de readquisición).

Además, esta tesis va en línea con los estudios existentes que sugieren que la relación entre la cognición de equipos y los patrones de interacción con el rendimiento adaptativo dependen de las características del cambio (Gersick & Hackman, 1990; Baard et al., 2014; Christian, Christian, Pearsall, & Long, 2017). En concreto, consideramos que los efectos propuestos de los TMMs, la coordinación de equipos, los TSMs y los patrones de interacción de equipo en el rendimiento adaptativo dependen de la magnitud del cambio (definida como la intensidad de la disrupción que causa la necesidad de adaptación –Maynard et al., 2015). Con respecto a la magnitud del cambio, cuando los equipos afrontan cambios de baja magnitud las situaciones de antes y de después del cambio comparten varios elementos que hacen que el nuevo contexto sea más o menos predecible. De forma alternativa, cuando la magnitud del cambio es alta, la situación después del cambio estará menos definida y será menos predecible (Hærem, Pentland & Miller, 2015).

Teniendo en cuenta las argumentaciones anteriores, hemos llevado a cabo tres estudios que analizan características de los equipos que ayudan a mejorar (o empeorar) los niveles de adaptación de los equipos durante la transición y la readquisición usando modelos de coeficientes aleatorios de crecimiento discontinuo (RCGM). Concretamente, con el primer estudio identificamos el estilo de liderazgo de los equipos y el propio contexto como predictores de los patrones de interacción de equipo y ponemos esta variable como clave en la adaptación por su efectos diferenciales en los diferentes momentos después del cambio. Con el segundo estudio, analizamos los efectos de las estructuras cognitivas estables y ambos tipos de coordinación en el rendimiento durante las fases de transición y readquisición. En el tercer estudio, identificamos el estilo de liderazgo y la precisión de los TMMs como predictores de la precisión de los TSMs. Además, encontramos efectos directos positivos de los TSMs en el rendimiento adaptativo que solamente fueron significativos cuando los cambios fueron de magnitud baja.

Con esta tesis doctoral que examina el rendimiento adaptativo, aportamos al campo de investigación interesantes contribuciones tanto teóricas como de gestión. Primero, contribuimos a la línea de investigación que analiza la adaptación de equipos de forma longitudinal con el modelo de dos fases (p. ej., Sander et al., 2015; Hale, Ployhart, & Shepherd, 2016). Segundo, arrojamos luz en por qué los hallazgos anteriores referentes a los efectos de los patrones de interacción de equipo en la adaptación no han sido concluyentes (p. ej., Stachowski et al., 2009; Uitdewilligen et al., 2013). Así, aportamos evidencia empírica que da soporte a sus efectos negativos durante la fase de transición y sus efectos positivos durante la fase de readquisición posterior. damos soporte a sus iniciales efectos negativos durante la etapa de transición pero sus beneficios durante la readquisición. Tercero, somos pioneros en generalizar los efectos positivos de los TSMs en el rendimiento (Hamilton, 2009) a situaciones donde los equipos afrontan cambios. Cuarto, damos soporte a los efectos diferenciales de los estilos de liderazgo en los procesos y el rendimiento de los equipos (p. ej., Lorinkova et al., 2013). Damos, por lo tanto, respuesta a la llamada de atención de estudios previos sobre la necesidad de analizar predictores de los TSMs (p. ej., van der Haar et al., 2015) y los patrones de interacción de equipo (p. ej., Stachowski et al., 2009). Además, damos soporte empírico a los efectos positivos de la similitud y la precisión de los TMMs así como a la coordinación explícita e implícita para la adaptación de equipos. Por último, avivamos el debate respecto a incorporar las características del cambio cuando se estudia la adaptación de equipos (p. ej., Baard et al., 2014; Christian et al., 2017) ya que probamos su efecto modulador en muchas de las relaciones entre procesos y resultados encontrados en los estudios de esta tesis.

La importancia para la industria radica en nuestras recomendaciones prácticas que intentan ayudar a los equipos que afrontan situaciones de cambio. En concreto, sugerimos varias formas de mejorar los niveles de adaptación tanto durante la fase de transición como durante la fase de readquisición dependiendo de la naturaleza del cambio que se afronta. Específicamente, proponemos adoptar comportamientos de liderazgo participativo para mejorar tanto los patrones de interacción de equipo como la precisión de los TSMs debido a sus efectos positivos en el rendimiento adaptativo. Además, proponemos mejorar los niveles de precisión de los TMMs de tarea y de equipo ya que hemos aportado evidencia empírica para relacionarlos directamente con el rendimiento adaptativo así como con la generación de TSMs más precisos. Además, los niveles de similitud de los TMMs de tarea y de equipo también estuvieron relacionados positivamente con el rendimiento después del cambio por lo que proponemos mejorar la similitud de los TMMs a través de técnicas como por ejemplo, los cross-trainings.

CHAPTER 2

THEORETICAL BACKGROUND: TEAM ADAPTATION AND THE TWO PHASE MODEL

1. The Importance of Studying Team Adaptation

Organizations operate in turbulent environments characterized by unpredictability, instability and dynamism derived from a wide variety of external and internal changes (e.g., new trends in labor market, technological advances, evolving customer needs, etc.) that demand an urgent need to recognize them and successfully adapt to them (Baard et al., 2014; Burke et al., 2006; Maynard et al., 2015).

As a present reality, organizations increasingly rely on teams to be effective operating under such environments that call for adaptation to new task demands (Burke et al., 2006). The main reasons is that teams have more advantages than isolated individuals to gain adaptability (Kozlowski, Gully, Nason & Smith, 1999) and also avoid constraints of rigid organizational structures that difficult team adaptation (Levinthal & March, 1993). Therefore, it is crucial to better understand team adaptation to be successful when working under changing circumstances (Rosen, Bedwell, Wildman, Fritzsche, Salas & Burke, 2011).

Proving the increasing interest on this topic, there has been a wide proliferation of research aiming to examine how teams increasingly gain adaptability, tolerate uncertainty and flexibility under dynamic work circumstances (e.g., Burke et al., 2006; Rosen et al., 2011; Pulakos, Arad, Donovan, & Plamondon, 2000). Research on the topic is relevant given the fact that teams who do not successfully manage changing situations will suffer from sharp team performance decrease, which is translated into financial loss, property damage, and in extreme situations even human lives.

Most of the research conducted on team adaptation has been carried out from the task-change paradigm but with a cross-sectional approach (Baard et al., 2014). This approach consists on making teams performing a given task and once a certain degree of expertise has been reached, introducing a change in the task and pay attention to a single measure of the post-change team performance. Besides, there have been subsequent efforts that have attempted to longitudinally analyze team adaptation by repeatedly measuring team performance after a task-change (LePine, Colquitt & Erez, 2000; LePine, 2003). Nevertheless, in both studies performance measures were averaged and trajectories of team performance were not examined. In this sense, extant research is valuable as it allows identifying for team variables that are positively related with post-change team performance.

However, temporal team models imply that teams are not static entities but they change and develop over time (Marks, Matthieu & Zaccaro, 2001; Kozlowski, Gully, Nason & Smith; 1999). Consequently, team processes unfold over time and although there has been a wide increase in theory development concerning team dynamics along the last decades the efforts of scholars to conduct empirical studies to test those theories is still needed (Collins, Gibson, Quigley, & Parker, 2016). In this sense, there might be certain team characteristics that may cost the team time and effort but that will contribute to team performance increase in the long run. Therefore, analyzing a single measure of post-change team performance would contribute to equivocal results, this leading to equivocal conclusions about the relationship between team variables and team adaptive outcomes.

2. The Two Phase Model to Study Team Adaptation

Bearing in mind the temporal nature of the adaptation process Lang & Bliese (2009) proposed a conceptual and methodological framework to study adaptation of individuals that has also been applied to the study of the adaptation process on teams (Sander et al., 2015). In particular, this framework proposes the use of discontinuous RCGM to longitudinally analyze team adaptation in different moments: transition adaptation and reacquisition adaptation. Under this approach, the study of the team adaptation focusing on different moments over time takes into consideration pre-change levels of team performance (i.e., basal performance and skill acquisition). Following the example of the introduction about a marketing team in a destination management organization, we briefly explain the importance on this longitudinal approach that studies team adaptation in several moments bearing in mind pre-change levels of team performance.

Teams' basal performance and skill acquisition. In a given task performance scenario, basal team performance refers to the mean level of performance whereas skill acquisition refers to the rate of improvement on team performance over time along the pre-change stage. For example, suppose the marketing team of our illustrated example (team A) and the marketing team of a direct competitor (team B). Both teams are likely to differ first in their mean level of team performance (e.g., perceived value, customer satisfaction, willingness to pay, market share, etc.). Second, both teams differ in the rate of improvement in their team performance as they perform their task over time (e.g., increase or decrease in perceived value, in customer satisfaction, in willingness to pay, in market share, etc.). In this sense, the marketing team of our destination management organization (team A) may have a market share of 5% in a given market in 2017 and increase this share to 6% in 2018. In contrast a direct competitor (team B) may have a 10% of share in the same market in 2017 but suffer from a decrease to 6% in 2018. In this sense, whereas team B has a higher basal performance than team A, team A possesses a higher skill acquisition than team B (i.e., our competitor's team performance has sharply decreased whereas our destination management organization team performance is increasing).

Teams' transition adaptation. When teams unexpectedly face a task-change (i.e., the irruption of Information and Communication Technologies in the global market) they have to make modifications in their behavioral repertoire to successfully adapt to it (Baard et al., 2014). The main reason is that the team may have been performing behaviors and following procedures that may not longer be useful in the new situation (i.e., carrying out offline marketing campaigns consisting in leaflets and TV advertisements, although useful before the irruption of new technologies is not likely to be useful in the new post-change situation). Consequently, team performance is to decrease right after facing a task-change that demands for adaptation (Sander et al., 2015). To this concern, teams' transition adaptation refers to the ability of the team to minimize the decrease in team performance right after a disruption takes place (i.e., the transition phase). It captures team members' capability to immediately adapt their behaviors when facing a disruptive trigger that demands for adaptation. Therefore, higher levels of transition adaptation imply fast reactions to the cue causing the change that facilitates team adaptation. In particular, the drop in team performance derived from the change is smaller for those teams with higher levels of transition adaptation, compared to those teams with lower levels of transition adaptation. In this sense, the disruption that opened this dissertation was demanding the marketing team to radically abandon their offline advertising but to target their potential customers through online channels. Those marketing teams that are able to identify that their target audience is not reachable offline anymore but that they need to start online marketing campaigns have higher levels of transition adaptation. In this sense, if both our destination management organization marketing team A and direct competitor team B suffer a team performance decrease from 6% on market share to 5%, it may seem that both teams have similar levels of transition adaptation. Nevertheless, if we bear in mind their pre-change team performance, team B was suffering from a sharp decrease in performance and they were able to somehow stop this fall. Consequently, team B showed more levels of transition adaptation that actually implies faster reaction to the task-change.

Teams' reacquisition adaptation. After the team performance decrease that characterizes the transition phase teams are expected to gradually recover team performance over time (Sander et al., 2015). This is because during the new post-change stage teams reformulate strategies and plan how to deal with the new situation faced (Rico, Sánchez-Manzanares, Gil & Gibson, 2008). Consequently, as team members continue to perform the new task they encountered, they are expected to enter in a new skill acquisition phase that is characterized by a progressive recovery of post-change team performance (Lang & Bliese, 2009). In this line, teams' reacquisition adaptation captures teams' capability to increase their recovery rates of team performance along the post-change stage (Sander et al., 2015). Therefore, higher levels of reacquisition adaptation imply team members' ability to select best team behavioral patterns that best suit the new situation encountered. In practical terms, teams with higher levels of reacquisition adaptation perform better during the post-change stage (e.g., they are better are developing online segmented marketing campaigns and therefore better at increase their market share).

3. Findings within the Two Phase Approach

In the study of team adaptation, teams' desirable characteristics are to maximize their levels of both, transition adaptation (i.e. to minimize the decrease in team performance after the task disruption) and reacquisition adaptation (i.e. to maximize the rate of improvement in team performance during the post-change stage) because that involves a high capability of teams to deal with changing situations (Sander et al., 2015). Consequently, in order to broaden our knowledge of team adaptation, it is interesting to identify teams' characteristics that fosters or hinders both transition adaptation and reacquisition adaptation.

To date, some scholars have already adopted the two-phase framework for the study of adaptation in both individuals and teams but research is still limited under this approach (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander et al., 2015). Under this approach important findings concerning the adaptation process have been incorporated to the field literature. For example, Lang & Bliese (2009) found that individuals' general mental ability had an overall general effect in performance along both the pre-change and the post-change stage, but that it particularly and negatively affected individuals' transition adaptation. Concerning team adaptation, Sander and coauthors (2015) found that accurate team knowledge structures had an overall effect on both pre-change and post-change team performance whereas the extent to which mental models where similar was irrelevant for team adaptation. The previous findings shed light on how cognition, team structures and other contextual factors differentially affect team adaption in different moments (i.e., right after a disruptive event takes place or later on during the reacquisition phase). However, the amount of studies under this approach is still little and more empirical efforts need to be done in order to enlarge this burgeoning research stream.

Consequently, we propose three experimental studies that analyze the existing relationship among team variables and contextual factors with team adaptive outcomes using the two-phase framework. In particular, we propose team inputs, team processes, team emergent states and contextual factors likely to directly and differentially impact teams' transition adaptation and reacquisition adaptation. In this doctoral dissertation, we build on recent theoretical developments (Baard et al., 2014; Burke et al., 2006; Maynard et al., 2015) and a meta analytic research (Christian, Christian, Pearsall, &

Long, 2017) to design three studies in order to identify team differences that positively impact teams' transition and reacquisition adaptation.

4. Effects of Team Variables and Contextual Moderators on Team Adaptation

Bearing in mind the relevant research on team adaptation and the importance of the longitudinal approach of the two-phase proposal we propose the following team inputs, team processes, team emergent states and contextual moderators to be studied thorough the experimental studies of this doctoral dissertation.

Team Inputs. Main theoretical models of team adaptation have included team inputs as relevant for teams coping with changing situations (Maynard et al., 2015; Burke et al., 2006). In particular, team inputs are strongly related to team processes that will ultimately and positively impact team adaptation (Christian et al., 2017). Consequently, we have considered here team leadership, as it is one of the main characteristics that make teams effective (Zaccaro et al., 2001).

Team Leadership. Team leadership can influence teams' adaptability in two ways. First, leaders' individual differences can directly impact team adaptation (Maynard et al., 2015). Second, team leaders can directly impact team processes and improve teams' transition and reacquisition adaptation. The second is our main concern as we place team leadership as a predictor of some of the team processes and emergent states considered in our model. Based on leadership literature we focus on two widely known leadership styles: empowering leadership and directive leadership. According to Fleishman and colleagues (1991) who identified 65 different classification systems of team leadership, most of leadership behaviors can be framed in these two leadership styles.

Empowering leaders focus on encouraging team members to exchange information and actively take part in decision-making processes as well as frequent interpersonal interaction (Amundsen & Martinsen, 2014; Arnold, Arad, Rhoades & Drasgow, 2000). In teams led by empowering leaders there is general tendency to increase team members' autonomy and responsibility (Srivastava, Bartol & Locke, 2006). In addition, empowering leaders tend to encourage team members to frequently express ideas and opinions with the rest of the members of the team (Lorinkova et al., 2013).

Alternatively, directive leaders adopt a top-down attitude where the leader is the decision maker and focus on giving order and instruction to the rest of team members as well as establishing goal and means to achieve them (Bass, Valenzi, Farrow & Solomon, 1975; Sims, Farak & Yun, 2009; House, 1996). In teams led by directive leaders the input of team members in decision-making is limited because directive leaders focus their efforts in controlling other team members behaviors (Schaubroeck, Shen & Chong, 2017). In teams with directive leaders, team members focus on their own tasks because leaders restrain interactive behaviors such as information sharing (Pearce & Sims, 2002).

Recent studies have analyzed differential effects of both kinds of leadership styles on team processes and team cognition (Lorinkova, Pearsall & Sims, 2013). They provided evidence on the positive effects of the empowering leadership style on several team processes related to coordination and cognition that would in turn improve team performance on the long run. We similarly want to extend the assumption of the benefits of empowering leadership style to teams working under changing circumstances. Our main concern in this doctoral dissertation is to place team leadership as a predictor of behavioral interaction patterns and short-term cognitive structures (explained later) that are both beneficial for team adaptation.

Concerning team behavioral interaction patterns, directive leaders restrain team members' participation because leaders focus on controlling team members' behaviours by providing them with guidance in terms of task assignment and performance goals (House, 1996; Schaubroeck, Shen, & Chong, 2017). In teams with directive leaders, team members tend to focus on their own tasks because directive leaders restrain interaction within the team (Pearce & Sims, 2002). In terms of team behavioural patterns, this would mean that directive teams are characterized by fewer team behavioural interaction patterns, but by unipersonal behavioural patterns instead. On the other hand, empowering leaders focus their efforts on encouraging behaviours that involve frequent interaction, such as the exchange of information and ideas among team members (Arnold, Arad, Rhoades, & Drasgow, 2000). Empowering leaders tend to repeatedly promote behaviours that involve constant interaction among team members, such as participative decision-making (Arnold et al., 2000). Because empowering leaders encourage interaction and participation among team members, the quantity of team behavioural interaction patterns is expected to be high.

Concerning team cognition, several studies already acknowledge the relationship between team leadership and TMMs through the encouragement of certain team processes that promotes communication and other kinds of interaction among team members (e.g., Marks, et al., 2000; Dionne, Sayama, Hao, & Busch, 2010; Lorinkova et al., 2013). However, no studies relate team leadership with TSMs yet. Extant research suggests that there are certain behaviors such as communication, exchange of ideas and information and team members' participation likely to positively affect the generation of accurate TSMs (MacMillan et al., 2004; van der Haar et al., 2015). This is not surprising as TSMs result from combining both, the knowledge already stored in TMMs and the specific new information gathered during the post-change situation (Rico, Gibson, Sánchez-Manzanares, & Clark, 2014). Teams with more information about the new situation are more likely to relate it with their TMMs generating therefore, a more accurate TSM. Consequently, we similarly expect that teams led by empowering leaders will show more of those behaviors that will positively contribute to the generation of accurate TSMs.

Team Processes. It is widely accepted in the team literature that team processes are fundamental of team adaptation (Burke et al., 2006; Maynard et al., 2015; Christian et al., 2017). This is because when teams face a task change they have to abandon, modify or perpetuate processes that were used before the change in order to face the new situation. In this dissertation, we build on recent developments on team coordination (Rico et al., 2008) that propose two complementary ways of coordination behaviors (i.e., explicit and implicit) that are differentially used and provide the team with different potential benefits in different moments of the team adaptation. Besides, we consider team interaction patterns of behaviors because although they have proven to be key on team adaptation (Uitdewilligen et al., 2013) the empirical evidence on the topic provides the field with contradictory findings that can be solved by using the longitudinal framework of the two-phase approach.

Team Coordination. Team coordination has been seen as one of the most important characteristics for team adaptation (Entin & Serfaty, 1999). It requires team members to carry out activities to manage their interdependencies in order to achieve a common goal (Malone & Crowston, 1994). The literature has proposed explicit and implicit coordination as two complementary mechanisms for teams aiming to manage their interdependencies (Rico et al., 2008). Whereas explicit coordination refers to those behaviors related to communication and planning, implicit coordination refers to those behaviors that allow team members to anticipate changes and dynamically adapt to other team members needs (Rico et al., 2008). Although theory suggest that when teams face a task change they need to engage in explicit coordination behaviors to reformulate strategies and better plan how to adapt to the disruption (Espinosa et al., 2002; Rico et al., 2008), there is evidence that supports the benefits of implicit coordination for teams working under non-routine situations (Marques-Quinteiro, Curral, Passos & Lewis, 2013). Apparently, both coordination mechanisms are beneficial for teams engaging in changing situations. However, the field lacks evidence on differential effects of coordination mechanisms bearing in mind the longitudinal nature of team adaptation. Consequently, with the longitudinal framework adopted in this dissertation through the two-phase approach, we want to extend previous findings to different moments of team adaptation (i.e., transition adaptation and reacquisition adaptation). In this line, as evidence is not conclusive, we aim to overcome limitations of previous studies refining the operationalization to shed light on its effect on team (Butchibabu, Sparano-Huiban, Sonenberg & Shah, 2016; Shah & Breazeal, 2010; Kolbe et al., 2014). Concretely, in this research we aim to refine the measurement of implicit coordination and shed light on its effect on team adaptation. The main reason is that many previous studies considered verbal communications as implicit coordination behaviors, which might have led to equivocal results.

Team Behavioral Interaction Patterns. Team interaction patterns of behaviors are defined as sequences of verbalizations and actions that are repeatedly performed by two or more team members (Zellmer-Bruhn, Waller & Ancona, 2004). Evidence suggests that they directly impact team effectiveness (Lei, Waller, Hagen & Kaplan, 2015) but there is still debate about their impact on team adaptation (Stachowski, Kaplan & Waller, 2009; Uitdewilligen, Waller & Pitariu, 2013). The highly structured and organized ways of working characterized by the presence of big amounts of patterned interaction among team members have been theorized for long as detrimental for managing team disruptions (Gersick & Hackman, 1990). Indeed, several studies provided empirical evidence on the negative relationship between behavioral interaction patterns and team performance of teams working in dynamic settings (Waller, Gupta & Giambatista, 2004; Stachowski et al., 2009). However, there are some exceptions claiming for the benefits of behavioral interaction patterns on team adaptation (Uitdewilligen et al., 2013).

We believe that opposing findings on the effects of behavioral interaction patterns on team adaptation have to do with the way empirical studies have been conducted until now. Research on team behavioral patterns have systematically neglected performance trajectories and also often paid attention to behaviors performed right in the moment of the disruption ignoring those performed along the pre-change and post-change stages resulting in several gaps in the field to be filled (Stachowski et al., 2009; Uitdewilligen et al., 2013; Lei et al., 2015; Ziljstra, Waller & Phillips, 2012). In the present dissertation we pay attention to behavioral interaction patterns performed both before and after the task change that demanded for adaptation took place and analyze their effects on transition and reacquisition adaptation. In particular, and in order to clarify the aforementioned contradictory findings, we analyze the effects of behavioral interaction patterns along the pre-change stage on transition adaptation and those along the post-change stage on reacquisition adaptation. We build on previous studies and theoretical propositions (Gersick & Hackman, 1990; Stachowski et al., 2009; Uitdewilligen et al., 2013) to indeed support the detrimental effects of behavioral interaction patterns but only during the transition phase.

Concerning pre-change team behavioural interaction patterns, during early team formation, teams develop team behavioural interaction patterns as a way to increase team efficiency when performing their tasks (Zijlstra et al., 2012). Such team behavioural interaction patterns are established during the initial skill-acquisition phase as team members continue to interact with each other and repeatedly perform sequences of behaviours (Uitdewilligen et al., 2018). However, research suggests that pre-change team behavioural interaction patterns obstruct the identification of changes and consequently, hinder teams' transition adaptation (Stachowski et al., 2009; Waller et al., 2004). The focus of studies to date has been on behaviours performed as an in-the-moment reaction to a disruption and not on those that had been performed during the pre-change stage. The available empirical evidence does not allow one to firmly state that pre-change team behavioural interaction patterns ease teams' transition adaptation. On the contrary, such studies suggest that effective pre-change team behavioural interaction patterns are difficult to abandon and may, indeed, become a liability when they are no longer appropriate for the new post-change situation (Cohen & Bacdayan, 1994; Uitdewilligen et al., 2018), because new tasks would require selecting other behaviours according to the demands of the new post-change situation (Kozlowski et al., 1999).

During the post-change stage, teams need to identify the new situational requirements necessary to successfully manage the situation and increase team performance. To do so, team members can engage in behaviours that imply frequent interaction, such as information sharing, that will fall into patterns as the team members repeatedly perform them (Rico, Sánchez-Manzanares, Gil & Gibson, 2008). Team behavioural interaction patterns might initially be detrimental because they might distract from the quick completion of the task when there is a task disruption (Stachowski et al., 2009), but the benefits are likely to emerge later, as these interaction patterns allow the identification of situational demands required for team adaptation and consequently, contribute to the gradual increase in post-change team performance (Abrantes, Passos, Cunha, & Santos, 2018).

Team Emergent States. As for emergent states research normally focuses on team cognition (Christian et al., 2017) because it is widely accepted in the literature that teams to be effective need their team members to share knowledge representations about key elements of their context (Cannon-Bowers, Salas & Converse, 1993). Team mental models (TMMs) are the team cognitive structures that have received most attention in the team cognition literature (Mohammed, Ferzandi & Hamilton, 2010). They are, indeed, placed at the core of theoretical models of team adaptation (Maynard et al., 2015; Burke et al., 2006; Christian et al., 2017). However, recent theoretical developments on team cognition suggest that not only the long-term characteristics of TMMs are enough to completely understand the team adaptation process but to move the focus over the situational nature of TSMs. Consequently, on this dissertation we pay attention to the effects of both team cognitive structures (i.e., TMMs and TSMs) in different moments of team adaptation.

Team Mental Models. TMMs are defined as organized and long-term mental representations of contextual relevant team and task elements that are shared across team members (Klimoski & Mohammed, 1994). Empirical evidence have provided the field with several evidence that TMMs positively impact team effectiveness (Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2005; Oranasu, 1990) and also that they are related to team adaptation (Sander et al., 2015).

Concerning the content of TMMs and as proposed by Cannon-Bowers et al. (1993), teams to be effective need to share four kinds of TMMs, each of which refer to different knowledge dimension: equipment, task, team interaction and team. For example in a front-office department of a hotel, the equipment TMM (i.e., operating procedures) refers to computer programs to carry out check-in and check-out of clients and reservation systems; the task TMM (i.e., task issues and how the environment affects the task) refer to procedures to be carried out in each task such as welcoming guests; the team interaction TMM (i.e., roles and interactions) refers to the understanding of different roles of the receptionist, the concierge and the bellboy; and the team TMM (i.e., knowledge, skills and abilities of team members) refers to knowledge about specific foreign languages of preferences to work in a given shift of each team member. They are typically grouped under task (i.e., equipment and task TMM) and team (i.e., team interaction and team TMM) categories (Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000; Mathieu et al., 2005). The task-related involve the understanding and conceptualization of task features of the situation such as equipment, activities and procedures (e.g., in a CRM department, knowledge about business intelligence programs and ways of obtaining relevant information about clients, market research and clients segmentation procedures, etc.,). The team-related TMMs concerns team aspects such as skills, abilities and patterns of interactions team members must carry out to perform effectively (e.g., in the same CRM department it implies knowledge about who is in charge of analyzing clients' profiles or obtaining raw data, who knows how to carry out different task, etc.,). Additionally, by trying to overcome task-related and team-related TMMs' limitations regarding temporal aspects, recent research proposes temporal TMM as "agreement among group members concerning deadlines for task completion, the pacing or speed of activities, and the sequencing of tasks" (Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015 p. 696). Although we consider this kind of TMMs in the discussion section to call for future lines of research, we limit our study to the classification proposed by Mathieu and colleagues (2000, 2005) and focus on task-related and team-related TMMs.

Following this classification we complement and overcome limitations of previous studies by aiming to capture the relationship between different kinds of TMMs (i.e., team-related and task-related TMMs) on team adaptation (Sander et al., 2015).

To analyze the effects of TMMs on team adaptation we have to pay attention to their two main properties: similarity and accuracy (Mohammed et al., 2010). Similarity refers to the extent that team members' mental models converge and allow them to be "on the same page" (Cannon-Bowers, et al., 1993). Accuracy refers to the degree of convergence between the TMMs and the real solution that typically refers to the mental model of an expert (Mohammed et al., 2010). TMM similarity allows team members to make predictions about what is going to happen next (Cannon-Bowers et al., 1993) and therefore should facilitate team adaptation. Besides, if the knowledge stored in the TMM is accurate team members' expectations about future events should be more accurate and consequently, improve team adaptation (Edwards et al., 2006).

Team Situation Models. As we said before, the long-term characteristics of TMM have been said to be insufficient when talking about team adaptation and the notion of TSMs have been proposed as the short-term understanding of a given situation to address this gap (Rico et al., 2008). TSMs properties are similarity and accuracy and as with TMMs, similarity refers to the extent team members share the same understanding of a given situation whereas accuracy refers to the extent that the understanding of a new given situation matches with the real expert understanding of that situation (Rico et al., 2008). TSMs are generated on the fly after facing a task change that demands for adaptation relating the long-term knowledge stored in TMMs with the characteristics of the new situation encountered (Rico et al., 2008). Consequently, we consider here that the accurate knowledge stored in the TMM will directly impact the accurate understanding of the new situation after a task-change (i.e., the accuracy of the TSM). Besides, we also consider that the focus of empowering leaders on identifying key features of the situation contrary to the focus of directive leaders on task completion will help the team to generate accurate TSMs. This is important because the little empirical evidence on TSMs proved that they are positive for team effectiveness (van der Haar, Segers, Jehn, & Van den Bossche, 2015) and we similarly expect positive effects on the reacquisition of team performance after the drop that characterizes the transition because of two main reasons.

First, accurate (or inaccurate) TSMs involve a good (or bad) assessment of the current situation and in the particular case of facing a task-change they imply that the team can (wrongly) comprehend and give meaning to the change (Mohammed et al., 2017). Second, accurate TSMs provide the team with an advantage for team adaptation, as they are more likely to know how to respond to the task-change (van der Haar et al., 2015). As highlighted by Kozlowski and colleagues (1999), the understanding of faced contingencies facilitates the selection of existing behaviors (stored in their TMMs) to successfully face the task-change. However, it may be the case that teams do not possess the necessary patterns of behaviors in their repertoire to successfully manage the new event and they need to engage in an invention process by exploring alternatives (Kozlowski et al., 1999). In such situations, accurate TSMs also provide teams with an advantage as they imply that team members are sharing a similar understanding of the ongoing situation (Hinsz, Tindale, & Vollrath, 1997). This shared understanding among team members implies fast consensus in the establishment of strategies, procedures and roles reorganization (Cannon-Bowers & Salas, 2001; Randall et al., 2011) that should positively relate with team adaptive outcomes.

Contextual Moderators. The recent meta-analytic review by Christian and colleagues (2017) provide evidence on contextual factors that are directly connected to the team adaptation process. In particular, scholars often proposed the moderating role of contextual factors on the relationship between team processes and team performance (Stewart & Barrack, 2000). Answering to several calls in team adaptation literature we suggest that the magnitude of change (defined as the severity of the task disruption that demands for team adaptation –Maynard et al., 2015) will moderate the effects of team processes and emergent states on team adaptation (Gersick & Hackman, 1990; Maynard et al., 2015; Uitdewilligen et al., 2013).

Magnitude of Change. The unexpected situation derived from task-changes that teams deal with are not all the same but they vary in terms of their magnitude (Maynard et al., 2015). When the magnitude of the task-change is high, the new situation that teams must cope with will be less defined and predictable than when the magnitude of the change is low. When the magnitude of the task-change is low, the new situation is somehow predictable as both situations before and after the change are similar to a certain extent. Following previous research we predict that the magnitude of change will moderate the relationship between team processes and team emergent states on transition and reacquisition adaption (Stewart & Barrack, 2000; Christian et al., 2017). The direction of each moderating effects will be amplified along the different chapters of this doctoral dissertation for each of the team processes and team emergent states mentioned before.

5. Experimental Studies Justification

Figure 1 shows the interrelation of the research variables to be examined thorough the three studies of the present doctoral dissertation. In the three studies, we focused on different team variables that affected team adaptation in different moments (i.e., transition phase and reacquisition phase) that have been mentioned thorough this theoretical background chapter and better explained in the next three chapters in order to develop our hypothesis for each study.

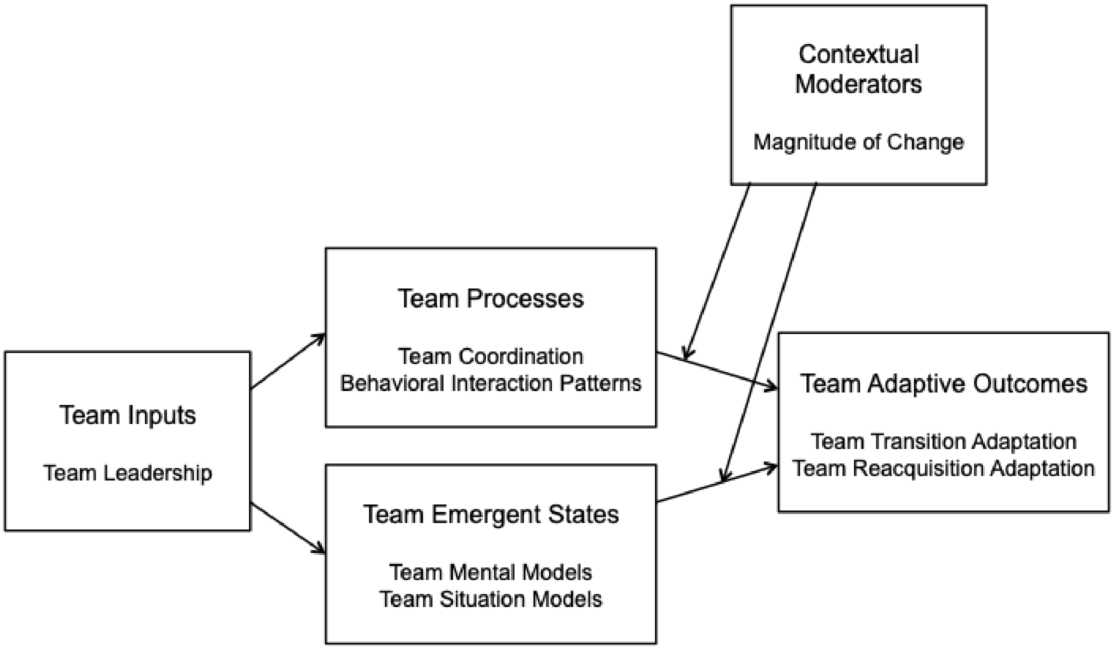


Figure 1. Doctoral Dissertation Research Model

As can be seen in Figure 1, with this doctoral dissertation we have examined different team processes (i.e., behavioral interaction patterns, team coordination) and team emergent states (i.e., TMMs and TSMs) effects on teams' transition and reacquisition adaptation for teams working under different magnitude of change condition (i.e., high and low magnitude changes). In addition, we analyzed the role of team leaders as enhancers of certain processes (i.e., behavioral interaction patterns – study 1) and emergent states (i.e., TSMs –study 3) given their mentioned potential to influence behavioral and shared cognition processes. Besides, and given the importance of contextual moderators highlighted before, we included the magnitude of change as a moderator of the proposed relationships between team processes and team emergent states with team adaptive outcomes. In particular, we analyzed the effects of behavioral interaction patterns (study 1), TMMs and team coordination (study 2), and TSMs (study

3) on team adaptive outcomes for teams working under high and low magnitude of change conditions.

CHAPTER 3

TEAM BEHAVIORAL INTERACTION PATTERNS FOR TEAM ADAPTATION: EMPOWERING AND DIRECTIVE LEADERSHIP AS BEHAVIORAL PREDICTORS

1. Abstract

In this study we analysed the effects of team leadership style and magnitude of change on team behavioural interaction patterns. We also analysed the effects of pre-change and post-change team behavioural interaction patterns on post-change team performance during the transition and reacquisition phases, respectively, for teams facing changes of different magnitudes. For this study, 67 three-person teams took part in a computer-based 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) factorial design. Our results indicated that teams led by an empowering leader tended to display more team behavioural interaction patterns than teams led by a directive leader. Through discontinuous random coefficient growth modelling (RCGM) we observed that pre-change team behavioural interaction patterns negatively affected teams' transition adaptation, but post-change team behavioural interaction patterns were beneficial for teams' reacquisition adaptation. Implications for theory and practice are discussed.

Keywords: directive leadership, empowering leadership, team behavioural interaction patterns, team adaptation, magnitude of change.

2. Introduction

Teams are constantly facing external and internal changes derived from the unpredictability and dynamism of the context in which they operate (Burke, Stagl, Salas, Pierce, & Kendall, 2006b). Team adaptation (defined as modifications made by team members in response to new situations; Baard, Rench, & Kozlowski, 2014) is therefore crucial for success (Rosen et al., 2011). There has been a wide proliferation of research examining how teams increasingly gain adaptability, toleration of uncertainty and flexibility under dynamic work circumstances (e.g. Burke et al., 2006b; Pulakos, Arad, Donovan, & Plamondon, 2000; Rosen et al., 2011). Most of the research on team adaptation has followed the task-change paradigm, which consists of examining post-change team performance when incorporating task-changes after a certain level of expertise has been reached (Baard et al., 2014).

Contributing to this burgeoning research, in this study we focus on the role of team leaders in the team adaptation process because of their ability to directly influence several processes at the team level, such as those related to the coordination and shared cognition required for team adaptation (e.g. Burke et al., 2006a; Marks, Zaccaro, & Mathieu, 2000; Zaccaro, Heinen, & Shuffler, 2009). Regarding team coordination, leaders can help the team establish and change team behavioural interaction patterns (defined as recurrent sequences of verbal and non-verbal interactions performed by team members developed during the early stages of team activity; Zellmer-Bruhn, Waller, & Ancona, 2004) in response to situational demands (Zaccaro, Rittman, & Marks, 2001). An example of team behavioural interaction patterns is commonly found in fast food restaurants, where team supervisors establish procedures such as: after each client orders their meal, a crew member passes the order to the cook, who assembles the product and hands the final product back to another crew member who delivers it back to the customer. As a team behavioural interaction pattern, this sequence is performed repeatedly among team members. Team leaders differ in their leadership style, however, and we therefore consider the potential differential effects that team leaders' behaviours (i.e. empowering and directive; Fleishman et al., 1991) will have on team behavioural interaction patterns. Whereas directive leaders focus their efforts on accomplishing the task with a top-down attitude and limit team members' participation, empowering leaders are more likely to encourage the use of team behavioural interaction patterns due to their focus on promoting frequent exchange of ideas and interaction among team members (House, 1996; Amundsen & Martinsen, 2014).

Team behavioural interaction patterns increase a team's efficiency because their recurrent nature increases the predictability of team members' actions (Zellmer-Bruhn et al., 2004), so team members do not need to deliberate explicitly each time they encounter a situation suitable for the use of those patterns. Although team behavioural interaction patterns have been identified as a central aspect of teams' adaptability (the team's ability to adapt to unforeseen changes; Cohen & Bacdayan, 1994; Uitdewilligen, Waller, & Pitariu, 2013) empirical evidence has not been conclusive, as it has suggested that team behavioural interaction patterns have both benefits and disadvantages for teams facing disruptions (Ericksen & Dyer, 2004; Kanki, Folk, & Irwin, 1991; Stachowski, Kaplan, & Waller, 2009; Uitdewilligen, Rico, & Waller, 2018; Waller, Gupta, & Giambatista, 2004).

These contradictory findings may very well be a consequence of the cross-sectional approach followed in most studies, which neglect teams' dynamic nature that requires a longitudinal approach to better capture team processes (Kozlowski, Gully, Nason, & Smith, 1999; Marks, Matthieu, & Zaccaro, 2001). We therefore adopt the two-phase framework proposed by Lang & Bliese (2009) that analyses team adaptation processes based on two post-change phases: the transition phase (i.e. the immediate decrease in team performance after facing a change) and the reacquisition phase (i.e. the gradual recovery of team performance after facing the change). By following this framework, we study the relationship between team leadership and team behavioural interaction patterns and its impact on both transition and reacquisition adaptation. In particular, we focus our attention on how team behavioural interaction patterns developed during the pre-change stage affect teams' transition adaptation and how team behavioural interaction patterns developed during the post-change stage have an impact on teams' reacquisition adaptation.

Most empirical studies on adaption characterize the post-change situation as more difficult and complex than the pre-change situation (e.g. Gorman, Cooke, & Amazeen, 2010; Lang & Bliese, 2009; LePine, 2005; Uitdewilligen et al., 2018). These differences in how difficult or complex the post-change situation turns out to be are related to the characteristics of the change itself (Christian, Christian, Pearsall, & Long, 2017). Accordingly, following recent developments that highlight the need to incorporate the characteristics of the situation into the study of team adaptation (e.g. Christian, et al., 2017; Maynard, Kennedy, & Sommer, 2015), we consider the effects of the magnitude of change in two ways. First, we consider whether the effect of team leadership style on post-change team behavioural interaction patterns is moderated by the magnitude of the change (defined as the severity of the task-based trigger that requires the adaptation; Maynard et al., 2015), because teams will adjust their behavioural repertoire according to the needs of the new post-change situation. Second, we also consider whether team behavioural interaction patterns differentially affects teams' transition and reacquisition adaptation depending on the magnitude of the change teams are facing (Gersick & Hackman, 1990; Uitdewilligen et al., 2013). We consider whether teams can operate at suboptimal levels under low magnitude changes, while under high magnitude changes, team performance problems will be more severe: that is, whether after a low magnitude change, the initial decline in team performance will not be as severe and the recuperation will be faster than after a high magnitude change.

We have designed a study to empirically test a research model (see Figure 1) that aims first to examine the differential effects of empowering and directive team leadership styles and the magnitude of change on both pre-change and post-change team behavioural interaction patterns; and second, to analyse the longitudinal effects of pre-change and post-change team behavioural interaction patterns on teams' transition and reacquisition adaptation, respectively, for teams working with task changes of different magnitudes (i.e. low and high magnitude of change). We use discontinuous random coefficient growth modelling (RCGM), a technique that allows the testing difference in team interaction patterns that may benefit post-change team performance during both the transition and reacquisition phases (Hale, Ployhart, & Shepherd, 2016; Lang & Bliese, 2009; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal, & Zijlstra, 2015).

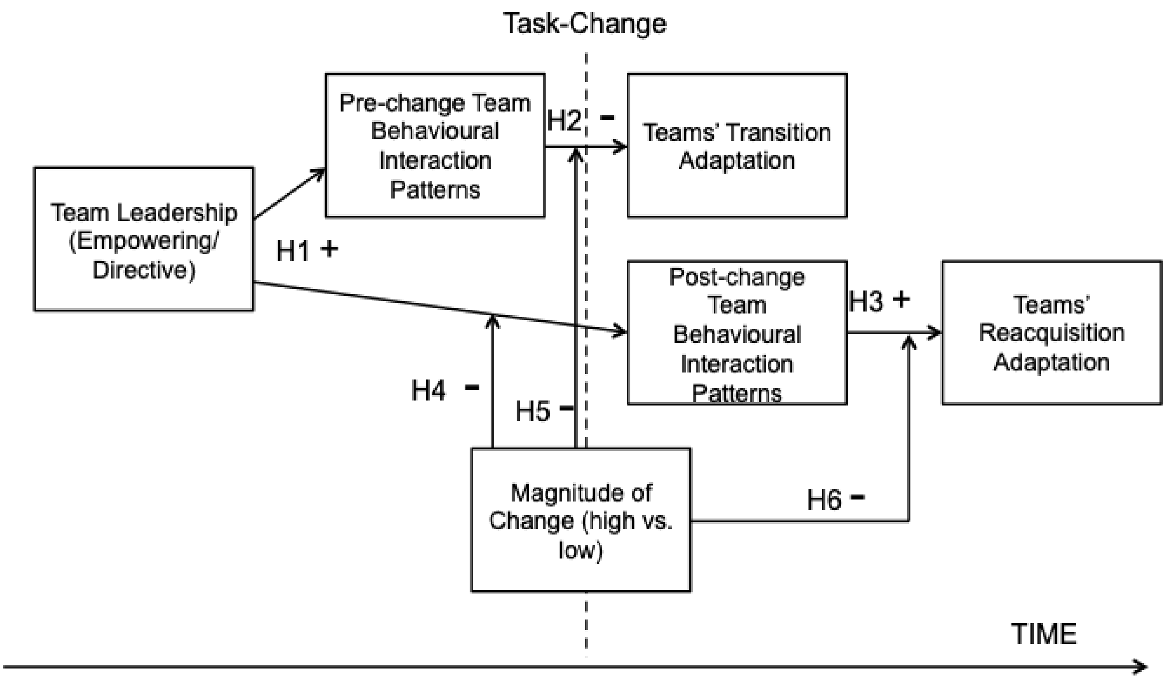


Figure 1. Research Model

3. Theoretical Framework and Hypotheses

The Effects of Team Leadership Styles on Team Behavioural Interaction Patterns

When teams work in unpredictable contexts, leaders can use different team leadership styles to help establish or adjust team behavioural interaction patterns in response to situational demands (Zaccaro et al., 2001). Whereas directive leaders tend to be the decision-maker and give instructions to the rest of the team (Sims, Faraj, & Yun, 2009), empowering leaders increase team members' autonomy and responsibility (Srivastava, Bartol & Locke, 2006). Recent research analysing the effects of directive and empowering team leadership styles on teams' dynamics has proved that teams led by empowering leaders (empowering-led teams) showed higher levels of team learning and team behavioural coordination (Lorinkova, Pearsall & Sims, 2013). This evidence suggests that empowering and directive team leadership styles can differentially affect team behavioural interaction patterns in two main ways.

As mentioned in chapter 2, directive leaders tend to restrain interaction among team members. For example, in hotels housekeeping departments, the supervisor is likely to proceed daily as follows: the supervisor monitors the daily needs of room cleaning according to check-ins, check-outs and the occupancy rate of the hotel (Behaviour A); the supervisor plans distribution of rooms for cleaning among housekeepers (Behaviour B); and the supervisor assigns each team member a task (Behaviour C). After this sequence of behaviours, each housekeeper engages in their own tasks and starts to clean the rooms according to the received assignments. Although some interaction is likely to occur, directive leaders restrain interaction and participation of other team members, and it is therefore reasonable to expect little to no team behavioural interaction patterns in teams led by directive leaders (directive-led teams).

In contrast, there is more interaction when leaders use empowering behaviours. For example, in the front-office departments of hotel, the shift leader is likely to proceed as follows: the shift leader asks the receptionist about incidents during the shift (Behaviour A); the receptionist warns the team about difficulties during the shift (Behaviour B); and the desk-clerk offers problem-solving assistance (Behaviour C). This sequence of behaviours will become a stable team behavioural interaction pattern as team members repeatedly perform them. Consequently, and as mentioned in chapter 2, we expect empowering leaders to encourage frequent interaction among team members (Arnold et al., 2000). Based on the rationalities above, we expect more team behavioural interaction patterns in empowering-led teams rather than in directive-led teams. Consequently, we hypothesize that:

Hypothesis 1: *empowering-led teams show more team behavioural interaction patterns than directive-led teams.*

Effects of Team Behavioural Interaction Patterns on Team Adaptation

Traditionally, most of the research carried out on team adaptation has adopted a cross-sectional task-change paradigm approach (Baard et al., 2014), and although some efforts have been made to longitudinally analyse post-change performance (LePine, 2003; LePine, Colquitt & Erez, 2000), only a few studies have taken into account the assessment of post-change performance trajectories (e.g. Lang & Bliese, 2009; LePine, 2005). The approach developed by Lang and Bliese (2009) for studying team adaptation distinguishes three different task performance phases: the initial skill acquisition or pre-change phase (where teams start performing their tasks, develop pre-change team behavioural interaction patterns and increase their performance) and the two different phases of team adaptation (i.e. the transition and reacquisition phases). Using this approach, we can study the effects of pre-change team behavioural interaction patterns on the transition phase and the effects of post-change team behavioural interaction patterns on the reacquisition phase. In this way we overcome the limitations of previous studies that neglected post-change team performance trajectories and focused only on team behavioural interaction patterns performed while managing the disruption (Stachowski et al., 2009; Waller et al., 2004; Zijlstra, Waller & Phillips, 2012).

As mentioned in chapter 2, teams develop team behavioural interaction patterns to increase team efficiency (Zijlstra et al., 2012). Such patterns will hinder teams' transition adaptation because they are difficult to abandon and will not be effective on the new post-change situations (Stachowski et al., 2009; Waller et al., 2004; Uitdewilligen et al., 2018). We therefore follow Gersick and Hackman's (1990) propositions suggesting that pre-change team behavioural interaction patterns increase teams' difficulty in adapting to changes and consequently impair teams' transition adaptation by increasing the initial post-change team performance decline associated with the transition phase. Thus, we submit that:

Hypothesis 2: *Pre-change team behavioural interaction patterns negatively impact teams' transition adaptation. The initial post-change team performance decline after facing a task change will be higher for teams displaying more pre-change team behavioural interaction patterns.*

After the team performance decline characterizing the transition phase, teams are expected to acquire new skills and to gradually recover their performance levels during the post-change stage (Sander et al., 2015). Teams with higher levels of reacquisition adaptation will recover faster from the team performance decline, because the rate of recovery for the team performance will be higher. During the post-change stage, teams establish team behavioural interaction patterns that improve team coordination and maximize team efficiency because of the availability of resources to perform the task (Gersick & Hackman, 1990; Uitdewilligen et al., 2018). Extant empirical research is not, however, conclusive on the effects of team behavioural interaction patterns on team performance during the post-change stage. Although Uitdewilligen and colleagues (2013) found that post-change team performance was predicted by team behavioural interaction patterns, other field studies have suggested that team behavioural interaction patterns do indeed have negative effect on managing disruptions (e.g. Stachowski et al., 2009).

As mention in chapter 2, although team behavioural interaction patterns are initially detrimental (Stachowski et al., 2009) their benefits are likely to emerge later and contribute to a gradual recovery of post-change team performance (Abrantes, Passos, Cunha, & Santos, 2018). We therefore expect that post-change team behavioural interaction patterns will ease teams' reacquisition adaptation and improve the rate of recovery in post-change team performance. Based on this, we state that:

Hypothesis 3: *Post-change team behavioural interaction patterns positively relate to teams' reacquisition adaptation. The post-change rate of recovery for team performance after facing a task change will be higher for teams that display more post-change team behavioural interaction patterns.*

The Moderating Effects of the Magnitude of Change on the Relationship between Team Leadership and Post-Change Team Behavioural Interaction Patterns

The team leader's strategy for leading a team is highly linked to the environmental circumstances in which the team operates (Zaccaro et al., 2001). Together with team leadership style, and based on previous research (Gersick & Hackman, 1990; Uitdewilligen et al., 2013), we consider the magnitude of change as a predictor of post-change team behavioural interaction patterns. When the magnitude of change is high, the resulting situation will be less defined and predictable than when the magnitude of change is low (Hærem, Pentland & Miller, 2015; Vashdi, Bamberger & Erez, 2013). For teams to effectively perform when the magnitude of change is high, it is important that the extant patterns of behaviour change or that new behaviours be developed according to the new situational demands (Gersick & Hackman, 1990). Alternatively, when the magnitude of change is low, several situational elements before and after the change overlap, which makes the post-change situation more predictable: in such cases, teams already know what works and what does not, as well as which kinds of patterned behaviours to slightly amend.

We expect that when both directive and empowering leadership is implemented, team leaders' strategies will differ according to the magnitude of the change they encounter. We therefore expect that when teams face low magnitude changes (e.g. temporary higher workloads), simple increases of effort will be sufficient to deal with the new situation. In practical terms, this would mean that patterned behaviours that were useful in the pre-change situation would be transferred to the post-change situation. For directive-led teams in particular, this would mean continuing to perform behaviours that lack interaction but that focus on task completion (e.g. cleaning rooms faster). For empowering-led teams, this would mean continuing to perform more team behavioural interaction patterns because of the stimuli of the new situation (e.g. dealing with customers faster). When the magnitude of change is low, we therefore expect a stronger relationship between an empowering leadership style and post-change team behavioural interaction patterns.

We also expect that when teams face high magnitude changes (e.g. new tasks or loss of resources), increases in effort are likely to be insufficient to deal with the new situational demands. Teams will then need to engage in other behaviours without team behavioural interaction patterns, such as coordination adjustments (Marks et al., 2000). In particular, this would mean leaving behind patterned behaviours that had worked well during the pre-change stage and finding new ones that are useful for the new post-change situational demands (Gersick & Hackman, 1990). Given our focus on team behavioural interaction patterns and according to the arguments above, we surmise that:

Hypothesis 4*: The magnitude of change moderates the relationship between team leadership style and post-change team behavioural interaction patterns. The positive effect of an empowering compared to a directive leadership style on post-change team behavioural interaction patterns after facing a task change will be higher when the magnitude of change is low.*

The Moderating Role of Magnitude of Change on the Effects of Team Behavioural Interaction Patterns on Team Adaptation

Although some authors have found that high magnitude changes facilitate team adaptation more than low magnitude changes because they are easier to recognize (DeRue, Hollenbeck, Johnson, Ilgen & Jundt, 2008), other studies have found that teams were better able to adapt to low magnitude changes (Hollenbeck, Ellis, Humphrey, Garza & Ilgen, 2011). This suggests that characterizing the severity of the trigger causing the disruption is important when examining the effects of both pre-change and post-change team behavioural interaction patterns on teams' transition and reacquisition adaptation, respectively (Gersick & Hackman, 1990; Jundt, Shoss & Huang, 2015; Schraub, Stegmaier & Sonntag, 2011).

Previous theoretically driven propositions proposed that the negative impact of pre-change team behavioural interaction patterns on teams' transition adaptation was particularly true for teams facing high magnitude changes (Gersick & Hackman, 1990).

After facing low magnitude changes, teams may still continue to perform at a suboptimal level during the period when teams need to respond to the change. This is due to the usability of pre-change team behavioural interaction patterns in the new situation. When the magnitude of change is high, however, teams may experience serious team performance problems until team members figure out that they need to abandon their established team behavioural interaction patterns and deal with the new situation in which they are engaged. Pre-change team behavioural interaction patterns will therefore have more of a negative impact on the teams' transition adaptation (i.e. the initial post-change team performance fall after facing a task change) when facing changes of high magnitude. Therefore we formally state that:

Hypothesis 5: *The magnitude of change moderates the relationship between pre-change team behavioural interaction patterns and teams' transition adaptation. The negative effect of pre-change team behavioural interaction patterns on the initial post-change team performance decline after facing a task change will be higher when the magnitude of change is high.*

Similarly, post-change team behavioural interaction patterns may not be as beneficial during the reacquisition phase of high magnitude changes compared to low magnitude changes. Effective teams are expected to establish team behavioural interaction patterns according to the demands of the new post-change situation and increase team efficiency (Uitdewilligen et al., 2018). However the effect of team behavioural interaction patterns on post-change team performance may differ according to the magnitude of the change the teams face. The main explanation for this effect is that team behavioural interaction patterns are more beneficial for teams working in more predictable situations (Lei et al., 2016 Stachowski et al., 2009; Waller et al., 2004). This means that teams facing low magnitude changes would recover faster from the initial post-change team performance decline than teams facing high magnitude changes. The reason for this difference in recovery rate has to do with the extent to which the attributes of the post-change situation overlap with the pre-change situation. When there is a high degree of overlap, the new situation is more routine and predictable. Stated formally we predict that:

Hypothesis 6: *The magnitude of change moderates the relationship between post-change team behavioural interaction patterns and teams' reacquisition adaptation. The positive effect of post-change team behavioural interaction patterns on the rate of recovery of post-change team performance after facing a task change will be higher when the magnitude of change is low.*

4. Method

Research Participants

Participants included 201 students (64% female) aged between 18 and 35 years old (*M* = 20.93*; SD* = 3.02) enrolled in different courses at a major University in Southern Europe; students were randomly assigned to 67 three-person teams that took part in a 3-hour computer simulation (two 90-minute 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. All participants provided informed consent and were given 10€ in exchange for their participation. This study is part of a larger research project on team adaptation and this study comprises 38% of participants.

Task

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

Simulation environment. NFC is a fire fighting scenario generator that allows for great flexibility in the study of teamwork because it permits the creation of detailed landscapes. The environment of the NFC scenarios consisted of a micro world of 99 columns by 79 rows combining forests, villages, roads, pastures and a river. In each scenario, participants were provided with seven vehicles to fight fires: three fire-trucks, two helicopters that use water to extinguish fires (helicopters can extinguish bigger fires), and two bulldozers that create barriers to prevent the fire from spreading. Vehicles have different limitations: water capacity (fire-trucks store more water than helicopters), need for fuel (bulldozers need more fuel than the rest of the vehicles) and travelling speed (helicopters are faster than the ground vehicles).

Fires were programmed to appear and spread over different locations. The spread of the fire was highly dependent on wind direction and intensity. Participants could see the current and predicted wind strength and direction on the left side of their screens.

Team members' roles. During the experiment, teams worked under a specific structure formed by three different roles: the leader, air officer and earth officer. Once roles were assigned, each team member was responsible for playing the same role throughout the whole experimental session. Each participant could execute different actions depending on his or her role. The leader of the team was only able to move and use the fire-trucks. The earth officer could move and use the fire-trucks, move and use the bulldozers, move the helicopters and refill water. The air officer could move and use the fire-trucks, move and use the helicopters, move the bulldozers and refill fuel. This task distribution made teamwork necessary.

Procedure

About 4-5 weeks before the experimental sessions, participants were sent an online questionnaire that assessed their demographic data, neuroticism and natural tendency to behave as directive or empowering leaders. Those participants with higher tendencies to act as directive or empowering leaders and with low neuroticism were assigned the role of team leaders and selected for training (see explanation in the leadership manipulation section). Team leaders were assigned to their corresponding leadership condition and randomly assigned to one of 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 (as described below). Team leaders were then introduced to the other two members of the team, and the entire team received an explanation about the purpose of the team task. To reinforce the manipulation, each leader was asked to distribute the rest of the team roles consistent with the leadership style in which he or she was trained. Team leaders were also given a cheat sheet with comments coherent with their leadership style they could use during the simulation. After the leader distributed the rest of the team roles, the entire team was trained for 10 minutes on how to use the simulation with a training protocol that explained the screen's features, how to operate in the simulation, the colour coding of the land types, the resources available and the vehicles. Each team member was also given an instruction sheet with similar information. After the training, each team performed 4 rounds of the task. The simulation was then paused until the next day. The second day, each team performed 5 rounds of the task. Before starting the fifth round, leaders were reminded about their cheat sheet with comments. After the fifth round, a change was introduced according as explained in the change manipulation section. The first five-round length of time corresponded to the pre-change period. The teams then performed four more rounds of the task that corresponded to the post-change period. After the end of the simulation, participants were asked to fill in a survey to measure their perceptions of their leader's behaviours and the magnitude of the change they had faced. After the entire team had finished the last questionnaire, each team member was given 10€ and thanked for his or her participation.

Manipulations and Measures

Leadership manipulation. Following extant studies, we manipulated team leadership through the selection and training of leaders (Durham, Knight, & Locke, 1997, Lorinkova et al., 2013) to maximize the effectiveness of our team leadership manipulation so that leaders would show the desired behaviour.

Selection. We measured participants' natural tendency to act as directive and empowering leaders in the initial questionnaire. In the initial online survey, we administered the Directive Leadership Scale (DLS), a 10-item scale developed to measure participants' natural tendency to act as directive leaders (Durham et al., 1997). Participants had to rate on a 5-point Likert scale (1 = "very uncomfortable," and 5 = "very comfortable") the extent to which they felt comfortable showing directive behaviours during teamwork, for example, "I feel comfortable if I have to give instructions to group members". Similarly, we administered the Empowering Leadership Questionnaire (ELQ), a 10-item scale to measure participants' natural tendency to perform empowering leader behaviours (Arnold et al., 2000). Participants had to rate on a 5-point Likert scale (1 = "very uncomfortable," and 5 = "very comfortable") the extent to which they felt comfortable performing empowering behaviours when working in a group, for example, "I feel comfortable when I have to encourage other team members to express their ideas". Subjects' responses to each set of items were summed to calculate a single DLS and ELQ score, respectively, for each individual. Participants considered for leadership training were selected based on two criteria: 1) having a score in the top fifth on the DLS or ELQ (i.e. a score of 40 or more), and 2) having a low level of neuroticism. The second criterion was incorporated because there was evidence from a pilot study that individuals scoring high in either the DLS or ELQ and trained to show the desired behaviours would eventually not play the role of leader because they found it difficult to lead a team of non-familiar people. We therefore decided to measure participants' neuroticism, which refers to the ability to remain calm when confronted with difficult, stressful or changing situations.

Training. Team leaders were asked to arrive early to the laboratory to be trained according to the experimental condition and show the desired behaviours. In this study, team leaders were trained for 12 minutes. They were first exposed to a 2-minute verbal presentation that explained the kinds of behaviours they were expected to show during the simulation consistent with their experimental condition. Directive leaders were then shown a 6-minute clip from *Apollo 13* (Grazer & Howard, 1995), while empowering leaders were shown a 6-minute clip from *The Cube* (Meh, Orr, & Natali, 1997), both of which emphasized the respective desired behaviours performed by the leader of a team. Leaders were then asked to listen to a 4-minute recorded audio clip, in which they heard other leaders doing the same task they were going to be asked to do consistent with their experimental condition. To reinforce the manipulation, directive leaders were asked to assign the other positions on the team according to their own preferences, whereas empowering leaders were asked to assign the other positions on their teams by reaching an agreement with their teammates.

Magnitude of change manipulation. After the sixth task, we programmed the NFC simulation so that two conditions of task change were created: high and low. We manipulated the magnitude of change by increasing the effect of the wind on the fire spreading, increasing the size of the fires and reducing the quantity of available resources. In the high-magnitude change experimental condition, some fires had longer warnings and were located in critical places (next to houses) and spread faster depending on the wind intensity and direction. There was no possibility of successfully fighting those fires using only fire-trucks and helicopters: the use of the bulldozer was crucial to prevent the fire spreading, as was prioritizing important over less important fires. The quantity of resources provided (water and fuel) was also reduced by half. In the low-magnitude change experimental condition, some fires appeared next to villages and also had longer warnings, but they spread more slowly than in the high-magnitude change condition. Consequently, fighting fires with trucks and helicopters was possible and the use of the bulldozer was not a priority; the quantity of the resources provided also remained the same as in the pre-change scenarios.

Team behavioural interaction patterns. Team behavioural interaction patterns concern actions that are both verbal and non-verbal (Zellmer-Bruhn, et al., 2004). We therefore developed an observational system to capture communications and actions based on a review of the observational systems developed in previous studies and discussion with expert researchers in the topic. The categories from the literature review (DeChurch & Haas, 2008; Grote, Kolbe, Zala-Mezö, Bienefeld-Seall & Künzle, 2010; Kolbe, Burtscher & Manser, 2013; Manser, Howard & Gaba, 2008) were complemented through discussion of behaviours repeatedly shown by participants during the simulation. Two different raters coded participants' behaviours. The behaviours coded by the raters are presented in the Appendix with examples. All the of the behaviours according to the behavioural system developed by the research team were explained to the raters. Both raters then coded the audiovisual material for the 10 teams and achieved an inter-rater reliability of .76 (Cohen's kappa) demonstrating substantial agreement. Next, each rater coded half of the remaining material. Raters obtained information about the team member who performed the behaviour and the time in which the behaviour was performed. Cohen's kappa was calculated again in the middle of the process using data from 5 teams showing substantial agreement (.73). The pre-change period consisted of behaviours performed during tasks 1, 3 and 5, and the post-change period consisted of behaviours performed during tasks 6, 8 and 9. This yielded a total of 60 minutes of coded material per team. Due to technical errors, the audiovisual material for three teams was missing for the whole simulation, for 2 teams this information was missing for the post-change period (i.e. the second session), and for one team this information was missing for the pre-change period (i.e. the first session), so we did not take those groups into consideration when calculating the team behavioural interaction patterns measure.

The coded material was used as input for team behavioural interaction pattern recognition. Team behavioural interaction patterns can be extremely difficult to detect by direct observation, particularly when there are other behaviours co-occurring or interrupting the sequence of behaviours that constitute a team behavioural interaction pattern. We therefore used THEME, a pattern recognition software algorithm (Magnusson, 2000) that detects patterns in temporally ordered data. This software detects T-patterns, which are sequences of behaviours that occur at a higher-than-chance frequency (see Casarrubea et al., 2015). Similar to other research in the field, we set the minimum number of times a pattern should occur to three and required a 95% probability that the patterns occurred above and beyond chance (Lei et al., 2016; Stachowski et al. 2009; Zijlstra et al., 2012). We obtained two indicators of team behavioural interaction patterns: 1) the total number of unique team behavioural interaction patterns and 2) the occurrence of team behavioural interaction patterns. The former refers to the number of different sequences of behaviours performed by more than one team member that occurred at a higher-than-chance frequency, while the latter refers to the number of times that the unique team behavioural interaction patterns occurred. Following similar research (Uitdewilligen et al., 2013), we aggregated both indicators by averaging their *z* scores into a single measure to obtain a global measure of pre-change team behavioural interaction patterns and post-change team behavioural interaction patterns, respectively.

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

5. Results

Manipulation Checks

Leadership manipulation check. We measured the extent to which team members perceived their leaders to behave in a directive or empowering way with a 6-item test (using a 5-point Likert scale: 1 = "strongly disagree", and 5 = "strongly agree"). Three items were adapted from the DLS (Durham et al., 1997) to measure perceived directive leadership (α = .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 (α = .90; e.g. "The leader of my team encourage team members to express their ideas"). Within group reliability was estimated with the R_{wg} (James, Demaree, & Wolf, 1984). The mean R_{wg} was .86 and .87 concerning the perception of empowering and directive leadership behaviours, respectively, which indicated strong agreement and exceeded the traditional .70 cut-off point to justify aggregation of individual-level data to team-level data (LeBreton & Senter, 2008).

Participants in the directive condition perceived their leaders to be significantly more directive (M = 4,03; SD = .45) than those in the empowering condition (M = 3.14; SD = .52; $t(65) = -7.98$, $p < .01$). A similar pattern was found among participants in the empowering condition, who perceived their leaders to be significantly more empowering (M = 4.28; SD = .59) than those in the directive condition (M = 3.51; SD = .83; $t(65) = 3.72$, $p < .01$). From these it appears that our leadership manipulation was effective and participants were correctly assigned to their team leadership experimental condition.

Magnitude of change manipulation check. We measured the extent to which team members perceived that the tasks in the second session had changed and become more challenging than tasks in the first session. We used a 2-item test on a 5-point Likert scale (1 = "nothing at all" and 5 = "to a great extent"), with a sample item being: "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 (α = .90). The mean R_{wg} was .79 and .51 for perceived high and low magnitude of change, respectively, which indicates strong and moderate agreement (LeBreton & Senter, 2008); this appeared to be sufficient 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 compared to those in the previous session (M = 3.58;

SD = .89) more than participants in the low magnitude of change condition (*M* = 3.02; *SD* = .70; $t(65) = 2.83$, $p < .01$). These results indicate that the magnitude of change manipulation worked well and participants were correctly assigned to their experimental conditions.

Hypotheses Testing

Means, standard deviations and intercorrelations among experimental conditions, pre-change and post-change team performances as well as pre-change and post-change team behavioural interaction patterns are shown in Table 1.

Hypothesis 1 stated that teams led by empowering leaders would show more team behavioural interaction patterns than teams led by directive leaders. In the empowering team leadership condition (*N* = 34), teams were associated with numerically higher indicators of team behavioural interaction patterns than in the directive team leadership condition (*N* = 29) both during the pre-change (*M* = .21; *SD* = 1.19 vs. *M* = −.25; *SD* = .56) and the post-change periods (*M* = .11; *SD* = .99 vs. *M* = −.13; SD = .97). We performed an independent sample *t*-test to verify the hypothesis that both groups were associated with statistically significantly different values of team behavioural interaction patterns. The independent sample *t*-test was associated with a statistically significant effect, $t(48,45) = 2.02$, $p < .05$ concerning pre-change team behavioural interaction patterns. The independent sample *t*-test was not associated with a statistically significant effect, $t(59) = .95$, $p = .34$ for post-change team behavioural interaction patterns. Therefore, hypothesis 1 was partially supported.

Hypothesis 4 stated that magnitude of change moderated the relationship between empowering team leadership and post-change team behavioural interaction patterns. A two-way ANOVA was conducted to examine the influence of team leadership and magnitude of change on post-change team behavioural interaction patterns, controlling for pre-change team behavioural interaction patterns. The main effect for magnitude of change yielded an F ratio of F (1,55) = 3.7, *p* = 0.6, indicating a tendency to significant difference between low magnitude of change (*M* = .21, *SD* = 1.16) and high magnitude of change (*M* = −.14, *SD* = .79). The main effect for team leadership yielded an F ratio of F (1,55) = .15, *p* = .7, indicating that the effect for team leadership was not significant. The interaction effect was also not significant, F (1,55) = .06, *p* = .8. This means that the amount of post-change team behavioural interaction patterns did not depend on team leadership style, but on the magnitude of change the teams faced. There does not, therefore, be sufficient evidence to support hypothesis 4.

To test our remaining hypotheses, we analysed the effects of the task change on team performance over time using discontinuous RCGM. This technique allowed us to study teams' transition and reacquisition adaptation relative to a discontinuous event and control for skill acquisition and baseline performance at the same time (Lang & Bliese, 2009). Table 2 shows the coding of the time variables based on similar studies (Hale et al., 2016; Lang & Bliese, 2009; Niessen & Jimmieson, 2016).

Table 1

Descriptive Statistics and Intercorrelations of the Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Team Leadership Condition	.55	.50	—						
2. Magnitude of Change Condition	.54	.50	−.07	—					
3. Pre-change Team Performance (tasks 1–5)	.62	.13	−.30*	−.19	—				
4. Transition Team Performance (task 6)	.33	.21	−.09	−.68**	.36**	—			
5. Post-change Team Performance (tasks 7, 8 & 9)	.59	.24	−.13	−.68**	.58**	.69**	—		
6. Pre-change Team Behavioural Interaction Patterns	.00	.98	.24†	.09	−.01	−.25*	.00	—	
7. Post-change Team Behavioural Interaction Patterns	.00	.98	.12	−.15	.19	.02	.24†	.47**	—

N = 67 teams

†= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

Table 2

Coding and Interpretation of Change Variables in the Discontinuous Mixed-Effects Growth Models Recommended by Lang & Bliese (2009).

Change variable	Pre-change					Post-change				
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 pre-change 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 post-change period
Quadratic skill acquisition (SA^2)	0	1	4	9	16	16	16	16	16	Quadratic growth rate in the pre-change period
Quadratic reacquisition adaptation (RA^2)	0	0	0	0	0	0	1	4	9	Quadratic growth rate in the post-change period

Estimating the basic model. We first calculated the intraclass correlation coefficient (ICC1) that indicates how much of the variability in team performance across the 9 missions is a result of between-team differences. Analyses revealed that ICC1= .38, indicating that between-team variance explained 38% of the variance in team performance over time.

We then calculated the significance for the fixed effects of each of the change variables. The linear model revealed a significant skill acquisition during the pre-change period (SA, $\gamma = 0.066$, $SE = 0.007$, $p < .001$); a significant negative effect of transition adaptation (TA, $\gamma = -0.343$, $SE = 0.033$, $p < .001$), which indicates a performance drop from the pre-change to the post-change period; and a significant reacquisition adaptation slope during the post-change period (RA, $\gamma = -0.031$, $SE = 0.014$, $p < .05$). The quadratic model showed significant effects for the quadratic terms (SA^2, $\gamma = -0.014$, $SE = 0.006$, $p < .05$; RA^2, $\gamma = -0.119$, $SE = 0.011$, $p < .001$). This means that the team performance trajectory shape is characterized by an early acceleration but that the rate of change declines with time.

Then we progressively added complexity in terms of random effects to account for potential team differences in the change variables. Our analysis revealed a significant amount of random variability in (1) the skill acquisition effect $\chi^2_{diff} = 32.80$, $p < .001$; (2) the transition adaptation effect $\chi^2_{diff} = 25.76$, $p < .001$; and (3) the reacquisition adaptation effect $\chi^2_{diff} = 9.65$, $p < .05$. These results suggest that adding random variability to skill acquisition, transition adaptation and reacquisition adaptation improved the model fit, which means that changes in team performance can be explained by allowing team performance to vary across teams. We then tried to extend our basic linear model to account for quadratic change, because we assumed non-linear changes in team performance were characterized by an early fast acceleration of team performance that declined over time (Niessen & Jimmieson, 2016; Sander et al., 2015). Models accounting for quadratic change ran into convergence problems, which is common with complex models. Nevertheless, our hypotheses could be tested with the linear model. Similarly to Lang & Bliese (2009) we also followed the recommendations of previous scholars and controlled for autocorrelation and heteroscedasticity in our model's errors (DeShon, Ployhart & Sacco, 1998). We compared models in which only the linear terms varied randomly. Analysis provided evidence of autocorrelation (φ = −.12; χ^2_{diff} = 3.71, p < .06), but not of heteroscedasticity (φ = −.12; χ^2_{diff} = 0.33, p = .85).

We included team behavioural interaction patterns as a level-2 predictor to find differences in change between groups derived from different amounts of team behavioural interaction patterns. As in previous research, we controlled for the number of actions performed by team members (Uitdewilligen et al., 2013), and we also controlled for magnitude of change. In the second step, we included magnitude of change as a level-2 predictor to test for moderation effects of this variable on the relationships between team behavioural interaction patterns and team adaptation.

Hypothesis 2 stated that pre-change team behavioural interaction patterns would 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 pre-change team behavioural interaction patterns. Those teams performing more pre-change team behavioural interaction patterns had a higher initial decrease in post-change team performance when they faced a task change (Figure 2A). In other words, the increase in the percentage of landscape burnt during the transition phase was higher for those teams showing more pre-change team behavioural interaction patterns. This provides enough evidence to support hypothesis 2.

Hypothesis 3 stated that post-change team behavioural interaction patterns would positively affect teams' reacquisition adaptation. As Table 4 (step 1) shows, there is a significant positive relationship between teams' reacquisition adaptation and post-change team behavioural interaction patterns. Those teams that showed more post-change team behavioural interaction patterns had higher post-change team performance recovery rates (Figure 2B). This means that the rate of improvement in the percentage of landscape saved was higher for teams that performed more post-change team behavioural interaction patterns. Therefore, hypothesis 3 was supported.

Hypothesis 5 proposed that the magnitude of change would moderate the relationship between pre-change team behavioural interaction patterns and teams' transition adaptation. As can be seen in Table 3 (step 2), there was no significant relationship among pre-change team behavioural interaction patterns, teams' transition adaptation and magnitude of change. This means that the negative effects of pre-change team behavioural interaction patterns on teams' transition adaptation took place in both magnitude of change experimental conditions (Figure 2C). Therefore, hypothesis 5 was not supported.

Hypothesis 6 proposed that magnitude of change would moderate the relationship between post-change team behavioural interaction patterns and teams' reacquisition adaptation. As Table 4 (step 2) shows, there was no significance in the relationship among post-change team behavioural interaction patterns, reacquisition adaptation and magnitude of change. This means that post-change team behavioural interaction patterns were positive in both high and low magnitude of change experimental conditions (Figure 2D). Therefore, hypothesis 6 was not supported.

Table 3

Discontinuous Random Coefficient Growth Models Predicting Teams' Transition and Reacquisition Adaptation as a Function of Pre-change Team Behavioural Interaction Patterns 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[c]**
Skill acquisition (SA)	0.11	0.02	5.23[a]**	0.11	0.02	5.22[c]**
Transition adaptation (TA)	−0.48	0.05	−14.15[a]**	−0.36	0.04	−9.30[c]**
Reacquisition adaptation (RA)	0.28	0.03	7.08[a]**	0.29	0.04	7.19[c]**
Quadratic skill acquisition (SA^2)	−0.01	0.01	−2.38[a]*	−0.01	0.01	−2.38[c]*
Quadratic reacquisition adaptation (RA^2)	−0.12	0.01	−11.81[a]**	−0.12	0.01	−11.81[c]**
Final Level 2 model						
Number of actions	0.00	0.00	2.94[b]**	0.00	0.00	2.98[d]**
Interaction Patterns (IP)	−0.01	0.02	−0.57[b]	−0.01	0.03	−0.52[d]
Magnitude of change (MC)	−0.13	0.02	−4.49[b]**	−0.05	0.03	−1.57[d]
TA × IP	−0.05	0.03	−2.03[a]*	−0.06	0.03	−1.87[c]†
TA × MC				−0.24	0.04	−5.93[c]**
IP × MC				0.00	0.03	−0.02[c]
RA × IP	0.03	0.01	2.94[a]**	0.03	0.02	1.75[c]†
RA × MC				−0.02	0.02	−1.33[c]
TA × IP × MC				0.04	0.04	0.85[c]
RA × IP × MC				0.00	0.02	0.09[c]

†= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] $df = 497$. [b] $df = 59$.

[c] $df = 493$. [d] $df = 58$.

Table 4

Discontinuous Random Coefficient Growth Models Predicting Teams' Transition and Reacquisition Adaptation as a Function of Post-change Team Behavioural Interaction Patterns 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[c]**
Skill acquisition (SA)	0.11	0.02	5.05[a]**	0.11	0.02	4.97[c]**
Transition adaptation (TA)	−0.37	0.05	−13.86[a]**	−0.48	0.04	−13.81[c]**
Reacquisition adaptation (RA)	0.27	0.04	6.83[a]**	0.31	0.04	7.63[c]**
Quadratic skill acquisition (SA^2)	−0.01	0.01	−2.28[a]*	−0.01	0.01	−2.24[c]*
Quadratic reacquisition adaptation (RA^2)	−0.12	0.01	−11.41[a]**	−0.12	0.01	−11.33[c]**
Final Level 2 model						
Number of actions	0.00	0.00	2.38[b]*	0.00	0.00	2.28[d]*
Interaction Patterns (IP)	−0.01	0.02	−0.63[b]	0.00	0.02	−0.22[d]
Magnitude of change (MC)	−0.16	0.03	−4.84[b]**	−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[c]
RA × MC				−0.07	0.02	−4.96[c]**
RA × IP × MC				0.01	0.02	0.62[c]

†= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 482. [b] *df* = 57.

[c] *df* = 480. [d] *df* = 56.

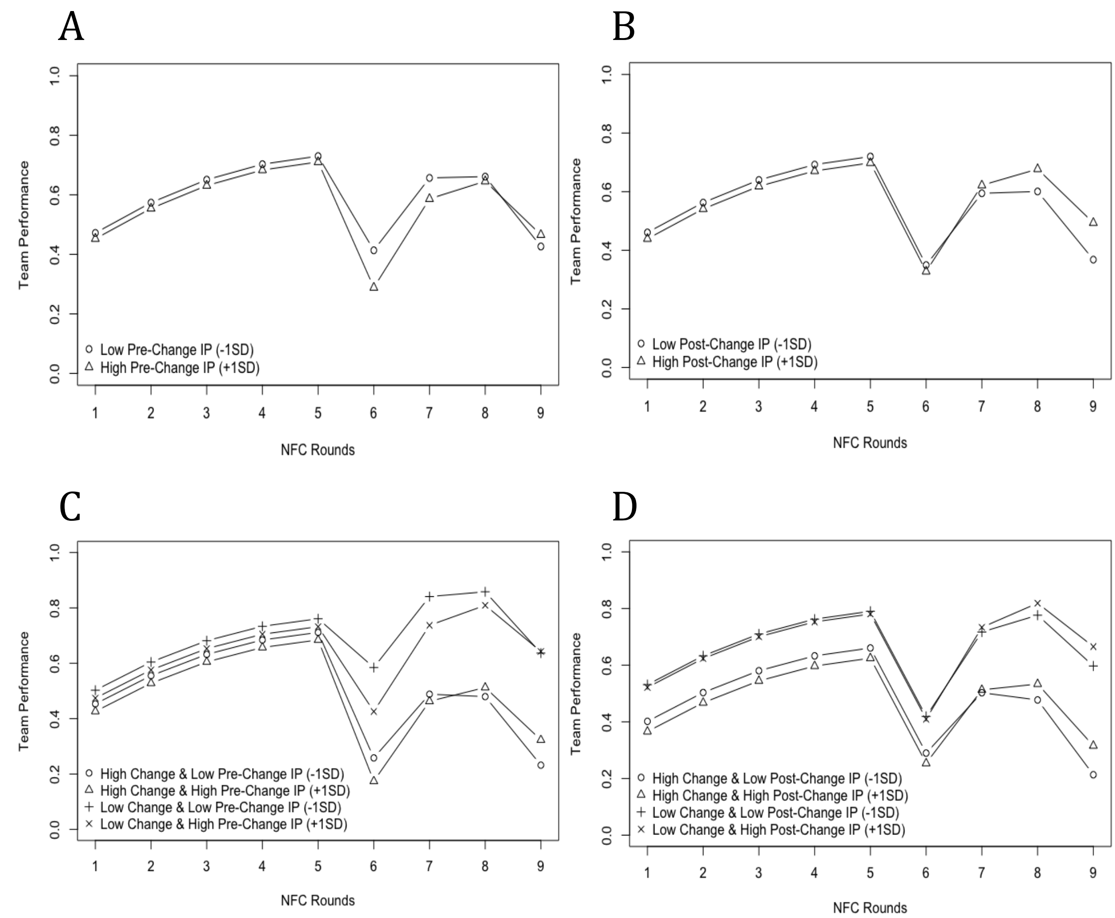


Figure 2. Team performance as a function of time (horizontal axes) and pre-change team behavioural interaction patterns (Graph A), post-change team behavioural interaction patterns (Graph B), magnitude of change and pre-change team behavioural interaction patterns (Graph C), and magnitude of change and post-change team behavioural interaction patterns (Graph D). IP = team behavioural interaction patterns; Change = magnitude of change (experimental condition).

6. Discussion

This study examined how directive and empowering leadership styles under high and low magnitude changes influenced team behavioural interaction patterns and their effects on team performance during transition and reacquisition adaptation phases. Our findings allow us to report that empowering-led teams tended to show more team behavioural interaction patterns than directive-led teams. All teams showed more team behavioural interaction patterns when adapting to low magnitude changes than when adapting to high magnitude changes. We also found that pre-change team behavioural interaction patterns hindered transition adaptation, but post-change team behavioural interaction patterns were beneficial later on during the reacquisition of post-change team performance. These findings have important theoretical as well as managerial implications that we address below.

Theoretical Implications

Our findings advance the literature for team leadership, team behavioural interaction patterns and team adaptation in several ways. We build on previous research on team adaptation that has attempted to identify team processes and behaviours that can foster team adaptation (Burke et al., 2006b; Maynard et al., 2015) and we relate them to recent studies that resolve conflicting evidence on the effects of different leadership styles on teams (Lorinkova et al., 2013; Martin, Liao, & Campbell, 2013), as well as with research on team behavioural interaction patterns (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012).

Like other studies, we compared the differential effects of empowering and directive leadership styles on team processes that directly impact team effectiveness (Lorinkova et al., 2013; Martin et al., 2013). In particular, we connected team leadership and team behavioural interaction patterns in response to previous calls on the need to identify the antecedents of behavioural patterns (Zijlstra et al., 2012). Specifically, we identified empowering leadership as an antecedent of team behavioural interaction patterns, as these leaders encourage team members to take part in behaviours that imply frequent interaction, such as idea and information sharing, interpersonal communication and participative decision-making (Srivastava et al., 2006). This effect was particularly significant during the pre-change period, but not during the post-change stage although the results were in the expected direction. A plausible reason for this finding may be that although team leaders mostly showed the desired behaviours according to our manipulations, effective leaders could perform other behaviours according to situational demands and therefore leaders in the directive group could also perform empowering behaviours response to the task change. This study underscores the importance highlighted by Lorinkova and colleagues (2013) of examining different moments of team performance to find out the differential effectiveness of both directive and empowering leadership styles. Our results are in line with Burke and colleagues' (2006b) proposal relating team leadership with team adaptation. We therefore complement the general assumption that empowering leadership behaviours are beneficial for enhancing team processes (Lorinkova et al., 2013; Srivastava et al., 2006), as they tend to promote more team behavioural interaction patterns among team members. However, patterned interaction is detrimental for the transition phase, although it is positive for the reacquisition phase of teams dealing with changing situations.

Team behavioural interaction patterns have often been regarded as detrimental for teams coping with disruptions (Stachowski et al., 2009). Our results partially agree with Gersick and Hackman's (1990) proposal, as we confirm the negative effects of pre-change team behavioural interaction patterns for teams' transition adaptation. However, through our longitudinal approach, we open a new debate regarding when team behavioural interaction patterns are beneficial for team adaptation, as we directly linked post-change team behavioural interaction patterns with higher levels of teams' reacquisition adaptation, suggesting long-term positive effects. Although we responded to the need 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 that magnitude of change had any moderating effects on the relationship between team behavioural interaction patterns and team adaptation. Consequently, our evidence is not consistent with previous research suggesting that teams facing more severe changes would have more performance problems than teams facing low magnitude changes (Gersick & Hackman, 1990; Hollenbeck et al., 2011). A plausible explanation may be that the changes implemented in this study were perceived as radical changes rather than incremental (Audia, Locke, & Smith, 2000) even when the magnitude of change was low. In such cases, team behavioural interaction patterns would be negative for teams' transition and adaptation and positive for teams' reacquisition adaptation, regardless of the magnitude of the change. When facing radical changes, behaviours that were useful during the pre-change stage become irrelevant in the new situation and teams operate at suboptimal levels even when the magnitude of change is low. It is also possible that our change manipulation may have resulted in changes that were not perceived as low enough to generate the expected effects for low magnitude changes. That would explain why our approach for assessing the magnitude of change using a dichotomous approach did not yield the expected results, but when using a logarithm measure of the magnitude of change, the hypothesized moderating effects of magnitude of change tended to be significant (see the limitations and future research section for further explanation).

Managerial Implications

From a practical perspective, our findings provide several useful insights for managers leading teams facing unforeseen situations. The time-sensitive nature of the relationship between team behavioural interaction patterns and team adaptation has important implications concerning team-leader training. Given the critical role of team behavioural interaction patterns on team adaptation, leading teams facing changes should emphasize and enable team members' interactions around the task. They can do so by adopting empowering leadership behaviours such as frequent information and idea sharing among team members and participative decision-making (Srivastava et al., 2006). However, as highlighted before, more empowering behaviours are not always better (Cheong, Spain, Yammarino, & Yun, 2016), and our findings should not be misunderstood and mistakenly used to draw the conclusion that empowering behaviours are good in all kinds of changing situations. We therefore recommend identifying the changing nature of the team environment to decide on the appropriate strategy to follow. If teams are constantly facing new situations and change triggers (i.e. they are constantly dealing with transition phases) or they have little time to cope with the new situation (e.g. emergency teams), we recommend training team leaders to avoid encouraging the team to engage in team behavioural interaction patterns because they imply lower levels of transition adaptation. As the benefits of team behavioural interaction patterns pay off in the long run, accentuating the completion of the task instead of participative behaviours is more beneficial in such cases because teams concentrate their efforts on minimizing the initial post-change performance decreases typical immediately after the disruptions take place. Accordingly, we encourage team leaders to focus on task completion when constantly dealing with transition phases. If, however, teams have extended lengths of time to adapt to changes (i.e. the post-change team performance trajectory will not be truncated by new disruptions), training team leaders to encourage frequent team behavioural interaction patterns among team members may be more beneficial, because after the initial decrease in team performance, their recovery rates would be higher and therefore beneficial in the long term. In this sense, training teams to abandon previously established team behavioural interaction patterns and engage in new ones seems to be a good option to increase team adaptability (Gorman et al., 2010). In line with Lorinkova et al. (2013), these kinds of changing contexts may demand the adoption of empowering leadership behaviours, because empowering leaders promote more team behavioural interaction patterns that will benefit the team in the long run.

Limitations and Directions for Future Research

Although this study constitutes the first study to longitudinally analyse the effects of team behavioural interaction patterns on team adaptation, our research has the following limitations. First, our study examined team leadership by manipulating and exclusively implementing directive and empowering leadership styles on teams. However, we detected that sometimes team leaders in our sample could exhibit both kinds of behaviours. For example, directive leaders could encourage proactive participation among team members, whereas empowering leaders could adopt a top-down attitude by giving orders and establishing performance goals. This is because different kinds of leadership behaviours are more suitable for different situations, and effective leaders have the ability to switch their behaviours according to contingency factors (Sims et al., 2009). We therefore encourage future research to consider adaptive leadership behaviours and consider how hybrid leadership styles impact team behavioural interaction patterns and consequently on team adaptation.

Also, although we identified team leadership as an antecedent of team behavioural interaction patterns, future research should further examine other predictors of such behaviours (Zijlstra et al., 2012). In particular, research should consider analysing the effects of team cognitive structures on behavioural patterns because of their relationship with team behavioural processes (Mohammed, Ferzandi & Hamilton, 2010). Recent research has suggested that the distinction concerning the nature of the change between internal (i.e. related to team composition alterations or team member rotations) and external changes (i.e. related to the task or the context) is crucial for analysing the effects of team processes on team adaptation (Christian et al., 2017). Because the change introduced in this study was task-related, future research on the effects of team behavioural interaction patterns on team adaptation should analyse the extent to which the effects found here hold when teams cope with team-related changes.

In addition, although we have a larger sample, and used large databases for each team that incorporated non-verbal behaviours to compute team behavioural interaction patterns, we have considered only their quantitative features and omitted their content. The literature on team behavioural interaction patterns has paid attention to the amount, length and complexity of patterns but not to the specific behaviours that form the patterns (Lei et al., 2016; Stachowski et al., 2009; Zijlstra et al., 2012). A valuable contribution would therefore be to identify which specific patterns of behaviours are beneficial for team adaptation so teams can incorporate them in their behavioural repertoires. Although we studied a larger sample of teams than previous studies (Stachowski et al., 2009; Zijlstra et al., 2012) and we considered more data for each team (i.e. 60 min of audiovisual coded material), future studies should replicate our study across different contexts to confirm the generalizability of our findings.

Lastly, our study has a limitation in the way we examined the perceived magnitude of change. Although our study is pioneering in the inclusion of this variable into the team adaptation examination, we characterized magnitude of change as high or low, while recent theoretical developments on task complexity have opened an interesting approach potentially useful for the study of team adaptation (Hærem et al., 2015). According to Hærem and colleagues (2015) studies on team adaption should best consider a logarithm scale to characterize magnitude of change for analysing team adaptation. This way magnitude of change can be assessed using a continuous measure that overcomes the limitations of variable dichotomization and might therefore provide more accurate insight into how trigger severity impacts processes and the performance of teams dealing with changing situations.

Conclusion

Empowering leadership is conducive to increased amounts of team behavioural interaction patterns. Although the predominance of those behavioural patterns initially impairs post-change team performance when facing task changes of different magnitudes, they are beneficial in accelerating recovery on post-change team performance during the reacquisition adaptation phase in the long run. Because today's team contexts are characterized by unpredictability and dynamism, we hope that our work stimulates further research to better understand and manage team adaptation.

CHAPTER 4

ENABLING CONDITIONS FOR TEAM ADAPTATION: THE ROLE OF TEAM MENTAL MODELS AND TEAM COORDINATION

1. Abstract

This study builds on recent developments on team adaptation, team cognition and team coordination to longitudinally analyze the effects of team-related and task-related team mental models (TMMs) and both explicit and implicit coordination on team adaptation to changes of different magnitude. Seventy three-person teams took part in the "gazogle" building task and were randomly assigned to one of our two conditions (magnitude of change: high vs. low). Through discontinuous random coefficient growth models (RCGM) we observed that accuracy of team and task TMMs had an overall positive effect on team performance. Besides, we observed that similarity of team and task TMMs had a positive for the reacquisition phase but only for teams that faced changes of high magnitude. In contrast, implicit coordination had an overall negative effect on team adaptive outcomes, whereas explicit coordination is beneficial during the transition phase after high magnitude changes. Our findings highlight the importance of team cognition and team coordination for team adaptation. Both theoretical and managerial implications are discussed.

Keywords: Team mental models, implicit coordination, explicit coordination, team adaptation, magnitude of change.

2. Introduction

Team adaptation literature recognizes that teams across organizations operate in dynamic and changing contexts and must adapt to unforeseen situations (e.g., Pulakos, Arad, Donovan, & Plamondon, 2000; Rosen et al., 2011). For example, when a sales team faces the irruption of a new substitutive product from a direct competitor, their sales performance may not only decrease but also they might not be able to recover their previous team performance levels resulting in serious problems for the organization if they do not manage this unforeseen situation properly. However, the sales team may be able to counter their competitors with sales promotion or pricing strategies, reducing therefore their initial performance decrease and allowing faster post-change sales performance recuperation. Similarly, all kinds of teams are challenged to adapt to unforeseen changes confronted unexpectedly, that demand team members to change their behaviors according to new situations (Bechky & Okhuysen, 2011; Stachowski, Kaplan, & Waller, 2009; Burtscher, Kolbe, Wacker & Manser, 2011; Lei, Waller, Hagen, & Kaplan, 2015; Toups & Kerne, 2007; Bolici, Howison & Crowston, 2016). Consequently, the analysis of team adaptation (defined as modifications made by team members in response to new situations –Baard, Rench & Kozlowski, 2014) becomes an imperative need to succeed in the change driven context in which teams operate nowadays.

In line with previous research, we argue that teams apply shared knowledge stored in their team mental models (TMMs, defined as stable mental representations of relevant elements of a team's environment that are shared across team members –Klimoski & Mohammed, 1994) as well as explicit and implicit mechanisms of team coordination (defined as the attempt to act in concert by multiple actors to achieve a common objective –Klein, 2001) to deal with changing situations (Kozlowski et al., 1999; Kozlowski & Ilgen 2006). In this line, whereas explicit coordination refers to overt verbal communications to define strategies, plan actions, provide feedback or share information, implicit coordination happens when team members are able to anticipate tasks or other team members' needs and dynamically adjust behaviors to task requirements (Rico, Sánchez-Manzanares, Gil & Gibson, 2008). Indeed, both TMMs and team coordination have taken core places in main theoretical models of team adaptation because of their potential role to enhance adaptive outcomes of teams facing task disruptions (Burke, Stagl, Salas, Pierce & Kendall, 2006; Maynard et al., 2015; Christian, Christian, Pearsall, & Long, 2017).

On the one hand, concerning TMMs, team literature suggests that they are necessary for teams engaging in changing situations (Cannon-Bowers, Salas, & Converse, 1993). The main reason is that they are key for team members to share similar pieces of information to better understand task-changes, improve team coordination and anticipate the kind of interaction that are likely to occur after facing a disruption (e.g., Mathieu et al., 2000; Sander et al., 2015). However, we do not know which kind of TMMs or which of their properties (i.e., similarity or accuracy) are better for enhancing team adaptive outcomes.

On the other hand, team coordination is widely acknowledged as a central aspect of team adaptation (Baard et al., 2014; Maynard et al., 2015) because it will determine how teams adjust behaviors to new situations, reformulate plans and strategies and carry out tasks. Nevertheless, extant studies neglect the fact that there are two complementary ways of team coordination (Rico et al., 2008). In this line, we still lack knowledge on which kind of team coordination (i.e., explicit and implicit) is more beneficial when teams face unforeseen changes.

In this research we are particularly interested on the role of TMMs and team coordination on team adaptability (defined as teams' capability to adapt to unforeseen changes –Maynard, Kennedy, & Sommer, 2015) in order to identify teams' characteristics or antecedents (i.e., team inputs or variables developed during the skill acquisition phase or pre-change stage) beneficial for team adaptation. This issue becomes important because as teams cannot be trained or prepared to work under all specific possible different environments they may confront in their context, they can enhance their team knowledge and team coordination processes to gain team adaptability and better respond to unforeseen changes (Chen, Thomas, & Wallace, 2005). To do so, we aim to find for team differences beneficial for the two post-change phases after facing a task disruption: transition phase (i.e., the immediate decrease in team performance after facing the change) and reacquisition phase (i.e., the gradual team performance recovery after facing the change) (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal & Ziljstra, 2015).

To test the effects of both TMMs and team coordination on team adaptation we consider task-changes that result in more difficult and complex post-change situations (e.g., Uitdewilligen, Rico, & Waller, 2018; LePine, 2005). Additionally, we consider that the varying context in which teams operate may result in different task-changes confronted by teams (Stewart & Barrick, 2000). In particular, and following recent recommendations (Christian et al., 2017; Maynard et al., 2015) we consider here magnitude of change (defined as the intensity of the trigger causing the disruption demanding for adaptation –Maynard et al., 2015) to hypothesize suboptimal levels of team performance under changes of low magnitude and amplified effects of TMMs and team coordination under changes of high magnitude.

Bearing in mind the previous reasoning we have designed a study to empirically test our research model (see Figure 1), that considers the effects of similarity and accuracy of team and task TMMs and both explicit and implicit coordination on team adaptation for teams facing changes of different magnitude. To do so we use discontinuous RCGM, a technique that allows testing for team differences that positively impact teams' transition (i.e., teams' ability to reduce the initial performance decline after a task-change) and reacquisition adaptation (i.e., teams' ability to recover post-change team performance).

With this study we increase the existing knowledge on how teams can better deal with changing circumstances and therefore, we provide the field with valuable contributions. First of all, we add new empirical evidence to the research stream examining team adaptation with the two-phase framework proposed by Lang & Bliese (2009) (e.g., Sander et al., 2015; Hale, Ployhart, & Shepherd, 2016). Second, we stimulate and further contribute to the ongoing debate on the effects of explicit and implicit coordination and TMMs on team adaptation (Sander et al., 2015; Marques-Quinteiro, Curral, Passos & Lewis, 2013). Third, we increase our knowledge on the need to examine the role of magnitude of change on the examination of team adaptation, which is a noteworthy contribution due to the several previous calls on the literature about this issue (e.g., Uitdewilligen et al., 2013; Baard et al., 2014; Maynard et al., 2015).

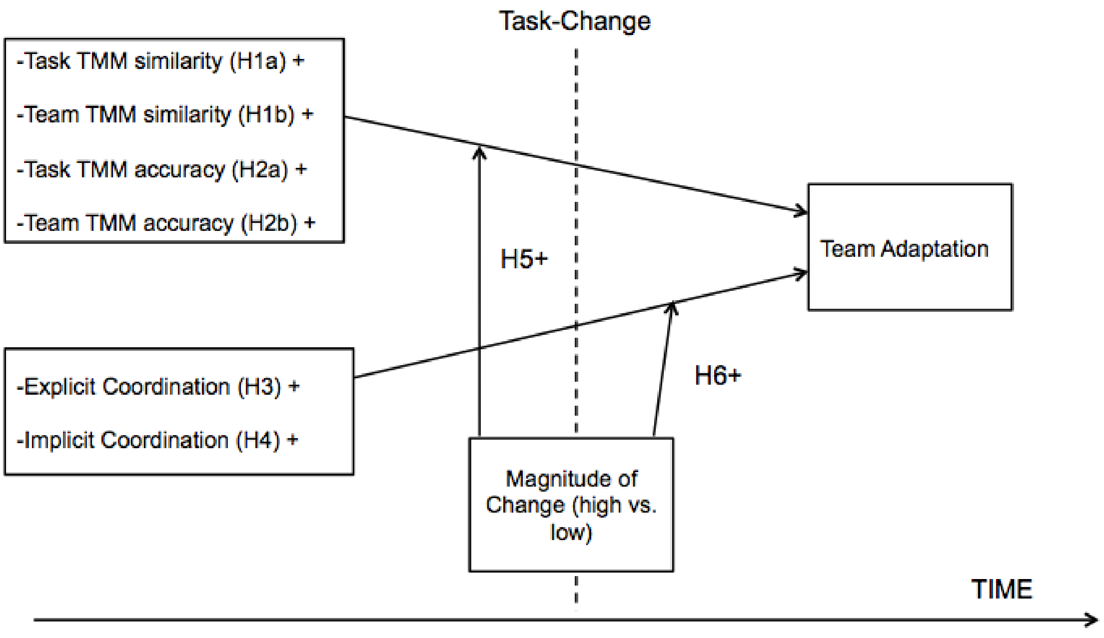


Figure 1. Research Model

3. Theoretical Framework and Hypotheses

The Effects of Team Mental Models on Team Adaptation

Previous research suggests that teams to be effective need team members to hold some common knowledge representations about the team and the task that is relevant in their context (Cannon-Bowers et al., 1993). In this sense, TMMs are the team cognitive structures that have received most attention in the team cognition literature (Mohammed, Ferzandi & Hamilton, 2010). Evidence supports the positive effects of TMM on team effectiveness (Lim & Klein, 2006; Ayoko & Chua, 2014; Mathieu, Heffner, Goodwin, Cannon‐Bowers, & Salas, 2005; Orasanu, 1990). However, although it is accepted that TMMs are essential for team adaptation (Burke et al., 2006; Maynard et al., 2015), empirical evidence is still not conclusive on which kinds of TMMs are beneficial for team adaptation or if they need to be similar or accurate in order to benefit team adaptive outcomes.

As mentioned in chapter 2, we consider task-related and team related TMMs to analyze their effects on team adaptation (Mathieu et al., 2000, 2005). In order to analyze the effects of TMMs on team adaptation, we have to pay attention to their two main properties: similarity and accuracy (Mohammed et al., 2010). TMMs similarity is the degree of convergence among team members' mental models concerning the team and task key features that allows them to be on the same page and therefore, be able to share expectations about what is going to happen in the future. Teams with high levels of task-related and team-related TMMs similarity facing a task-change are more likely to share similar information (Hinsz, Tindale, & Vollrath, 1997) allowing for rapid assessment of team and task relevant issues. Consequently, teams with similar TMMs are more likely to rapidly assess what has changed, what has to be done or who is in charge of doing what in the new situation, improving therefore, the initial cue recognition crucial for team adaptation (Rosen et al., 2011; Burke et al., 2006). Besides, having similar representations of relevant team and task features implies team members fast consensus on strategies, procedures and team members' assignments in the new situation (Cannon-Bowers & Salas, 2001; Randall, Resick, & DeChurch, 2011) and also reduce flux in team coordination (Summers, Humphrey, & Ferris, 2012). In addition, teams that develop similar TMMs are more likely to have in their behavioral repertoire the configuration needed to successfully perform the new task (Pearsall, Ellis, & Bell, 2010). In practical terms, this would mean that teams with similar task-related and team-related TMMs are better at coping with task-changes and have a lower team performance decrease right after the disruption and a faster recuperation of post-change team performance. Hence we predict that:

Hypothesis 1: *(a) task-related and (b) team-related TMM similarity positively relates with teams' transition and reacquisition adaptation.*

However, although most of studies have focused on the effects of similarity over accuracy (quality of the knowledge team members are sharing and consequently, the extent to which team members' mental representations of team and task features resembles that of high quality, normally the mental model of an expert –Edwards et al., 2006) on team performance, several scholars argue that TMMs accuracy is more important than similarity for team performance even under changing circumstances (Edwards, Day, Arthur & Bell, 2006; Sander et al., 2015). The main reason is that TMMs can be similar but inaccurate, meaning that team members are sharing a wrong view of a given task situation (i.e., inaccurate knowledge about the equipment, procedures and team members' roles). Alternatively, when TMMs are accurate, team members are sharing the "true state of the world" (Edwards et al., 2006, p. 728). Teams with high levels of task-related and team-related TMM accuracy facing a task-change are more likely to properly evaluate the nature of the change and effectively select a new strategy to deal with new situational demands (Randall et al., 2011). In this line, more accurate TMMs imply that they are more experts in their tasks which allow them to integrate information about new situations in a more deeply manner (Walker et al., 2010). This will help teams to better understand new situations and proceed properly when facing unforeseen changes (Mohammed et al., 2017). In practical terms, after facing a task-change, those teams with accurate task-related and team-related will suffer from lower performance decline and will faster recover their post-change team performance. Consequently, we formally formulate that:

Hypothesis 2: *(a) task-related and (b) team-related TMM accuracy positively relates with teams' transition and reacquisition adaptation.*

Besides TMMs similarity and accuracy, team coordination is key for teams facing unforeseen situations that need to improve their team adaptive outcomes (e.g., Baard et al., 2014). In this sense, we consider explicit and implicit coordination mechanisms effects on team adaptive outcomes (Rico et al., 2008).

Effects of Team Explicit and Implicit Coordination on Team Adaptation

The extent to which team members align knowledge and carry out activities to manage their dependencies (i.e., team coordination –Malone & Crowston, 1994) is key for team adaptation (Entin & Serfaty, 1999; Burke et al., 2006; Maynard et al., 2015). Consequently, there has been a wide increase in the body of research that connects team coordination and team adaptation (e.g., Bergström, Dahlström, Henriqson & Dekker, 2010). However, most of the studies have analyzed coordination as a whole dimension neglecting the two different ways of team coordination identified in the literature (Rico et al., 2008).

As mentioned in chapter 2, whereas explicit coordination refers to verbal communication, implicit coordination happens imperceptibly (Chang, Lin, Chen & Ho, 2017; Rico et al., 2008). For example, if the bellboy of the front-office department of a hotel located in Spain sees a Chinese tourist, being aware that he is the only team member with Chinese knowledge, he can anticipate his workmates needs and proactively approach reception and provide help without explicit request. During this time his tasks remain unattended until the shift leader explicitly assigns another receptionist to take care of them. Whereas the former is a clear example of implicit coordination the latter refers to explicit coordination behaviors.

Upon team formation teams start to develop their patterns of verbalizations that will determine how coherent and structured the team will work together (Zijlstra, Waller, & Phillips, 2012). In particular, behaviors such as information sharing, planning and reorganizations of strategies (i.e., explicit coordination) influence team adaptation (Burke et al., 2006). However, from team literature we can infer both advantages and disadvantages of team explicit coordination on team adaptation. On the one hand, as team members frequently perform those behaviors, they can fall into patterns and impair teams' ability to recognize task-changes (Stachowski et al., 2009). On the other hand, those teams that perform more explicit coordination can communicate more effectively, which constitutes a positive advantage after a task-change despite they will have to readjust their behaviors to the new situation (Sander et al., 2015). These teams are more likely to have incorporated in their behavioral repertoire the need to share information about the task and planning, which increase teams' adaptability because of their usefulness to handle task-changes. As those behaviors improve team adaptability, in practical terms it means that those teams who perform more explicit coordination along the pre-change stage will both suffer from lower team performance decrease after facing task-disruptions and will recover faster their team performance. Stated formally we predict that:

Hypothesis 3: *explicit coordination positively relates with teams' transition and reacquisition adaptation.*

As can be inferred from the example above, teams are expected to increase their implicit coordination as they get used to a particular task and get to better know expected team members' interactions (Rietmüller, Fernandez Castelao, Eberhardt, Timmermann, &

Boos, 2012). Whereas implicit coordination is supposed to enhance team performance under more routine situations because it frees cognitive resources that can be used for task completion (Rico et al., 2008; Rietmüller et al., 2012; Grote et al., 2004), it has also proven to be positive for team adaptation (Marques-Quinteiro et al., 2013).

Implicit coordination is highly grounded on shared knowledge about the team and the task among team members and consequently allows predicting how colleagues will act in their working context (Rico et al., 2008; Huber & Lewis, 2010). In this sense, it is reasonable to think that when teams face a task-change, those teams who were coordinating implicitly will be more able to adapt to the needs of other team members as well as to the new task requirements itself. Consequently, we believe that teams that coordinate implicitly will have an advantage when facing changing situations and reduce the initial performance decline right after a task-change and increase the recovery of post-change team performance. Formally we hypothesize that:

Hypothesis 4: *implicit coordination positively relates with teams' transition and reacquisition adaptation.*

The Moderating Role of Magnitude of Change on the Effects of TMMs and Team Coordination on Team Adaptation

The way teams deal with task-changes may vary depending on the severity of the trigger that causes the change (Maynard et al., 2015). When magnitude of change is low both situations before and after the change share several features that makes them similar to an extent and somehow predictable. On the contrary, when magnitude of change is high, the situations before and after the change are more discrepant and the new situation becomes more complex and unpredictable. The latter case implies teams to make severe modifications of the previous ways of working and therefore, adopt new procedures (Rafferty & Griffin, 2006). For example, changes of low magnitude could consist on higher workloads whereas changes of high magnitude could consist on loss of resources or encountering new tasks. On this regard, extant evidence is not conclusive on the effects of magnitude of change on team adaptation (DeRue, Hollenbeck, Johnson, Ilgen & Jundt, 2008; Hollenbeck, Ellis, Humphrey, Garza & Ilgen, 2011). However, existing literature suggest that the effects of TMMs and team coordination on team adaptation will be determined by task-change characteristics (Christian et al., 2017; Maynard et al., 2015).

A central argument in this research is that similarity and accuracy of TMMs positively impact team adaptation because both, task-related and team-related TMMs compel features necessary for team adaptation. In particular, task-related TMMs concern knowledge about contingencies that are likely to happen, possible future scenarios the team have to deal with and component and sequences of tasks that are to be carried out that are of more value when tasks become more unpredictable (Mathieu et al., 2000). Complementary, team-related TMMs are formed of knowledge related to likely patterns of interaction, interdependencies and responsibilities that also are more useful when situations become more unpredictable (Mathieu et al., 2000). This might be because when magnitude of change is low, teams might simply work harder to successfully adapt to the encountered situation or even work at suboptimal levels initially, regardless of the quantity or quality of knowledge shared among team members. However, when magnitude of change is high, teams need to make extensive behavioral modifications relying on the knowledge stored on their TMMs. Consequently, the benefits of similarity and accuracy of TMMs are more remarkable when magnitude of change is high. Following this reasoning we formally predict that:

Hypothesis 5: *magnitude of change moderates the relationship between TMMs and team adaptation. The positive effects of (a) task-related and (b) team-related TMM similarity and (c) task-related and (d) team-related TMM accuracy on team adaptation are higher when magnitude of change is high.*

We followed a similar reasoning for team coordination. Research suggests that the positive effects of team coordination on team performance are amplified when magnitude of change is high (Vashdi, Bamberger & Erez, 2013; Gladstein, 1984; Howitz & Horwitz, 2007). Consequently, we expect that the positive effects of explicit and implicit coordination for team adaptation will be accentuated under high magnitude changes. The main reason is that teams can continue to perform their task (although not as efficiently as in the pre-change situation) under low magnitude changes but there is more room for improvement when teams work under high magnitude changes. In particular, and as argued by Stewart & Barrick, team coordination is more beneficial for teams when "ends and means of production are unclear, requiring team members to interact in novel ways to determine how to proceed" (2000: 137). Although the previous reasoning is directly referring to explicit coordination, it may also hold true for implicit coordination. In this line, Manser and coauthors (2008) found that surgery teams displaying implicit coordination in critical situations would lead to higher team performance. Similarly, other studies found that implicit coordination improved team performance when the characteristics of the situation were more unpredictable (Marques-Quinteiro et al., 2013). Consequently, the positive effects of coordination on team adaptation will be more noticeable when magnitude of change is high. Following the reasoning above we formally predict that:

Hypothesis 6: *magnitude of change moderates the relationship between team coordination and team adaptation. The positive effects of (a) explicit and (b) implicit coordination on team adaptation are higher when magnitude of change is high.*

4. Method

Research Participants

210 students (31% males; 91% Spanish; age *M* = 21.16; *SD* = 4,38) enrolled in different courses at two major Spanish universities, were randomly assigned 70 3-person

teams that took part in a 2-hour experimental task. Teams were randomly assigned to one of the two conditions (magnitude of change: high vs. low). All participants provided informed consent and were given 15€ in exchange for their participation.

Task

Three people forming a team took part in the “gazogle” team task (Weiss, 2006), an experimental task that consisted on building figures using LEGO® blocks. Participants were comfortably sitting face-to-face around a table being audio-visually recorded. The purpose of the team was to collectively build as many identical copies of a given model as possible. The model was placed in the middle of the table and participants were given a set of LEGO® bricks at the beginning of each round to perform their task. Teams did not know the model they would have to build until the beginning of the round when it was placed in front of them. They had to perform 6 rounds of the task that lasted for eight minutes each. Participants were provided with the following instructions each round: 1) they had 8 minutes per round to build as many copies of the model in front of them as possible, 2) the color of the LEGO® bricks was not relevant so that they could mix different colors and 3) they could combine smaller bricks to create bigger ones in order to replicate the shape of the model provided. After the task-change teams were recommended to check that what they built was correct and in the high level magnitude of change condition participants were also warn that there were special bricks in the LEGO® sets provided.

Procedure

About one month before the experimental session, participants answered an online questionnaire that assessed their demographic data, their previous experience taking part in other team work experiments, their familiarity with LEGO® and their availability to take part in the task. Participants were randomly assigned to teams according to their availability and teams were randomly assigned to each of the two conditions.

Participants were asked to arrive in the laboratory ten minutes before the session started so that they could provide informed consent. After signing the informed consent, they were told to sit-down around a table. When each team member had taken place, the entire team received an explanation about the purpose of the team task and the instructions. After the instructions were provided each team performed 6 rounds of the task. Several kinds of LEGO® bricks were used in this experiment: normal bricks, special bricks, special circles and angles bricks and bricks with slope. In the pre-change period and in the low level of magnitude of change participants were given only normal bricks to build identical copies of the models. In the high level of magnitude of change participants were additionally given special bricks, special circles and angles bricks and bricks with slope (see each brick set in the Appendix).

After the 3rd task a change in the task was introduced according to what is explained in the magnitude of change manipulation section. The first three-round length of time corresponded to the pre-change period and the following rounds corresponded to the post-change period. Between rounds participants were asked to fill in questionnaires. After the end of the session the models that participants had to build during the pre-change and post-change periods were placed in front of them and they were asked to fill in a survey to measure their perception of the magnitude of change they had faced. After the team had finished the last questionnaire participants were thanked for their participation and given 15€.

Measures and Manipulations

Magnitude of change manipulation. After the 3rd round we altered several aspects of the task so that we created two conditions of task-change: high vs. low. We manipulated the magnitude of change by increasing the difficulty of the models teams had to replicate, by altering the number of models provided in each round and by altering the number and kind of LEGO® bricks provided during the post-change period. A replication of the models provided to participants as well as the total amount of models they could build is shown in the Appendix. During the post-change period, teams in the low level magnitude of change experimental condition were provided with one model, similar to that in the pre-change period but with some modifications that slightly increased its difficulty. The kind of LEGO® bricks remained the same although the amount was increased. In the high level magnitude of change experimental condition teams were provided with five different models that did not resemble to that in the pre-change period. In this condition participants had to work with several new kind of LEGO® bricks.

Team coordination. In this study we developed an observation system based on literature review (Manser, et al., 2008; DeChurch & Haas, 2008; Grote, Kolbe, Zala-Mezö, Bienefeld-Seall & Künzle, 2010; Kolbe, Burtscher & Manser; 2013) and trough discussion with researchers in the topic and the researchers in charge of the data collection. The result was a list of eight behaviors, two for each sub-dimension of explicit and implicit coordination. Concerning explicit coordination, we included 1) instructions and commands and 2) directly stated information for communication and for planning we included 1) deliberate planning and 2) reactive planning. Concerning implicit coordination, we included for anticipation 1) monitoring and 2) undertaking a task as first mover and with regards to dynamic adjustment we included 1) actively giving help and 2) reaction to comments. Behaviors shown by participants during the experimental session were assigned to the categories of the observational system. Behaviors and examples are presented in the Appendix. Two different raters were first explained all the behaviors according to the behavioral system developed by the research team. Then both raters coded the audiovisual material of 10 teams and achieved an inter-coder reliability of .72 (Cohen's kappa) demonstrating substantial agreement. Then one of the raters coded the rest of the behaviors performed by teams during tasks 2 and 3 and that coded material was used in the analysis of this study. We averaged the number of implicit coordination behaviors for tasks 2 and 3 and obtained an indicator of implicit coordination. A similar procedure was followed for explicit coordination.

Task-related and team-related TMMs. We developed two sets of items assessing task-related and team-related issues respectively. We asked participants to make paired-comparisons about the relatedness of the different items. Each TMM consisted on a total amount of 21 paired-comparisons. Participants were shown two matrices listing the items along the top and the side of the answer sheet. Team members were asked to rate each attribute of the mental model in relation to all other items using a 7-point scale ranging from -3 (item A and B are negatively related, a high degree of one requires a low degree of the other) to 3 (items A and B are positively related, a high degree of one requires a high degree of the other) with the 0 (items A and B are independent).

TMM similarity. We first calculated the quadratic assignment proportion (QAP) correlations (Mathieu et al., 2000, 2005), which are equivalent to Pearson correlations for each dyad in the team. Then we averaged them to obtain the TMM similarity score for the team.

TMM accuracy. To obtain the expert referent model, we asked three subject-matter experts to independently complete both matrices. They were then asked to compare their individual expert solution with the other two experts. In those cases that the scores assigned to a pair-comparison were not the same, they were asked to reach agreement through discussion. When agreement was not reached we averaged their ratings. We calculated the QAP correlation between each team member TMM and our expert solution. We averaged the three QAP correlations to obtain the accuracy score for the team.

Team Performance. Team performance was an index that represented the percentage of correct copies of the model built from the total that the team could build using the complete set of LEGO® bricks. The index ranged from 0 to 1 where 0 means that the team was not able to build any identical copy of the model given and 1 means the team used the whole set of bricks and all the copies built were correct.

5. Results

Manipulation Check

Magnitude of change manipulation check. We measured the extent to which team members perceived that the tasks after the disruption had change and become more challenging than tasks before the disruption. We used a 3-item test on a 7-point Likert scale (1=nothing at all and 7 = to a great extent). An example of the items used is "To what extent have the models of the rounds after the disruption changed compared to the models of rounds before the disruption?" The reliability coefficient for the scale was high (α = .89). The mean R_{wg} was .70 for both high and low level of perceived magnitude of change, which means moderate agreement and is considered enough evidence to justify agreement from individual to team level (LeBreton & Senter, 2008).

Participants in the high level task-change condition perceived that tasks after the disruption had changed more compared to those tasks before the disruption (M = 5,31; SD = .83) than participants in the low level task-change condition (M = 3,24; SD = .72; $t(68)$ = 11.15, $p < .01$). These results provide evidence that our manipulation of the magnitude of change worked well and participants were therefore correctly assigned to their experimental conditions.

Hypotheses Testing

Means, standard deviations and intercorrelations among experimental conditions, pre-change and post-change performances, task and team related TMMs similarity and accuracy and both explicit and implicit coordination are shown in Table 1.

We performed discontinuous RCGM, that allows studying both transition and reacquisition adaptation relative to a discontinuous event controlling for pre-change performance (Lang & Bliese, 2009). Table 2 shows the coding of the time variables, which is similar to studies employing this technique (Lang & Bliese, 2009; Hale et al., 2016; Niessen & Jimmieson, 2016; Sander et al., 2015).

Table 1

Descriptive statistics and intercorrelations of study variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Magnitude of Change	.50	.50	—									
2. Pre-change Performance (tasks 1 - 3)	.83	.08	-.01	—								
3. Transition Performance (task 4)	.61	.19	-.79**	.18	—							
4. Post-change Performance (tasks 5 & 6)	.77	.16	-.73**	.18	.75**	—						
5. Task TMM Similarity	.27	.20	.04	.18	-.01	.12	—					
6. Task TMM Accuracy	.31	.14	-.04	.28*	.14	.20	.38**	—				
7. Team TMM Similarity	.18	.21	.28*	-.04	-.16	-.03	.15	.06	—			
8. Team TMM Accuracy	-.04	.15	-.03	.05	-.04	.02	.14	.02	-.20	—		
9. Explicit Coordination	38.36	14.89	-.15	-.18	.14	.13	.14	-.07	-.03	.02	—	
10. Implicit Coordination	9.96	3.50	.04	-.20	-.06	-.06	.05	-.04	-.15	-.12	.29*	—

N = 70 teams

*= $p < 0.05$; **= $p < 0.01$

Table 2

Coding and Interpretation of Change Variables in the Discontinuous Mixed-Effects Growth Models recommended by Lang & Bliese (2009)

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

Estimating the basic model. We calculated intraclass correlation coefficient (ICC1) that indicates how much of the variability in team performance across the 6 tasks was a result of between-team differences. Analyses revealed that ICC1=.41, which indicates that between-team variance explained 41% of variance in team performance over time.

We then calculated the fixed effects' significance of each change variable. Our linear model showed that there was a significant skill acquisition during the pre-change period (SA, $\gamma = 0.13$, *SE* = 0.01, $p < .001$), a significant negative effect of transition adaptation (TA, $\gamma = -0.47$, *SE* = 0.03, $p < .001$), which means that there was a performance drop from the pre-change to the post-change period, and a significant reacquisition adaptation slope during the post-change period (RA, $\gamma = -0.04$, *SE* = 0.02, $p < .01$). Our quadratic model revealed a significant effect for the quadratic skill acquisition (SA^2, $\gamma = -0.08$, *SE* = 0.02, $p < .001$) and a trend towards significance on the quadratic reacquisition adaptation (RA^2, $\gamma = -0.04$, *SE* = 0.02, $p = .05$).

In order to account for team differences in change variables we progressively added complexity in terms of random effects. Performed analysis revealed a significant amount of random variability in (a) the skill acquisition effect $\chi^2_{diff} = 69.46$, $p < .001$; (b) the transition adaptation effect $\chi^2_{diff} = 51.28$, $p < .001$; and (c) the reacquisition adaptation effect $\chi^2_{diff} = 38.07$, $p < .001$. From this pattern of results we conclude that adding random variability to skill acquisition, transition adaptation and reacquisition adaptation improved the model fit. This means that changes in team performance are explained when allowing team performance to vary across teams. Models accounting for quadratic change ran into convergence problems, which is common with complex models. However our hypotheses could be tested with the linear model. We controlled for autocorrelation and heteroscedasticity in our model's errors (DeShon, Ployhart & Sacco, 1998). We compared models in which only the linear terms varied randomly. Analysis did not provide evidence of autocorrelation (φ = -.18; χ^2_{diff} = 2.43, p = .12) and heteroscedasticity (φ = -.20; χ^2_{diff} = 2.47, p = .12).

We built six models including our team variables as level-2 predictors to find differences in change between groups derived from different amounts of (a) task-related TMM similarity, (b) task-related TMM accuracy, (c) team-related TMM similarity, (d) team-related TMM accuracy, (e) explicit coordination and (f) implicit coordination. We then included in the second step, magnitude of change as a level-2 predictor to test for its moderating effects on team performance.

Hypothesis 1 proposed that (a) task-related and (b) team-related TMMs similarity positively relates with teams' transition and reacquisition adaptation. Results from table 3 (step 1) claim that although we found effects in the expected direction we failed to reach significance. However there is a strong trend towards significance in the relationship between task-related TMM similarity and reacquisition adaptation. Therefore, those teams with more similar task-related TMM recovered faster from the drop of team performance after the task disruption (Figure 2A). For team-related TMMs similarity, results from table 5 (step 1) show that we found a significant negative effect on transition adaptation, that means that those teams with more similar team-related TMM suffered from a bigger performance decrease right after the task disruption (Figure 2C). Although the effects on the reacquisition were found in the expected direction, we failed to reach significance. Consequently, we partially support our hypothesis 1a for task-related TMM similarity, but we cannot provide support for our hypothesis 1b for team-related TMM similarity.

Testing the moderating role of the magnitude of change (Hypotheses 5a and 5b) we included, in the second step, the magnitude of change in each of the models as a level-2 predictor to analyze its role as a moderator of the effects. Results from table 3 (step 2) show that there is a strong trend towards significance in the positive effect of the task-related TMM similarity in team performance as well as in the triple interaction among task-related TMM similarity, magnitude of change and reacquisition adaptation. This means that teams with more similar task-related TMMs perform generally better both before and after the change and also recovered faster when the magnitude of change was high (Figure 3A). Therefore, we partially support our hypothesis 5a as we found the moderating effects on the expected direction concerning the positive effects of task-related TMM similarity on the reacquisition, but not on the transition, when the change faced was high.

We found a strong trend towards significance in the interaction among team-related TMM similarity, magnitude of change and reacquisition adaptation. This means that team-related TMM similarity had a significant positive effect on the reacquisition adaptation of teams facing changes of high magnitude. This suggests that teams with more similar team-related TMMs recovered faster their performance that teams with less similar team-related TMMs (Figure 3C). Therefore, we provide evidence to partially support our hypothesis 5b as we found the moderating effects of the magnitude of change for the reacquisition but not for the transition phase.

Hypothesis 2 posed that (a) task-related and (b) team-related TMMs accuracy positively affects teams' transition and reacquisition adaptation. Results in table 4 show that we found a strong trend towards significance on the overall effect of task-related TMM accuracy on team performance. That means that those teams with more accurate task-related TMM performed better both before and after the task-change and therefore, we can claim that accurate task-related TMM are beneficial for team adaptation (Figure 2B), providing support to our hypothesis 2a. With regards to team-related TMM accuracy, although the effects found were in the expected direction (see table 6), we failed to reach significance. That means that team-related TMM accuracy did not significantly affected team performance (Figure 2D), and therefore, we cannot provide support to our hypothesis 2b. In the second step, we included magnitude of change as a level-2 predictor to test for moderating effects (hypothesis 5c and 5d). Results stand in table 4 and table 6 (step 2). From results in table 4 (step 2) we suggest that there is a moderating effect of the magnitude of change on the relationship between task-related TMM accuracy and transition adaptation. The positive effect of task-related TMM accuracy on the transition adaptation was higher when the magnitude of change was low (Figure 3B). As results were the opposite as expected we could not support our hypothesis 5c. With regards to the accuracy of team-related TMMs we did not find the expected effects (Figure 3D) and therefore, we cannot provide evidence to support our hypothesis 5d.

Table 3

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of task-related TMM similarity and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.66	0.03	20.68[a]**	0.63	0.03	19.39[c]**
Skill acquisition (SA)	0.31	0.03	10.26[a]**	0.31	0.03	10.32[c]**
Transition adaptation (TA)	-0.63	0.05	-13.25[a]**	-0.50	0.04	-11.19[c]**
Reacquisition adaptation (RA)	-0.16	0.04	-3.82[a]**	-0.15	0.04	-3.61[c]**
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.71[a]**	-0.08	0.01	-6.79[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.10[a]**	-0.04	0.01	-3.13[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.04	0.01	-2.91[b]**	0.02	0.02	0.89[d]
Task TMM Similarity	0.13	0.09	1.38[b]	0.18	0.10	1.83[d]†
SA x Task TMM Similarity	-0.05	0.05	-1.01[a]	-0.05	0.05	-1.00[c]
TA x Task TMM Similarity	0.03	0.13	0.21[a]	0.07	0.12	0.61[c]
RA x Task TMM Similarity	0.13	0.07	1.81[a]†	0.04	0.08	0.56[c]
TA x MC				-0.26	0.04	-5.93[c]**
RA x MC				-0.01	0.02	-0.30[c]
MC x Task TMM Similarity				-0.11	0.07	-1.60[d]
TA x MC x Task TMM Similarity				-0.04	0.13	-0.31[c]
RA x MC x Task TMM Similarity				0.17	0.09	1.92[c]†

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] $df = 342$. [b] $df = 67$.

[c] $df = 338$. [d] $df = 66$.

Table 4

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of task-related TMM accuracy and magnitude of change

Variable	Step 1			Step 2		
	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.62	0.05	13.40[a]**	0.61	0.06	12.70[c]**
Skill acquisition (SA)	0.32	0.04	9.02[a]**	0.32	0.03	9.06[c]**
Transition adaptation (TA)	-0.70	0.07	-10.71[a]**	-0.60	0.06	-9.74[c]**
Reacquisition adaptation (RA)	-0.15	0.05	-3.08[a]**	-0.15	0.05	-2.89[c]**
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.71[a]**	-0.08	0.01	-6.81[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.09[a]**	-0.04	0.01	-3.15[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.04	0.01	-3.11[b]**	-0.02	0.04	-0.64[d]
Task TMM Accuracy	0.24	0.13	1.82[b]†	0.22	0.13	1.63[d]†
SA x Task TMM Accuracy	-0.09	0.07	-1.20[a]	-0.09	0.08	-1.20[c]
TA x Task TMM Accuracy	0.26	0.18	1.43[a]	0.38	0.17	2.26[c]*
RA x Task TMM Accuracy	0.08	0.10	0.82[a]	0.03	0.12	0.23[c]
TA x MC				-0.16	0.06	-2.49[c]*
RA x MC				-0.01	0.04	-0.16[c]
MC x Task TMM Accuracy				0.05	0.10	0.47[d]
TA x MC x Task TMM Accuracy				-0.37	0.18	-1.99[c]*
RA x MC x Task TMM Accuracy				0.14	0.13	1.09[c]

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] $df = 342$. [b] $df = 67$.

[c] $df = 338$. [d] $df = 66$.

Hypothesis 3 submits that explicit coordination behaviors positively affect transition and reacquisition adaptation. From the results shown in table 7 (step 1) we claim that although we found the effects in the expected direction we failed to reach significance. Explicit coordination did not significantly affect team performance (Figure 2E) and therefore, we cannot support our third hypothesis. We then included the magnitude of change as a level-2 predictor to test for moderating effects (hypothesis 7). From results shown in table 7 (step 2) we suggest that that those teams who displayed more explicit coordination behaviors suffered from a smaller performance decrease when facing changes of high magnitude that those teams who performed less explicit coordination behaviors (Figure 3E). Therefore, our hypothesis 6a was partially supported as we only found the expected effects during the transition.

Hypothesis 4 proposed that implicit coordination behaviors positively affect transition and reacquisition adaptation. From results in table 8 (step 1) and contrary as expected we found that there is a strong trend towards significance on the negative relationship between the transition adaptation and implicit coordination. That means that those teams who were coordinating more implicitly had bigger performance drops right after the change occurred that those teams with less implicit coordination behaviors (Figure 2F). In addition, we found that implicit coordination had an overall negative effect on team performance that means that those teams with more implicit coordination performed generally worse both before and after the change and therefore, we cannot provide support for our fourth hypothesis. To test for moderating effects of the magnitude of change we included that variable as a level-2 predictor. We did not find significance on the triple way interaction, that means that the negative effects of implicit coordination hold true independently of the magnitude of the change faced (Figure 3F). Therefore, we cannot provide evidence to support our hypothesis 6b.

Table 5

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of team-related TMM similarity and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.71	0.03	27.23[a]**	0.70	0.03	26.44[c]**
Skill acquisition (SA)	0.28	0.03	9.99[a]**	0.28	0.03	10.08[c]**
Transition adaptation (TA)	-0.57	0.04	-14.74[a]**	-0.46	0.04	-12.37[c]**
Reacquisition adaptation (RA)	-0.13	0.04	-3.20[a]**	-0.13	0.04	-3.14[c]**
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.71[a]**	-0.08	0.01	-6.81[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.10[a]**	-0.04	0.01	-3.14[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.05	0.01	-3.46[b]**	-0.02	0.02	-0.82[d]
Team TMM Similarity	-0.06	0.09	-0.63[b]	-0.09	0.10	-0.89[d]
SA x Team TMM Similarity	0.08	0.05	1.49[a]	0.08	0.05	1.48[c]
TA x Team TMM Similarity	-0.29	0.12	-2.43[a]*	-0.13	0.13	-0.96[c]
RA x Team TMM Similarity	0.01	0.07	0.13[a]	-0.11	0.08	-1.24[c]
TA x MC				-0.28	0.04	-7.83[c]**
RA x MC				0.00	0.02	0.08[c]
MC x TMM Similarity				0.01	0.08	0.19[d]
TA x MC x Team TMM Similarity				0.04	0.14	0.29[c]
RA x MC x Team TMM Similarity				0.16	0.09	1.77[c]†

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 342. [b] *df* = 67.

[c] *df* = 338. [d] *df* = 66.

Table 6

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of team-related TMM accuracy and magnitude of change

Variable	Step 1			Step 2		
	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.71	0.02	33.07[a]**	0.69	0.02	33.00[c]**
Skill acquisition (SA)	0.29	0.03	10.93[a]**	0.29	0.03	10.97[c]**
Transition adaptation (TA)	-0.61	0.03	-18.53[a]**	-0.48	0.03	-14.91[c]**
Reacquisition adaptation (RA)	-0.12	0.04	-3.22[a]**	-0.14	0.04	-3.64[c]**
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.71[a]**	-0.08	0.01	-6.75[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.10[a]**	-0.04	0.01	-3.12[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.04	0.01	-2.78[b]**	-0.02	0.01	-1.53[d]
Team TMM Accuracy	0.09	0.13	0.72[b]	0.22	0.13	1.64[d]†
SA x Team TMM Accuracy	-0.07	0.07	-1.00[a]	-0.07	0.07	-1.01[c]
TA x Team TMM Accuracy	0.11	0.18	0.63[a]	0.07	0.16	0.43[c]
RA x Team TMM Accuracy	0.09	0.10	0.92[a]	0.07	0.11	0.65[c]
TA x MC				-0.28	0.09	-9.96[c]**
RA x MC				0.04	0.02	2.12[c]*
MC x TMM Accuracy				-0.28	0.09	-2.94[d]**
TA x MC x Team TMM Accuracy				0.02	0.18	0.14[c]
RA x MC x Team TMM Accuracy				0.05	0.13	0.41[c]

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 342. [b] *df* = 67.

[c] *df* = 338. [d] *df* = 66.

Table 7

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of explicit coordination and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.73	0.05	14.55[a]**	0.72	0.05	13.62[c]**
Skill acquisition (SA)	0.29	0.04	7.89[a]**	0.29	0.04	7.90[c]**
Transition adaptation (TA)	-0.69	0.07	-9.76[a]**	-0.45	0.07	-6.65[c]**
Reacquisition adaptation (RA)	-0.13	0.05	-2.61[a]**	-0.16	0.06	-2.91[c]**
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.75[a]**	-0.08	0.01	-6.84[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.11[a]**	-0.04	0.01	-3.16[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.04	0.01	-2.60[b]*	-0.01	0.04	-0.37[d]
Explicit Coordination	0.00	0.00	-0.90[b]	0.00	0.00	-0.81[d]
SA x Explicit Coordination	0.00	0.00	-0.05[a]	0.00	0.00	-0.04[c]
TA x Explicit Coordination	0.00	0.00	1.07[a]	0.00	0.00	-0.46[c]
RA x Explicit Coordination	0.00	0.00	0.22[a]	0.00	0.00	0.46[c]
TA x MC				-0.40	0.07	-5.75[c]**
RA x MC				0.05	0.05	1.06[c]
MC x Explicit Coordination				0.00	0.00	0.04[d]
TA x MC x Explicit Coordination				0.01	0.00	1.92[c]†
RA x MC x Explicit Coordination				0.00	0.00	-0.29[c]

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 342. [b] *df* = 67.

[c] *df* = 338. [d] *df* = 66.

Table 8

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of implicit coordination and magnitude of change

Variable	Step 1			Step 2		
	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.79	0.05	15.06[a]**	0.77	0.06	13.99[c]**
Skill acquisition (SA)	0.23	0.04	6.10[a]**	0.23	0.04	6.11[c]**
Transition adaptation (TA)	-0.49	0.07	-6.63[a]**	-0.39	0.07	-5.49[c]**
Reacquisition adaptation (RA)	-0.08	0.05	-1.43[a]	-0.08	0.06	-1.44[c]
Quadratic skill acquisition (SA^2)	-0.08	0.01	-6.72[a]**	-0.08	0.01	-6.80[c]**
Quadratic reacquisition adaptation (RA^2)	-0.04	0.01	-3.10[a]**	-0.04	0.01	-3.14[c]**
Final Level 2 model						
Magnitude of change (MC)	-0.04	0.01	-2.71[b]**	0.01	0.04	0.20[d]
Implicit Coordination	-0.02	0.01	-2.07[b]*	-0.02	0.01	-1.84[d]†
SA x Implicit Coordination	0.01	0.01	2.09[a]*	0.01	0.01	2.07[c]*
TA x Implicit Coordination	-0.03	0.01	-1.87[a]†	-0.02	0.01	-1.35[c]
RA x Implicit Coordination	-0.01	0.01	-1.32[a]	-0.01	0.01	-1.38[c]
TA x MC				-0.25	0.08	-3.32[c]**
RA x MC				0.02	0.05	0.40[c]
MC x Implicit Coordination				0.00	0.01	-0.41[d]
TA x MC x Implicit Coordination				0.00	0.01	-0.29[c]
RA x MC x Implicit Coordination				0.00	0.01	0.32[c]

†= $p \leq 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 342. [b] *df* = 67.

[c] *df* = 338. [d] *df* = 66.

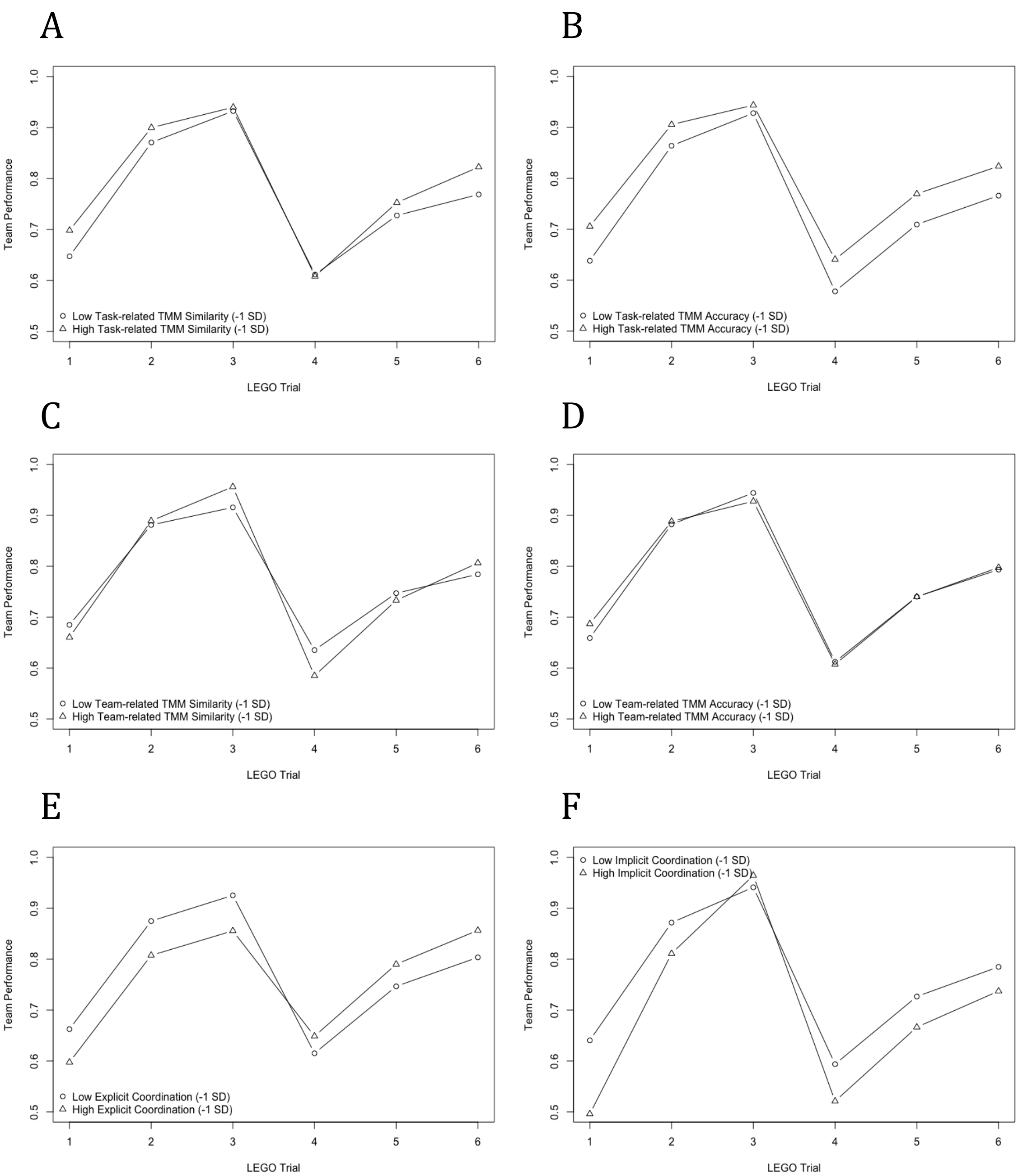


Figure 2. Team performance as a function of time (horizontal axes) and task-related TMM similarity (Graph A), task-related TMM accuracy (Graph B), team-related TMM similarity (Graph C), team-related TMM accuracy (Graph D), explicit coordination (Graph E), implicit coordination (Graph F).

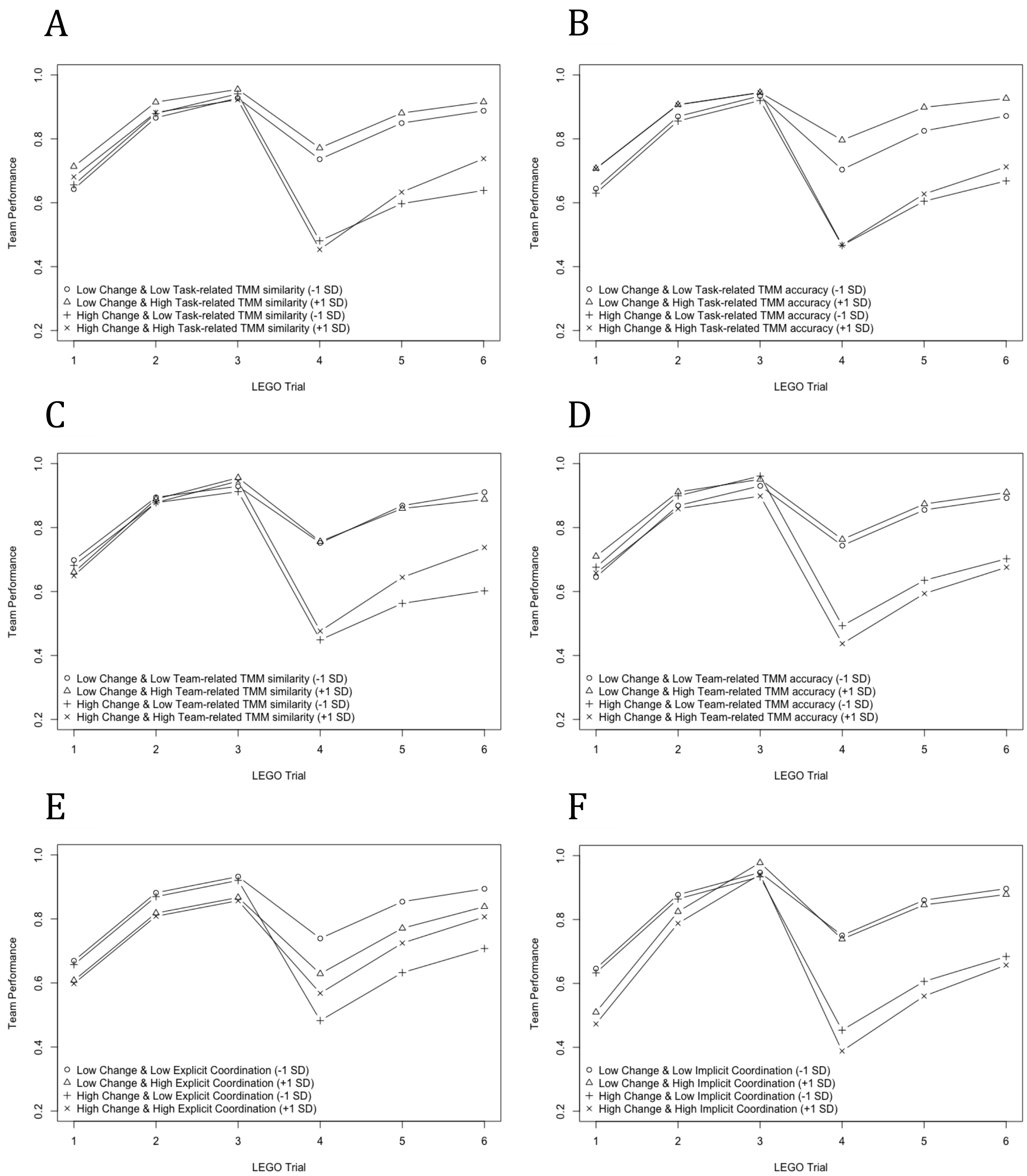


Figure 3. Team performance as a function of time (horizontal axes) and magnitude of change and task-related TMM similarity (Graph A), task-related TMM accuracy (Graph B), team-related TMM similarity (Graph C), team-related TMM accuracy (Graph D), explicit coordination (Graph E), implicit coordination (Graph F). Change = Magnitude of Change experimental condition.

6. Discussion

This study highlights the importance of similarity and accuracy of task-related and team-related TMMs, explicit and implicit team coordination on team adaptation for teams facing changes of different magnitude. We found that task-related TMM similarity and accuracy were positive for team adaptation because of the general positive effects for performance (before and after the task-change). Similarity was particularly good for teams' reacquisition adaptation of teams facing high magnitude changes, whereas accuracy positively affected teams' transition adaptation, but especially when teams faced low magnitude changes. With regards to team-related TMMs, accuracy tended to positively impact overall team performance whereas similarity was both negative for teams' transition adaptation but positive for teams' reacquisition adaptation when facing high magnitude changes. With regards to coordination, explicit coordination behaviors proved beneficial concerning the transition of teams facing changes of high magnitude. In contrast, implicit coordination proved positive for the skill acquisition although had an overall negative effect for team adaptation. Our findings have both theoretical and managerial implications addressed below.

Theoretical Implications

The findings revealed on this study advance team adaptation, team cognition and team coordination literature in several ways. We built on recent models of team adaptation (e.g., Burke et al., 2006; Maynard et al., 2015) highlighting the importance of team cognition and team coordination for team adaptation. In particular we focused on TMMs (Mohammed et al., 2010) and both explicit and implicit coordination (Rico et al., 2008) effects on team adaptation following a two-phase approach (Lang & Bliese, 2009). We wanted to overcome limitations of previous studies that did not distinguished task and team TMMs effect on team adaptive outcomes, or took only into consideration explicit behaviors when examining team coordination leaving the implicit dimension of team coordination aside (e.g., Sander et al., 2015). In addition, we tested our expected effects under different magnitude of change conditions (i.e., high vs. low) therefore, answering several calls pointing out the importance of the change characteristics in the team adaptation examination (Maynard et al., 2015; Christian et al., 2017; Baard et al., 2014).

Concerning TMMs, our research confirmed the general assumption that such team cognitive structures positively impacts team adaptation (Burke et al., 2006; Maynard et al., 2015). Our findings are in line with those of previous studies (Sander et al., 2015) claiming that TMMs accuracy is positive for team adaptation. In particular, accurate task-related TMMs had an overall general effect for teams dealing with changing situations and although the results for accurate team-related TMMs did not reach significance there was a distinct trend towards the expected direction. A plausible explanation for this may be the fact that the disruption introduced in this research was task-related and not team-related. In addition, we shed light on previous findings concerning similarity. We found that both, task-related and team-related TMMs similarities were positive for the reacquisition of team performance when teams faced a change of high magnitude. This pattern of results is in line with those of Marks and colleagues (2000) as we confirm that TMMs similarity is beneficial for teams facing changes of high magnitude compared to those that resemble situations before the change. Therefore, we provide an explanation of why Sander and colleagues (2015) did not find the expected effects of TMMs similarity on team adaptation, as it may have to be with the severity of the trigger that caused the disruption teams had to face in their research. As they explained, teams with similar TMMs may be less able to detect the need of readjustment when facing a task-change and that may be the reason that teams with similar TMMs did not benefit from them in our low level magnitude of change condition. Aligned with that explanation we found that team-related TMM similarity was negative for the transition adaptation. However, when the magnitude of change was high, similar team and task TMMs proved to be beneficial for the reacquisition of previous levels of team performance. Overall, the evidence here supports that those teams with more accurate and similar TMMs are better able to cope with task-changes.

With regards to team coordination our findings have to be taken into account cautiously. We found a direct positive effect of implicit coordination on the skill acquisition phase, a negative effect on performance during the transition phase and an overall negative general effect on team performance. That means that teams who engaged more implicit coordination behaviors perform generally worse during the whole study and suffered from a sharper decrease during the transition. However, during the pre-change period implicit coordination positively impacted the rate of improvement on team performance. Findings revealed here do not necessarily mean that implicit coordination is detrimental for team adaptation but that it might depend on its time sensitive nature (Espinosa et al., 2002). Indeed, if the study conducted here had been longer the positive effects of implicit coordination during the post-change period would have been likely to emerged. Consequently, a possible venue for future research would be to find out if implicit coordination behaviors are beneficial in the rate of improvement after the task-change (i.e., reacquisition adaptation) if we allow teams to work together for a longer length of time. In addition, previous research on implicit coordination revealed that it is not a unique predictor of team performance but that it depends on the existence of shared knowledge of cognitive structures (Burtscher et al., 2011) and therefore, its effects are likely to be positive when in presence of similar and accurate TMMs. As for explicit coordination, we confirm the assumption of its benefits for team adaptation (Rico et al., 2008) and we advance our knowledge by concretely placing its benefits on the transition phase. In particular we confirm that those behaviors concerning planning and communication set a useful basis for teams that are facing changes of high magnitude. However, recent studies suggest that it is not only the frequency of isolated coordination behaviors but also the patterns of behaviors that discriminate higher- from lower- performing teams (Kolbe et al., 2014). A plausible explanation for the findings obtained here may be that we took into consideration explicit and implicit coordination separately and it is the combination of both kinds of mechanisms which is better for teams adapting to changing situations. In addition, the findings revealed in this research confirm that TMMs and team coordination differentially affects both transition and reacquisition adaptation. Consequently, we confirm and support the need of approaching the study of team adaptation from a longitudinal perspective that considers the effects of team differences in the initial team performance decline and in the reacquisition of post-change team performance (Lang & Bliese, 2009; Hale et al., 2016; Niessen & Jimmieson, 2016; Sander et al., 2015).

Managerial Implications

From a practical perspective, the findings of this study reveal useful insight for managers that are in charge of teams working in dynamic contexts and are to encounter task-changes. Proven the importance of TMMs and team coordination on team adaptation, we recommend team leaders to adopt behaviors that encourage the generation of shared and accurate knowledge among team members and also to stimulate and improve the way team members coordinate with each other in order to manage their interdependencies. A possible solution would be the intervention concerning team leadership behaviors as they have been proven to be an antecedent of shared cognition and team coordination. A plausible recommendation for team leaders would be to encourage behaviors that are positively related with the development of shared cognitive structures and team coordination such as frequent interaction and the exchange of ideas and information among team members (Srivastava, Bartol & Locke, 2006; Lorinkova, Pearsall and Sims, 2013).

As we found explicit coordination to positively impact team adaptive outcomes during the transition phase, we recommend encouraging team interventions targeted at improving the way team members communicate with each other. In this sense, when communication takes place via technological devices, we recommend managers to firmly invest in organizational equipment because communication failures may be disastrous for team adaptation (Sander et al., 2015). On the contrary, when communication takes places face to face among team members, a positive implementation would be to encourage daily meetings or daily briefings and debriefings, behaviors that positively enhance team communication and exchange of information (e.g., Marks et al., 2000; Leonard, Graham, & Bonacum, 2004)

In addition, team managers should periodically assess their TMMs with those of experts in order to monitor and compare their TMMs with experts' solutions and therefore contribute to the generation of accurate knowledge that will positively and directly impact team adaptation. However and as it has been previously pointed out (Edwards et al., 2006) the recommendations here best suit when teams operate in an environment when a limited number of solutions are available as there might be contexts in which much more than one expert solution are available.

Besides, managers should monitor the nature of the disruption their teams have to deal with. From our results we suggest that the recommendations proposed here are more necessary when teams have to deal with changes of high magnitude. Therefore, assessing the severity of the task trigger demanding for adaptation could help team leaders on the prioritization of the recommendations here. Nevertheless, these patterns of managerial recommendations apply for teams when the nature of the situation after the task disruption remains the same and not for those facing radical changes (Gersick, 1991) as in such cases the abandon of obsolete knowledge stored in TMM and the generation of new knowledge is a better recommendation (Audia, Locke & Smith, 2000).

Limitations and Directions for Future Research

Although we were pioneer on the incorporation of the magnitude of change on the analysis of how teams adapt to changing situations, the change was always task-related and we did not examined team adaptation to team-related changes. Future research should take into consideration team-related changes varying in different magnitude (e.g., team member rotation, changes in structure, etc.) to see if the effects revealed in this study with a task-change hold true when teams adapt to new situations derived from team-based disruptions. In addition, although we exclusively analyzed the severity of an unexpected task-based disruption, future studies should bear in mind other characteristics of team and task-changes such as its frequency or origin (Rafferty & Griffin, 2006; Christian et al., 2017). For example, future research could consider a similar design as Uitdewilligen and colleagues (2018), and analyze the effects of TMMs and team coordination to repeated changes or even analyze the way teams adapt to changes coming within the team (e.g., team member rotations) compared to task-changes analyzed in this research.

As for team cognition, although we complement previous studies by incorporating similarity and accuracy measures of both team-related and task-related TMMs (Sander et al., 2015), there is a stream of literature suggesting that stable characteristics of TMMs cannot provide enough explanation for teams working under dynamic circumstances. The notion of Team Situation Model (TSM) have been proposed as short-term mental representations of a situation that can impact team adaptation (Rico et al., 2008). Little empirical research about TSMs has been carried out (van der Haar Segers, Jehn, & Van den Bossche, 2015; Cooke, Kiekel & Helm, 2001), which further justifies the pertinence of our study in the next chapter (i.e., focus placed on the accuracy of TSMs). In this line, we encourage future studies to continue analyzing if not only accurate but also similar TSMs impact transition and reacquisition team adaptation. In addition, although the general tendency in studies of TMMs is to group its content within team- and task- categories, there might be effects emerging when avoiding this categorization. Consequently, future research should consider the initial four TMMs proposed by Cannon-Bowers and colleagues (1993) (i.e., equipment-, task-, team interaction- and team- TMMs) as there might be information lost due to the bias of grouping the content of TMMs under two broad categories.

Concerning team coordination, although we provided useful insights on the effects of explicit and implicit coordination on team adaptation, we used global measures for both of them. A future venue of research should consider separately analyzing the basics mechanisms for both explicit and implicit coordination (i.e., communication, planning, anticipation or dynamic adjustment). Additionally, recent developments on the measure of explicit and implicit coordination have been carried out and future research could consider using such auto-informed measures in order to analyze explicit and implicit coordination effects on team adaptation (Chang et al., 2017). In addition, other studies considered a single measure of coordination bearing in mind the relative weight of explicit and implicit coordination that takes places in a team (Riethmüller et al., 2012), which might be useful as both kinds of coordination act in concert and not in isolation. Besides, the time sensitive nature of implicit coordination (Espinosa et al., 2002) demands for a research design that allows teams to work together for longer periods of time. Future studies should bear this in mind and implement tasks that allow teams to be able to manage interdependencies for a long length of time. Lastly, and following the reasoning mentioned before, future lines of inquiry should consider the interactive effects of implicit coordination with shared TMMs as its effect might emerged when considered together (Burtscher et al., 2011).

Conclusion

As organizations increasingly rely on teams to handle changes derived from the turbulent context in which they operate, the understanding of team adaptation becomes key to succeed. In this line, we have highlighted the importance for team members of sharing accurate knowledge as well as coordinating properly in order to successfully manage changing situations. Consequently, we hope this research helps to advance our current knowledge on the team adaptation field and is found useful by researchers and practitioners working in this topic.

CHAPTER 5

TEAM LEADERSHIP AND TEAM MENTAL MODELS AS PREDICTORS OF TEAM SITUATION MODELS AND THEIR EFFECTS ON ADAPTIVE OUTCOMES AFTER TASK-CHANGES OF DIFFERENT MAGNITUDE

1. Abstract

This study builds on recent developments on team cognition, team leadership and team adaptation to analyze the effects of team leadership styles and the accuracy of team mental models (TMMs) on the accuracy of team situation models' (TSMs) and their impact on the reacquisition of post-change team performance, when teams cope with changes of different magnitude. We arranged 67 3-person teams to take part in a computer-based simulation task who were randomly assigned to one of the four conditions resulting from our 2 (leadership style: directive vs. empowering) x 2 (magnitude of change: high vs. low) bifactorial design. We found direct positive effects of accuracy of TMMs and empowering leadership on the accuracy of TSMs. Through discontinuous random coefficient growth modeling (RCGM) we observed that the accuracy of TSMs positively impacts the reacquisition of post-change team performance although the effect reached significance only under low magnitude changes. These results highlight the importance of team leadership styles and both TMMs and TSMs for teams operating under changing situations.

Keywords: directive leadership, empowering leadership, team situation models, team mental models, team adaptation.

2. Introduction

As highlighted in the official report by the Arizona State Forestry Division (ASFD), the 30th of June 2013, flames in the Yarnell Hill area suppressed the Granite Mountain Crew, a team of 19 elite fire fighters, in a location prone to burn as they were repositioning from a black area to a safe ranch. Although the ASFD found no negligence, sharp increase in fire complexity, unpredictable weather conditions as well as communications breakdowns were highlighted. There were three key courses of actions: 1) decision to reposition through the two-track road, 2) decision to move toward the ranch through the box canyon and 3) shelter deployment in their current location. Halfway through their relocation, flames were spreading towards the team and they had little time to act. They decided to prepare the area for shelter deployment, which would result in fatal ending" (ASFD, 2013).

The example above shows the importance of accurate understanding of task-changes as they can result in critical decisions with disastrous consequences. Consequently, studying team adaptation (behavioral modifications that respond to new situational demands –Baard, Rench, & Kozlowski, 2014) is important because it is a key aspect of teams to be successful when facing changing situations (Kozlowski, Gully, Nason, & Smith; 1999; Rosen et al., 2011). In particular, understanding how to improve team adaptive outcomes (i.e., team performance after task-changes –Maynard et al., 2015) is imperative for scholars and practitioners preventing property damage but more importantly saving tragic loss of human lives.

In line with previous research, we argue that team cognition may be the key to enhance adaptive outcomes for teams engaging in changing situations (Cannon-Bowers, Salas & Converse, 1993). Traditionally, team mental models (TMMs, defined as organized long-term mental representations of the key elements within a team's relevant environment that are shared across team members –Klimoski & Mohammed, 1994) have taken core places in several models of team adaptation (e.g., Burke, Stagl, Salas, Pierce, & Kendall, 2006; Maynard, Kennedy, & Sommer, 2015). Nevertheless, Granite Mountain Crew's decisions were more likely to be based on their dynamic perceptions of the situation developed moment by moment as they were engaged in their task. Therefore, and following recent developments on team cognition (Mohammed, Hamilton, Sánchez-Manzanares, & Rico, 2017) suggesting that TMMs' stable characteristics are insufficient to analyze team adaptive outcomes, we shift our focus here to the role of team situation models (TSMs, defined as the in-situ shared understanding of a specific situation developed by team members moment by moment as they perform a task –Rico, Sánchez-Manzanares, Gil, & Gibson, 2008) as enhancers of team adaptive outcomes. We are particularly interested on the extent to which the accuracy of TSMs (degree to which team members' shared understanding of a given situation most resembles reality –Rico et al., 2008) impact teams' reacquisition adaptation (i.e., teams' ability to recover post-change team performance after a task-change –Sander, van Doorn, van der Pal, & Ziljstra, 2015).

TSMs are constantly being generated and updated both in routine and non-routine situations and they represent the understanding of any situation teams cope with (Rico et al., 2008). Thus, in the particular case of teams facing a task-change, the TSM refers to the dynamic understanding of the situation resulting from the process by which teams comprehend and give meaning to the encountered change (Mohammed et al., 2017). Specifically, TSMs are created relating stable knowledge acquired due to earlier team experience and stored in TMMs (e.g., effects of wind on fire spreading, fire line construction, evacuation procedures, priority on escape routes, etc.) with the specific information collected of the evolving task-changes (e.g., wind changes have not materialized, comfortable view of the fire, fire apparently moving away, village is in danger, safe area seems close to current position and better for re-engagement, alternate escape routes, etc.). Thus, teams generate a

TSM concerning the post-change situation (e.g., the first key action of the team of elite fire fighters was to reposition to a safe ranch for tactical re-engagement as it was apparently safe) representing the real-time understanding of what has changed and what has to be done to successfully adapt (Orasanu, 1990; MacMillan, Entin, & Serfaty, 2004; Rico et al., 2008). Those TSMs are more likely to impact team adaptive outcomes than could generic TMMs because they are situational driven (Cooke, Salas, Cannon-Bowers, & Stout, 2000; Cooke et al., 2003) and directly impact team decision-making processes. Therefore, when TSMs are accurate teams are more likely to better know what is happening around them and respond better to what is required after facing task-changes (van der Haar, Segers, Jehn, & Van den Bossche, 2015).

Although theoretical and empirical research relates TSMs with team effectiveness, we lack knowledge on TSMs' predictors, that is, how teams generate better quality TSMs (e.g., Rico et al., 2008; van der Haar et al., 2015; Mohammed et al., 2017). As TSMs can be seen as "the dynamic and evolving product of an integration of the TMM and shared situation awareness in a specific situation" (van der Haar et al., 2015, p.45) we believe that the quality of the knowledge stored in TMMs will positively affect the accuracy of TSMs. Besides, together with TMMs, we consider here that team leaders are likely to impact accurate TSMs' generation because of their capability to influence processes related with cognition (Marks, Zaccaro, & Mathieu, 2000; Zaccaro, Rittman, & Marks, 2001). Whereas some leaders focus their efforts on task accomplishment (e.g., directive leaders), others encourage team members to share information and exchange ideas about the situation at hand (e.g., empowering leaders), behaviors that will contribute to the on-going generation of accurate TSMs.

In addition, and considering recent developments on team adaptation theory highlighting the need to consider specific characteristics of the event triggering the need for adaptation (Baard, et al., 2014; Maynard et al., 2015; Christian, Christian, Pearsall, & Long, 2017); we suggest that the relationship between TSMs and reacquisition of post-change team performance may be influenced by the magnitude of change faced by the team (the severity of the task-based trigger causing the disruption that requires for adaptation –Maynard et al., 2015). Following recent research, we also consider that task-changes result in post-change situations in which tasks complexity is higher (e.g., Lang & Bliese, 2009; Uitdewilligen, Rico & Waller, 2018). In this sense, when magnitude of change is low, certain elements of the pre-change and post-change situation are somehow similar, but when magnitude of change is high, the post-change situation is unpredictable and less defined (Hærem, Pentland & Miller, 2015).

Bearing in mind the previous reasoning we have designed a study that investigates the effects of TMMs and team leadership styles on TSMs' accuracy and its subsequent effects on teams' reacquisition adaptation for teams facing changes of different magnitude. To test for team differences that positively impact teams' reacquisition adaptation, we use discontinuous random coefficient growth modeling (RCGM) (Lang & Bliese, 2009). Our research model is captured in Figure 1.

Examining team adaptive outcomes offers the opportunity to advance our knowledge on team effectiveness under changing situations and therefore, this study provides the field with valuable theoretical and managerial contributions. First, with this research we contribute to the burgeoning research stream analyzing team adaptation from a longitudinal approach by using the two-phase team adaptation framework to identify for team differences that enhances team adaptive outcomes (e.g., Lang & Bliese, 2009; Hale, Ployhart, & Shepherd, 2016). Second, our study design answers several calls on empirical research on TSMs (Rico et al., 2008; Mohammed et al., 2017). Thus, we expand our knowledge about TSMs analyzing TSMs accuracy antecedents. This is a noteworthy contribution as we are particularly interested on the positive role of TSMs on team adaptive outcomes. By doing, so we shed light on the role of TMMs on team adaptation (Maynard et al., 2015), and the differential effects of directive and empowering team leadership styles on team processes and performance (Martin, Liao, & Campbell, 2013). Third, we extend our current understanding concerning the need to incorporate change characteristics on the examination of team adaptive outcomes (Christian et al., 2017) as TSMs effects on team performance depend on the magnitude of change teams encounter.

Consequently, we provide managerial recommendations for teams dealing with changing circumstances. In particular, we offer recommendations to enhance TMMs accuracy and to choose a particular leadership style (i.e., empowering leadership) to help their teams in developing more accurate TSMs. Teams act according to the meaning they assign to the situations they handle, and inaccurate situational understanding may very well turn into in fatal consequences.

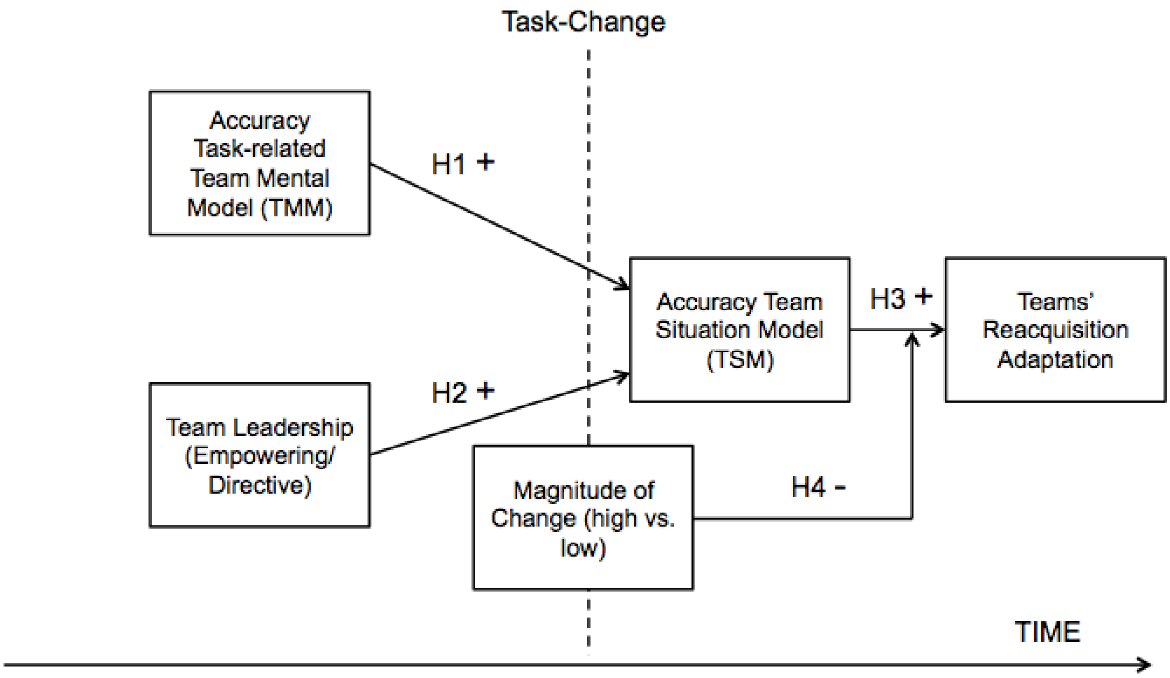


Figure 1. Research model.

3. Theoretical Framework and Hypotheses

Task changes and the relationships between TMMs and TSMs

Literature on team cognition ample acknowledges the effects of TMMs on team processes and performance (Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2005; Lim & Klein, 2006; Cooke, Gorman, Duran, & Taylor, 2007). Although prevalence has been given to TMMs similarity (i.e., degree of convergence among team members' mental representations –Cannon-Bowers et al., 1993) over accuracy (i.e., quality of knowledge team members are sharing –Edwards, Day, Arthur, & Bell, 2006), research suggest that accurate TMMs are more related to team performance than shared ones (Lim & Klein, 2006; Edwards et al., 2006; Resick, Dickson, Mitchelson, Allison, & Clark, 2010) even when teams face task changes that require them to adapt (Sander et al., 2015). The main reason is that team members can share inaccurate knowledge that will impair performance. But when team cognitive structures are accurate, the team is sharing the "true state of the world" and will be in a more solid foot to respond accordingly (Edwards et al., 2006, p.728). TMMs' content is typically grouped under two broad categories: task and team (Mathieu et al., 2000, 2005). Whereas the former refers to knowledge representations about the equipment and task procedures the latter refers to knowledge representations about skills, abilities and patterns of interactions among team members (Cannon-Bowers et al., 1993). In addition, temporal-TMMs have been recently proposed as "agreement among group members concerning deadlines for task completion, the pacing or speed of activities, and the sequencing of tasks" (Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015 p. 696). Nevertheless, and because the change trigger in this study is task-related we focus here on task-TMMs although we consider other kinds of TMMs in the discussion.

Although TMMs have been identified as key for team adaptation (e.g., Burke et al., 2006; Randall, Resick, & DeChurch, 2011), there is a growing stream of research pointing out that TMMs long-term characteristics may not be sufficient to explain team adaptation (Rico, et al., 2008). In this case, the focus should shift to the real-time processing happening during the post-change situation the team engages; that is, the focus moves over the TSM in the moment that comes after facing a task-change (Rico et al., 2008; Mohammed et al., 2017). When teams face task changes, TMMs contain the stable knowledge representations of team members composed by previous working experiences that have been useful in similar circumstances (e.g., offensive strategies such as fire extinguishing, or defensive movements such as fire lines construction). Complementarily, TSMs get build on the go using the perceptions of team members regarding the changing circumstances (e.g., changes in wind directions, flames spreading faster as expected towards the team) and relating them with extant content included in TMMs (Rico et al., 2008). Thus, when teams face a task-change, TSMs go further than TMMs by incorporating key features about how the new situation has changed (Cooke et al., 2000). This context-dependency nature associated to TSMs make them more appropriate to predict team adaptive outcomes; however, research is still needed to provide support to this assumption (Cooke, Salas, Cannon-Bowers, & Stout, 2000; Rico et al., 2008; van der Haar et al., 2015; Mohammed et al., 2017).

As highlighted in recent developments on team cognition (Mohammed et al., 2017), TMMs are the cognitive inputs for the team-level process of providing meaning to perceptions of situations that results in a TSM as the in-situ understanding of the situation at hand. The reason is that the team will integrate their situational perceptions with the knowledge they already have to identify the parts of the task that have changed. In the presence of accurate TMMs, the team will be more capable of incorporating relevant information of the situation to their TSMs and manage the change accordingly (Mohammed et al., 2017). For example, if the knowledge stored in TMMs is accurate (e.g., offensive strategies are to be executed only when escape routes are assured) and the team is executing an offensive strategy, they may interpret changes in wind directions to create an accurate TSM and change their course of action (e.g., flames will cut our escape route, then, our offensive strategy is no longer safe and we need to find alternate routes to escape). In contrast, if TMMs are not accurate, the team could erroneously understand the situation and continue performing wrongly (e.g., wind have no effect on flames and therefore, the situation is still under control). Thus, an accurate TMM helps the team to at least understand that the situation has changed and that there is new information to pay attention to. This fact is further supported by the assumption that experts pose more knowledge and expertise in tasks than novices (Walker et al., 2010). Therefore, their TMMs are more accurate, which allow them to more deeply process and integrate information about the situation they are facing (Walker et al, 2010). In this line, if we continue with our introductory example, the brigade decided to reengage because changes in fire direction made the city of Yarnell to be suddenly characterized as a danger zone (ASFD, 2013). That happened because team members of the brigade identified relevant information from the situation (e.g., flames spreading towards the area of Yarnell), interpreted the effect of changes (e.g., flames will get to the city, structures need to be protected and residents evacuated) and predict future events (e.g., our help will be needed in Yarnell to evacuate and prevent fire spreading). These perceptions on the new situation together with their existing long-term knowledge resulted in an accurate TSM (i.e., there are no tactical reasons to remain in the black area, we currently have limited operational or tactical effectiveness and moving to Yarnell provides the fastest opportunity to reengage – ASFD, 2013). In this sense, we argue that the accurate task-TMM was supporting the decision to reposition to the Yarnell area, which seemed an accurate decision as their help would be needed for operations in the village. Consequently, we predict that if the task-TMM serving as a cognitive input for the generation of TSMs is accurate, the resulting TSM generated after the task-change is more likely to be accurate. In particular, we argue that accurate knowledge stored in the task-TMM will help the team to depart from an accurate point from where to understand task-changes and generate an accurate TSM. Hence, we predict that:

Hypothesis 1: *when teams face a task-change, the accuracy of their task-TMM positively affects the accuracy of the TSM they generate.*

Besides TMMs, TSMs are very sensitive to the kind of interactions taking place in the team (e.g., ideas sharing, gathered information sharing, participative decision-making, etc.). In this sense, we consider team leadership as the element most likely influencing team members' interactions.

Leadership Style as a Predictor of TSMs

Team leaders are well positioned in teams to influence team cognition processes that are central for team adaptation (Marks et al., 2000; Burke et al., 2006; Lorinkova, Pearsal, & Sims, 2013). However, empirical evidence to understand team leaders' influence on team cognition is still scant (van Ginkel & van Knippenberg, 2012; Ayoko & Chua, 2014). In particular, existing evidence relates team leadership with long-term TMMs through the encouragement of communication and team members' interaction (Marks, et al., 2000; Zaccaro et al., 2001; Dionne, Sayama, Hao, & Busch, 2010).

Although not all team leaders adopt the same style to lead a team, most of their behavioral patterns fall into directive or empowering categories (Fleishman et al., 1991). Whereas directive leaders adopt behaviors such as task assignment and organization of team activities (House, 1996; Martin, Liao, & Campbell, 2013) empowering leaders emphasize behaviors of information exchange as well as participative decision-making processes (Arnold, Arad, Rhoades, & Drasgow, 2000; Amundsen & Martinsen, 2014). Several studies provided evidence of differential effects of directive and empowering leadership styles on both team processes and performance (e.g., Yun, Faraj, Xiao, & Sims, 2003; Yun, Faraj, & Sims, 2005). Particularly interesting are the findings of Lorinkova and coauthors (2013) who found in a lab study that the greater improvement of team performance over time of empowering-led compared to directive-led teams was explained because of higher levels of team learning and TMMs similarity, as well as because of more levels of coordination and empowerment. In essence, the interactions promoted by empowering leaders are helpful for team members to jointly investigate about the task and each other's role so that they can share information. In this line, other studies have also pointed out the benefits of empowering leadership to TMMs similarity (Dionne, et al., 2010).

The findings above suggest that empowering and directive leaders differentially impact TMMs, but there is no empirical evidence on how leaders' behaviors can influence the generation of accurate TSMs when teams cope with task changes. This is important to the extent that we are interested in this research on the potential benefits of accurate TSMs on team adaptive outcomes. As mentioned in chapter 2 certain behaviors such as communication and interaction positively affect the generation of accurate TSMs (MacMillan et al., 2004; van der Haar et al., 2015).

Thus, we argue that after a task-change, directive leaders will focus on giving instructions to their followers and make decisions alone (Sims, Faraj & Yun, 2009). In contrast, empowering leaders will focus their efforts on encouraging frequent interaction, ideas sharing among team members and participative decision-making (Amundsen & Martinsen, 2014). Thus, helping the team to provide meaning to what has changed in the new situation compared to the situation before the change and comprehend how to adapt to the change resulting in the generation of more accurate TSMs. Hence, we hypothesize that:

Hypothesis 2: *when teams face a task-change, team leadership influence the accuracy of the new TSM generated. In particular, teams led by empowering leaders will generate a more accurate TSM than teams led by directive leaders.*

Effects of Team Situation Models on Team Adaptive Outcomes

When teams face a task-change, they first enter the transition phase, that refers to the initial team performance decrease right after the task-change takes place and then the reacquisition phase, that concerns the gradual recovery of post-change team performance (Sander et al., 2015). Under the particular approach developed by Lang & Bliese (2009) the most valuable contribution to the field of team adaptation is to find out for team differences that allow for higher levels of teams' transition adaptation (i.e., smaller team performance decrease during the transition phase) and reacquisition adaptation (i.e., higher recovery rates of post-change team performance during the reacquisition phase).

Given the fact that TSMs are associated with team effectiveness (Cooke, Kiekel & Helm, 2001; Hamilton, 2009; van der Haar et al., 2015), we similarly expect that they can positively affect teams' adaptive outcomes when coping with changing situations. In particular, by going further than TMMs in the incorporation of specific features of the new situation derived from a task-change, we believe that accurate TSMs will positively impact post-change team performance during the reacquisition phase for several reasons.

As mentioned in chapter 2, accurate (or inaccurate) TSMs involve a good (or bad) assessment of the current situation and in the particular case of facing a task-change they imply that the team can (wrongly) comprehend and give meaning to the change (Mohammed et al., 2017). For example, the brigade's TSM of our example in the first key moment accurately allowed them to understand the new situation (i.e., Yarnell area will be soon in danger). Therefore, they decided to move for reengagement as staying in the black area would result in the team being useless for tactical operations. In contrast, the brigade's inaccurate

TSM in the second key moment made the team to wrongly understand the situation (i.e., descending the canyon box is fastest and safe) because they were missing relevant information about wind direction and velocity, flames behavior, real distance to the ranch and time needed to safety relocate (ASFD, 2013). In both cases, TSMs guided the team's next steps, which would lead to high performance when the TSM was initially accurate, but led to fatal outcomes in the second critical decision.

Additionally, accutare TSMs will help the team to better know how to respond to the task change even if they do not possess the necessary behaviors in their behavioral repertoire. Accordingly, teams with accurate TSMs are better in selecting other behavioral repertoires previously learn due to earlier experience or to develop new effective behaviors for the new post-change situational demands. To be specific, the accurate representation of the situation developed after a task-change should positively impact the planning reformulation and also the actions carried out (e.g., the decision and execution of leaving the black area and move along the two-track road so that the team can better reposition for reengagement) by team members to successfully manage the task-disruption (Burke et al., 2006). On the contrary, if the representation of how the task-change demands for certain behavioral modifications is not accurate (e.g., the team believes that descending to the ranch through the canyon is fast and safe), the team could engage in actions with negative effects on adaptive outcomes resulting sometimes, in tragedies such as the occurred with the Granite Mountain crew. Based on the previous reasoning we predict that:

Hypothesis 3: *when teams face a task-change, the accuracy of their TSMs positively affects the reacquisition of post-change team performance*.

The Moderating Role of Magnitude of Change on the Effects of Team Situation Models on Team Adaptive Outcomes

Several scholars highlighted the importance of magnitude of change when studying teams adapting to changing circumstances (Gersick & Hackman, 1990; Uitdewilligen, Waller & Pitariu, 2013; Maynard et al., 2015). Therefore, we proposed that the positive effects of TSMs on adaptive outcomes depend on the amount of change teams are facing (see Figure 1). In relation to the effects of magnitude of change on team adaptation, whereas some studies found that teams better adapt to changes of high magnitude (DeRue, Hollenbeck, Johnson, Ilgen, & Jundt, 2008) others suggest that teams are more able to adapt when facing changes of low magnitude (Johnson et al., 2006; Hollenbeck, Ellis, Humphrey, Garza, & Ilgen, 2011). Therefore, existing evidence is still inconclusive.

With regards to the effects of TSMs on team performance depending on magnitude of change, extant research seems to point at one direction. In this regard, Hamilton (2009) predicted that TSMs would have a positive stronger relationship with performance under non-routine compared to routine situations but she failed on finding this effect. In contrast, Van der Haar and colleagues (2015) found that TSMs positively impacted effectiveness of teams dealing with emergency situations (i.e., situations characterized by dynamism, unpredictability and turbulent contexts). However, it is interesting to note that Van der Haar and coauthors (2015) found positive effects of TSMs on team performance when contextual factors somehow facilitated the task. Therefore, the above findings allow us to infer that, although TSMs are positive for teams dealing with changing situations, their effects are impaired when changes are of high magnitude. This might be because the selection or development of behavioral repertoires to be implemented into the new situation will be more difficult and therefore hinders team adaptive outcomes (Kozlowski et al., 1999).

Bearing in mind our illustrated example, we can imagine several hypothetical scenarios in which the faced task-change that led to the third critical decision was low. For example, the team could have realized that the wall of flames was approaching them, when they still had time to reach the ranch in safety. In such a situation, working harder (i.e., running faster instead of walking) may be a plausible solution for coping with the task-change. Another example involves that the speed of fire spreading would have been slower than it actually was. In such cases, the team could have continue to perform in a suboptimal way and simply reorganize themselves by changing their relocation strategy to a defensive escaping prevention. Both kinds of situations do not demand extensive behavioral modifications, as all team members are likely to know how to keep using the necessary equipment as well as standard procedures that remain useful for the new situational demands.

However, the Granite Mountain crew faced a change of high magnitude and although they acted as any other trained and experienced elite crew would have acted in the same situation, there was another alternative course of action (ASFD, 2013). Contrasting the taken course of action, the crew could have relocated to a nearby rocky area, which appeared to have less vegetation to deploy shelters. However "uneven terrain and rock piles are not preferred fire shelter deployment locations" (ASFD, 2013 p.41). Therefore, we may think that the team did not have in their behavioral repertoire the ability to engage in extensive behavioral modifications required for adaptation (i.e., preparing a rocky area for shelter deployment) (Maynard et al., 2015). The explanation is that when magnitude of change is high, pre-change behaviors and procedures are less likely to be useful in the new post-change situation and teams need to implement new behaviors. It may be the case that the TSM of the Granite Mountain crew was accurate but not enough to successfully adapt to the new contingencies. Whatsoever the case, "there is much that cannot be known about the crew's decision prior to their entrapment and fire shelter deployment" (ASFD, 2013 p. 1). In this sense, although accurate TSM might have helped the team to change their strategy, it would have been more useful when confronting a change of low magnitude. Therefore, we predict that the positive effects of accurate TSMs on post-change team performance will be higher when magnitude of change is low. Hence, we formally state:

Hypothesis 4: *when teams face a task-change, magnitude of change moderates the relationship between accuracy of their TSMs and the reacquisition of post-change team performance. In particular, the positive effects of accuracy of their TSMs on the reacquisition of post-change team performance will be higher when magnitude of change is low.*

4. Method

Research Participants

67 teams formed of three people randomly assigned to each of them participated in our laboratory experiment that consisted in a 3-hour firefighting simulation that took place on two different sessions. Participants were students from a main University in Spain. Thirty-six per cent of the participants were males and their average age was 20.93 (SD = 3.02). Teams were randomly assigned to one of the four conditions that resulted from our 2 (magnitude of change: high vs. low) x 2 (leadership style: empowering vs. directive) factorial design. Participants provided informed consent and in exchange for their participation they were given 10€. This study is part of a larger research project and this study considers 38% of the total number of teams.

Task

Team members were located in different cubicles and were able to communicate with each other via headphones using the software Ventrilo. They play the Networked Fire Chief (NFC) simulation (Omodei, Taranto & Wearing, 2003) using networked computers. Teams' objective was to protect the maximum amount of land possible from fires programmed to appear over different locations using appliances to drop water and create control barriers. At the end of each round, the NFC simulation generates a file with the objective measure of team performance.

Simulation environment. NFC software allows designing firefighting scenarios that can be used to study teamwork. We designed landscapes that consisted in 99x79 squares combining forests, villages, roads, pastures and a river. Participants were provided with three fire-trucks, two helicopters and two bulldozers in each scenario to extinguish fires with some real-world limitations: water capacity (fire-trucks store more water than helicopters), need of fuel (bulldozers need more fuel than the rest of appliances) and travel speed (air vehicles are faster than earth vehicles). Helicopters and fire trucks use water to extinguish fires whereas bulldozers are used to create barriers that prevent fire spreading. Fires are programmed to appear and spread over different locations. Fire spreading highly depends on wind direction and intensity. Participants can see on the left side of their screens the current and predicted wind strength and direction.

Team members' roles. Teamwork interdependence was assured by assigning different roles to team members: leader, earth officer and air officer. The leader of the team was able to move and use fire trucks. The earth officer was able to move all appliances but only able to use fire trucks and bulldozers. The air officer was able to move all the vehicles but only able to use fire trucks and helicopters. Concerning refilling of the vehicles, the leader was not able to refill any of the resources. Air officer could refill the fuel of all the vehicles whereas earth officer could refill the water for the fire trucks and the helicopters. Each team member had to play the same role during the whole simulation

Procedure

One month before the experiment took place participants had to fill in an online survey that assessed their demographic data, their natural tendency to behave as directive and empowering leaders and their neuroticism. Participants selected to play the role of leaders were those with higher natural tendencies to act as empowering or directive leaders and with low neuroticism (see further explanations in the manipulation variables section). Team leaders were assigned to their corresponding leadership condition and then randomly assigned to any of the magnitude of change experimental conditions. Rest of team members were randomly assigned to any of the four experimental conditions. Team leaders were trained in the lab immediately before the session started so that they would show the desired behaviors. After the training of the leader, the rest of team members would come into the lab and the entire team received an explanation of the purpose of the task. To reinforce the manipulation each team leader was in charge of assigning the rest of positions to the other two members of the team. Besides, each team leader had a cheat sheet listing comments and sentences they could use matching their leadership style (see Appendix). Before the session started, the entire team was trained together for ten minutes on how to use the simulation with a training protocol that explained the basics of the simulation. In addition, each team member had an instruction's sheet that explained how to operate the simulation and the color of the different features of the simulation. When the training finished the team performed 4 rounds of the task, then the simulation was paused until the next day, when the team performed 5 additional rounds of the task. After the 6th round a change in the task was introduced. TMMs were measured after the 3rd task, and TSMs were measured right after the 6th task ended. After the end of the simulation, participants were asked to fill in a survey to measure their perceptions of their leader's behaviors and magnitude of change they had face. After the entire team had finished the last questionnaire they were given the 10€ and thanked for their participation

Measures and Manipulations

Team leadership manipulation. We manipulated team leadership through selection and training (Durham et al., 1997; Lorinkova et al., 2013) so that team leaders would show the desired empowering or directive behaviors.

Selection. In the initial online survey participants had to fill in the Directive Leadership scale (DLS) and the Empowering Leadership Questionnaire (ELQ) to assess their natural tendency to act as directive or empowering leaders (Durham et al., 1997; Arnold et al., 2000). Each of them consisted on a 10-item scale where participants had to rate on a 5-point Likert scale (1 = “very uncomfortable,” and 5 = “very comfortable”) to which extent they felt comfortable showing directive or empowering behaviors. An example for the items of the directive behaviors was “I feel comfortable if I have to distribute tasks among team members”. An example for the items of the empowering behaviors was “I feel comfortable if I have to encourage other team members to share information”. Participants considered for training were selected according to their score on the DLS and ELQ (having a relative score in the top fifth compared to the whole pool of participants) and their level of neuroticism. The second criterion was incorporated because there was evidence from a pilot study that individuals scoring high either in the DLS or ELQ and trained to show the desired behaviors would eventually not play the role of leaders because they found difficult to lead a team of non-familiar people. Consequently, we decided to measure participants’ neuroticism, which refers to the ability to remain calm when confronted with difficult, stressful or changing situations.

Training. Team leaders were first exposed to 2 minutes recorded verbal presentation that explained them the main behaviors they were expected to show during the whole simulation. Then they were shown a 6-minute clip from a film in which they would see team leaders acting in a directive or empowering way. The clip for the directive leaders was adapted from Apollo 13 (Howard, 1995) and the clip for the empowering leaders was adapted from The Cube (Natali, 1997). Both clips emphasized the desired behaviors to be performed by team leaders consistent with their experimental conditions. Directive leaders were then asked to assign the rest of positions of the team members according to their own preferences whereas empowering leaders were asked to reach agreement with their team mates to distribute the rest of team roles.

Magnitude of change manipulation. We created two different conditions according to magnitude of change teams faced after the 6th task. We manipulated the size of the fires, the effects of the wind on the fire spreading and the amount of available resources. After the task-change, some fires had longer warnings, were located next to houses, spread faster and were bigger. In the high-level task-change condition the speed of fire spreading was faster than in the low-level task-change condition. Consequently, in the high-level task-change condition the use of bulldozers was critical to prevent fire spreading, whereas in the low-level task-change condition, the use of bulldozer, although possible was not necessary as the fires could still be extinguished with fire-trucks and helicopters. The amount of resources in the high-level task-change condition was reduced to the half whereas in the low-level task-change condition the amount of resources remained the same.

Team Mental Models. We measured TMMs accuracy following extant studies (Mathieu et al., 2000, 2005). First, we developed a set of items assessing relevant issues about the task. The mental model consisted on a total amount of 21 paired-comparisons. Participants were shown a matrix listing the items along the top and the side of the screen. They were asked to rate each attribute of the mental model in relation to all other items using a 7-point scale ranging from -3 (item A and B are negatively related, a high amount of one implies a low amount of the other) to 3 (items A and B are positively related, a high amount of one implies a high amount of the other) with the 0 (items A and B are independent). We measured TMMs after the third task.

Accuracy. We developed an expert solution and compared it with TMMs of each team, which is a procedure widely followed in TMMs studies (Mohammed et al., 2010; Burtscher, Kolbe, Wacker, & Manser, 2011). A team of three experts was first asked to perform the task several times, getting better scores than any of the groups involved in the research. Then they completed the matrix and compared them. They were asked to reach agreement through discussion when they had different scores on a paired-comparison. When agreement was not reached, it was solved through averaging their rates. We calculated the Euclidean Distance (ED) of each team member mental models with our experts' solution. After calculating the three dyads, we averaged them to calculate the overall ED of the team. We decided to reverse the scores so that higher amounts of the measure implied more accuracy. Accuracy of TMMs was the difference between the team ED and maximum ED possible.

Team Situation Models. We measured the accuracy of TSMs with typical procedures of extant studies on team cognition literature (Hamilton, 2009; DeChurch & Mesmer-Magnus, 2010) We developed a set of 8 items closely related with the situations that teams had to face during the task. We showed participants a matrix listing the items along the top and the side of the screen, resulting in 28 pair-comparisons that needed to be rated in a 7-point scale ranging from -3 (item A and B are negatively related, a high amount of one implies a low amount of the other) to 3 (items A and B are positively related, a high amount of one implies a high amount of the other) with the 0 (items A and B are independent). We measured TSMs after the sixth task, right after the change.

Accuracy. A similar procedure as with the TMMs was followed to calculate accuracy of TSMs (Hamilton, 2009). First, we obtained the high quality TSM through discussion and agreement of task experts. Then we calculated ED between each team member situation model and that of the experts; and lastly, we averaged the three dyads to obtain the average ED of the team. Accuracy of TSMs was the difference between team ED and the maximum ED possible.

Team performance. Team performance was an objective measure obtained from the simulation (Uitdewilligen et al., 2018). It referred to the amount of landscape the team saved from the total that they could have saved. It consisted on an index that ranged from 0 to 1 (0 = no land saved, 1 = all the land possible saved).

5. Results

Manipulation Checks

Team leadership manipulation check. We measured team members' perception about their leader directive and empowering behaviors with a 6-item scale. Three items were adapted from Durham et al. (1997) to measure perceptions about directive behaviors (α = .70). An example of the items was "The leader of my team establishes performance goals alone". The other three items were adapted from Arnold and coauthors (2000) and measured perceptions about empowering behaviors (α = .90). An example of the items was "The leader of my team encourages team members to express their ideas". To justify aggregation of individual data to team-level data we calculated within group reliability with the R_{wg} (James, Demaree, & Wolf, 1984). The mean R_{wg} was .86 and .87 for directive and empowering leadership behaviors, which means strong agreement and exceeded the traditional .70 cut-off point (LeBreton & Senter, 2008). Participants in the empowering condition perceived their leaders to be significantly more empowering (M = 4.28; SD = .59) than those in the directive condition (M = 3.51; SD = .83; $t(65)$ = 3.72, p < .01). Similarly, participants in the directive condition perceived their leaders to be significantly more directive (M = 4.03; SD = .45) than those in the empowering condition (M = 3.14; SD = .52; $t(65)$ = -7.98, p < .01).

Magnitude of change manipulation check. We measured team members' perception of the change with a 3-item scale specifically build for this study (e.g., "To what extent were the tasks of this session different compared to the tasks of the previous session?"). Cronbrach's alpha of the scale was high (α =.90). In order to justify aggregation of individual data to team-level data we calculated within group reliability with the R_{wg} (James et al., 1984). The mean R_{wg} was .66, which means 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-level task-change condition perceived that the tasks of the second session had changed more compared to the tasks of the first session (*M* = 3.73; *SD* = .79) than participants in the low-level task-change (*M* = 3.07; *SD* = .66; t (65) = 3.64 $p < .01$).

Testing Hypotheses

Means, standard deviations and correlations among experimental conditions, team performance before and after the task-change, accuracy of TMMs and accuracy of TSMs are shown in Table 1.

Our first two hypotheses submitted that the accuracy of TMMs (H1) and the empowering leadership style (H2) would significantly and positively predict the accuracy of the TSMs. A multiple linear regression was calculated to predict the accuracy of TSMs based on team leadership style and the accuracy of TMMs. A significant regression equation was found (F(2.64)= 3.53, $p < .05$ with a R^2 of .10. Teams' TSMs predicted accuracy was equal to 13.9 + .54 (leadership) + .30 (Acc. TMMs), where leadership is coded as 1 = empowering, 0 = directive. Teams' accuracy of their TSMs increased .30 for each unit of accuracy of TMMs and empowering teams had .54 more accuracy in their TSMs than directive teams. Accuracy of TMMs was a significant predictor of accuracy of TSMs. Team leadership was marginally significant a predictor of accuracy of TSMs. These findings provided enough evidence to support our first and second hypotheses.

To test the rest of our hypothesis we examined reacquisition adaptation relative to a disruption event controlling for pre-change performance using discontinuous RCGM (Lang & Bliese, 2009). Table 2 shows the coding of the time variables that was based on similar studies (Lang & Bliese, 2009; Hale et al., 2016; Niessen & Jimmieson, 2016).

Table 1

Descriptive Statistics and Intercorrelations of Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Team Leadership Condition	.55	.50	—						
2. Magnitude of Change	.54	.50	.07	—					
3. Pre-change Team Performance (tasks 1 – 5)	.62	.13	-.30*	-.19††	—				
4. Transition Team Performance (task 6)	.33	.21	-.09	-.68**	.36**	—			
5. Post-change Team Performance (tasks 7, 8 & 9)	.59	.24	-.13	-.68**	.58**	.69**	—		
6. Accuracy TMM	17.32	1.12	.04	-.01	-.03	.12	-.01	—	
7. Accuracy TSM	19.44	1.40	.20†	.01	-.06	.08	.04	.25*	—

N = 67 teams

††= $p < 0.2$; †= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

Table 2

Coding and Interpretation of Change Variables in the Discontinuous Mixed-Effects Growth Models Recommended by Lang & Bliese (2009).

Change variable	Pre-change					Post-change				
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 pre-change 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 post-change period
Quadratic skill acquisition (SA^2)	0	1	4	9	16	16	16	16	16	Quadratic growth rate in the pre-change period
Quadratic reacquisition adaptation (RA^2)	0	0	0	0	0	0	1	4	9	Quadratic growth rate in the post-change period

Estimating the basic model. Through the calculation of the intraclass correlation coefficient (ICC1=.38) we found out that 38% of variance in team performance across the 9 missions was explained because of between-team differences.

Through RCGM we calculated fixed effects for change variables. Analysis revealed significant effects for the linear terms (SA, $\gamma = 0.066$, *SE* = 0.007, $p < .001$; TA, $\gamma = -0.343$, *SE* = 0.033, $p < .001$; RA, $\gamma = -0.031$, *SE* = 0.013, $p < .05$). This means that team performance trajectory had a positive rate of improvement during the pre-change period that was followed by a sharp decrease during the transition from the pre-change to the post-change stage and ended with significant slope on reacquisition adaptation during the post-change length of time. Analysis concerning our quadratic model revealed significant effects for the quadratic terms (SA^2, $\gamma = -0.014$, *SE* = 0.006, $p < .05$; RA^2, $\gamma = -0.119$, *SE* = 0.011, $p < .001$). This means that the rate of improvement in team performance is characterized by an early acceleration, but it decreases with time.

We afterwards accounted for team differences in the change variables by adding complexity in the random effects. Analysis revealed a significant amount of random variability in the skill acquisition (χ^2_{diff} = 32.80, $p < .001$), the transition adaptation (χ^2_{diff} = 25.76, $p < .001$) and reacquisition adaptation (χ^2_{diff} = 9.65, $p < .05$). We then tried to extend our model to account for quadratic changes in team performance as we assumed an early fast acceleration of team performance that declines over time (Niessen & Jimmieson, 2016) but those models ran into convergence problems. In addition and following previous recommendations (DeShon, Ployhart & Sacco, 1998) we controlled for autocorrelation ($\varphi = -.12$; χ^2_{diff} = 3.71, $p < .06$) and heteroscedasticity ($\varphi = -.12$; χ^2_{diff} = 0.33, $p = .85$) comparing models in which only the linear terms varied randomly.

We then included accuracy of TSMs as a level-2 predictor to find differences between groups in team performance derived from different amounts of accuracy of TSMs and we controlled for magnitude of change. In the second step, we included magnitude of change as a level-2 predictor to test for the expected moderation effects on the relationship between accuracy of TSMs and team performance.

Hypothesis 3 poses that teams' accuracy of TSMs would positively impact reacquisition of post-change team performance. As can be seen in the Table 3 (step 1), although we found the effects on the expected direction concerning the relationship between accuracy of TSMs and teams' reacquisition adaptation we failed to reach significance. This means that the rate of improvement after the task-change in the percentage of landscape saved is not significantly higher for teams with more accurate TSMs (Figure 2A). Therefore, we could not support our third hypothesis.

Hypothesis 4 proposed that magnitude of change would moderate the relationship between the accuracy of teams' TSMs and the reacquisition of team performance. As can be seen in the Table 3 (step 2), we found a very slight trend towards significance concerning the negative relationship among the accuracy of TSMs, magnitude of change and teams' reacquisition adaptation. This confirms that teams with accurate TSMs and facing low magnitude changes recovered their post-change team performance faster than those teams with less accurate TSMs (Figure 2B). Therefore, we provide evidence to partially support our hypothesis 4.

Table 3

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of team situation models and magnitude of change

	Step 1			Step 2		
Variable	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.77	0.23	3.29[a**]	0.86	0.34	2.53[c*]
Skill acquisition (SA)	0.12	0.02	5.65[a**]	0.12	0.02	5.67[c**]
Transition adaptation (TA)	-0.52	0.34	-1.52[a††]	0.00	0.43	0.00[c]
Reacquisition adaptation (RA)	0.32	0.13	2.40[a*]	0.13	0.20	0.67[c*]
Quadratic skill acquisition (SA^2)	-0.01	0.01	-2.74[a**]	-0.01	0.01	-2.75[c**]
Quadratic reacquisition adaptation (RA^2)	-0.12	0.01	-11.95[a**]	-0.12	0.01	-11.99[c**]
Final Level 2 model						
Accurary of TSM (ACC_TSM)	-0.01	0.01	-1.07[b]	-0.02	0.02	-1.13[d]
Magnitude of change (MC)	-0.13	0.03	-4.46[b**]	-0.37	0.45	-0.83[d]
ACC_TSM x MC				0.02	0.02	0.73[d]
MC x TA				-0.67	0.56	-1.19[c]
ACC_TSM x TA	0.01	0.02	0.46[a]	-0.01	0.21	-0.56[c]
MC x RA				0.35	0.26	1.35[c††]
ACC_TSM x RA	0.00	0.01	0.56[a]	0.01	0.01	1.39[c††]
ACC_TSM x MC x TA				0.02	0.03	0.78[c]
ACC_TSM x MC x RA				-0.02	0.01	-1.44[c††]

††= $p < 0.2$; †= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 529. [b] *df* = 64.

[c] *df* = 525. [d] *df* = 63.

Ancillary analysis

We created two experimental conditions in order to analyze the moderating role of magnitude of change on the relationship between teams' accuracy of TSMs and teams' reacquisition adaptation. However, the effects we found only reached a slight trend towards significance. A plausible explanation may be that certain teams in high-level magnitude of change perceived the task-change they faced as of low magnitude and vice versa. Therefore, and following recent recommendations (Hærem et al., 2015) we decided to replicate our RCGM analysis using the continuous measure of magnitude of change. Results can be seen in table 4. Although we still could not provide evidence to support our third hypothesis our results were in the expected direction ($\gamma = 0.01$, $SE = 0.01$, $p > .05$) (Figure 3A). Concerning the fourth hypothesis we included the continuous measure of magnitude of change as a level-2 predictor to test the triple negative interaction among magnitude of change, teams' accuracy of TSMs and teams' reacquisition adaptation. We found a significant effect when we replicated the analysis with the continuous measure of magnitude of change ($\gamma = -0.02$, $SE = 0.01$, $p < .05$). This means that for teams facing low magnitude changes, the rate of improvement on the percentage of landscape saved after the task-change was higher when they had accurate TSMs (Figure 3B), which provides support to confirm our fourth hypothesis.

Table 4

Discontinuous Random Coefficient Growth Models predicting transition and reacquisition adaptation as a function of team situation models and magnitude of change (using continuous measure for the magnitude of change)

Variable	Step 1			Step 2		
	Coef.	Coef. *SE*	*t*	Coef.	Coef. *SE*	*t*
Fixed effects						
Final Level 1 model						
Intercept	0.60	0.23	2.61[a]**	0.27	0.96	0.28[c]*
Skill acquisition (SA)	0.12	0.02	5.65[a]**	0.12	0.02	5.69[c]**
Transition adaptation (TA)	-0.52	0.34	-1.51[a]††	-0.11	1.36	-0.08[c]
Reacquisition adaptation (RA)	0.32	0.13	2.39[a]*	-0.84	0.55	-1.54[c]††
Quadratic skill acquisition (SA^2)	-0.01	0.01	-2.74[a]**	-0.01	0.01	-2.76[c]**
Quadratic reacquisition adaptation (RA^2)	-0.12	0.01	-11.94[a]**	-0.12	0.01	-11.99[c]**
Final Level 2 model						
Accurary of TSM (ACC_TSM)	-0.01	0.01	-0.76[b]	0.01	0.05	0.11[d]
Magnitude of change (MC)	0.01	0.02	0.34[b]	0.10	0.29	0.37[d]
ACC_TSM x MC				0.00	0.01	-0.30[d]
MC x TA				-0.12	0.41	-0.30[c]
ACC_TSM x TA	0.01	0.02	0.44[a]	0.01	0.07	0.07[c]
MC x RA				0.35	0.16	2.19[c]*
ACC_TSM x RA	0.00	0.01	0.59[a]	0.06	0.03	2.17[c]*
ACC_TSM x MC x TA				0.00	0.02	0.05[c]
ACC_TSM x MC x RA				-0.02	0.01	-2.09[c]*

††= $p < 0.2$; †= $p < 0.1$; *= $p < 0.05$; **= $p < 0.01$

[a] *df* = 529. [b] *df* = 64.

[c] *df* = 525. [d] *df* = 63.

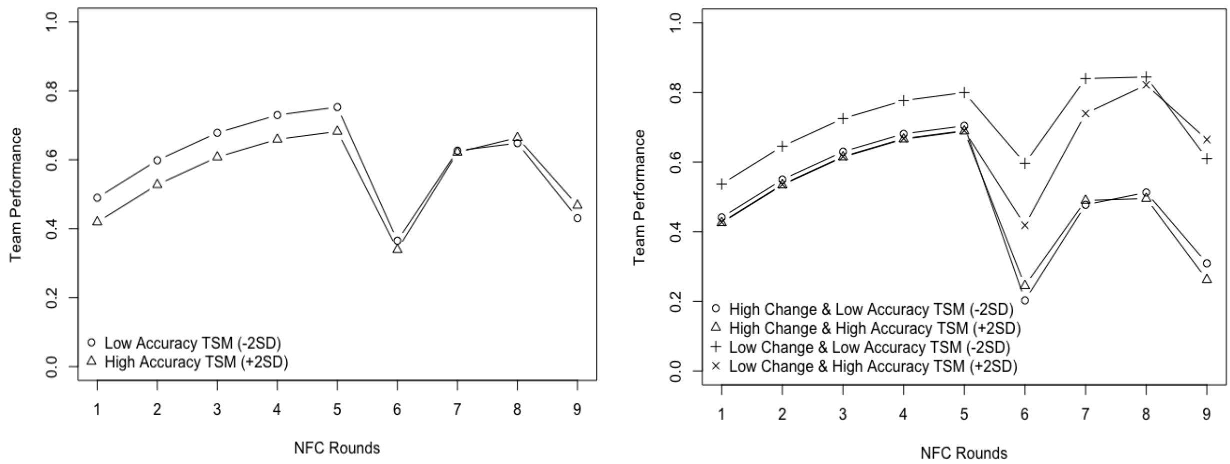


Figure 2. Team performance as a function of time (horizontal axes) and accuracy of team situation models (Graph A), and magnitude of change and accuracy of team situation models (Graph B). TSM = Team situation models; Change = magnitude of change (experimental condition).

A B

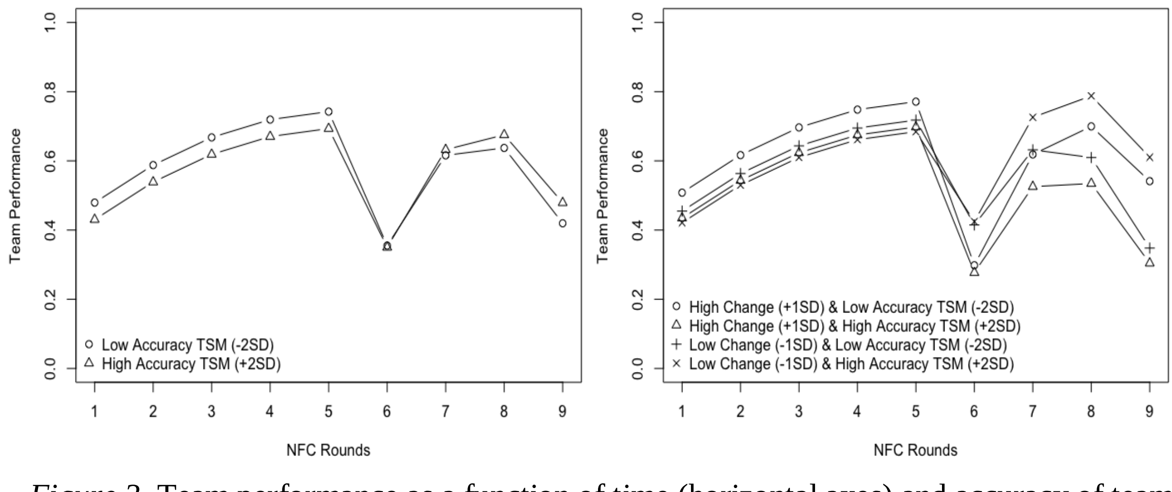


Figure 3. Team performance as a function of time (horizontal axes) and accuracy of team situation models (Graph A), and magnitude of change and accuracy of team situation models (Graph B). TSM = Team situation models; Change = magnitude of change (continuous measure).

6. Discussion

The main purpose of our study was to examine how accurate TMMs and different team leadership styles relate with TSMs accuracy and their ultimate impact on teams' reacquisition adaptation for teams facing changes of different magnitude. Our findings suggest that TMMs accuracy and empowering leadership style are positively related TSMs accuracy after facing a task-change, and that such TMSs accuracy positively impacts the reacquisition of post-change team performance. However, although our results were in the expected direction, they reached significance only for teams facing low rather than high magnitude changes. Nevertheless, our findings contribute to both theory and practice in several ways that we address below.

Theoretical Implications

Our results contribute to the team adaptation, team leadership and team cognition literatures in several ways. We build from previous models of team adaptation placing team cognition at the core of the team adaptation process (Burke et al., 2006; Maynard et al., 2015), literature on TMMs (Mohammed et al., 2010), and TSMs (Rico et al., 2008; Mohammed et al., 2017) and relate them with recent studies aiming to analyze differential effects of empowering and directive team leadership styles on team processes and performance (Martin et al., 2013; Lorinkova et al., 2013).

Our findings support the body of research that relates team cognition with team performance (Marks et al., 2000). In particular, our results are in line with those of Edwards and colleagues (2006) and Sander and coauthors (2015) as we provide evidence of the benefits of accurate team cognitive structures for team adaptation. To be specific, our findings suggest that accurate TMMs influence how accurate will be the mental representation about the situation generated in real time as teams face task-changes. Additionally, we also identified empowering leadership style as predictive of the generation of accurate TSMs. Consequently, our results support the assumption that empowering leadership is beneficial for long-term team cognition, (Dionne, et al., 2010; Lorinkova et al., 2013) and makes it generalizable to short-term team cognition.

Therefore, we contribute to the TSMs literature by providing the first study that empirically supports previous theoretically driven assumptions on the relationship between TMMs and TSMs and consequently, the first research reporting evidence on TSMs' predictors (Rico et al., 2008; Mohammed et al., 2017). Consequently, we contribute to the TSMs stream of research by identifying TMMs and empowering leadership style as positive determinants of the generation of accurate TSMs. As we argued before, the frequent interaction encouraged by empowering leaders (i.e., exchange of information, ideas sharing) benefits the process by which teams can identify and provide meaning to the relevant information that has change in teams' context (Rico et al., 2008). This pattern of results supports the benefits of empowering leadership already revealed in extant literature (Srivastava et al., 2006; Lorinkova et al., 2013) and make it generalizable for teams adapting to changing situations; therefore, giving support to Burke and colleagues' (2006) model in highlighting the relevance of team leadership for team adaptation.

Besides, we also contribute to the research stream aiming to longitudinally analyze the adaption process by identifying team differences that benefit teams' transition and reacquisition adaptation (Lang & Bliese, 2009; Sander et al., 2015; Hale et al., 2016; Niessen & Jimmieson, 2016). In particular we placed accurate TSMs as a positive predictor of teams' reacquisition adaptation. Therefore, we answer previous calls for the need to empirically examine TSMs effect on team performance (Rico et al., 2008; Mohammed et al., 2010; Mohammed et al., 2017) and claim that accurate TSMs after task changes positively impact team adaptive outcomes during the reacquisition phase. Such findings align with and complement those of Cooke et al. (2001) and van de Haar et al., (2015) claiming for the benefits of TSMs for teams, as we extend such benefits for teams dealing with changing situations. In doing so, we further support several models of team adaption by highlighting the relevance of team cognition as a precursor of team adaptive outcomes (Burke et al., 2006; Maynard et al., 2015; Christian et al., 2017).

However, and although our results were in the expected direction, the effects of the accuracy of TSMs on teams' reacquisition adaptation only reached significance when magnitude of change was low. A plausible explanation for that may be related with some studies reporting the paradox of success, showing that previous success hinders team adaptation due to the persistence of past strategies and actions (Audia, Locke, & Smith, 2000). In this sense, it might be the case that accurate TMMs that led to high team performance in the past (i.e., along the pre-change stage) and positively impacted the accuracy of TSMs after the task-change, also led to a high level of cognitive entrenchment (Dane, 2010). Thus, those with accurate knowledge and therefore, more expertise in the task, are more likely to have higher levels of entrenchment and more difficulties to adapt to task-changes. The reason is that teams are likely to get stuck in the same strategies that led to success in the past, avoiding alternative courses of action and be biased towards what was successful in the past (Dane, 2010).

Similarly, although we argued that accurate TMMs favoured accurate TSMs, sometimes, complete overlapping of knowledge and agreement about task-aspects is dysfunctional for teams (Badke-Schaub, Goldschmidt, & Meijer, 2010). In this sense, it might be the case that when team members accurately share all pieces of knowledge, they are less likely to discuss about opposing points of view and ideas which might be negative for managing new situations (Badke-Schaub, et al., 2010). Accordingly, teams facing high magnitude changes might guide their actions based on their TMMs and ignore the specific information and perceptions of the new situation, producing negative effects on team adaptive outcomes. In this sense, our findings definitely support the importance of incorporating change characteristics causing the disruption demanding adaptation, on the study of team adaptation and calls for further research on this topic (Baard et al., 2014; Maynard et al., 2015; Christian et al., 2017).

Managerial Implications

Our findings suggest several useful ways for team managers aiming to improve team performance under changing situations. We propose two recommendations to improve the accuracy of TSMs generated after task changes to better position teams to deal with changing circumstances.

First, along with Lorinkova and coauthors (2013), for teams that are to face task-changes we recommend training team leaders to adopt empowering behaviors that positively relate with the accuracy of TSMs. Team leaders can do so by encouraging team members to exchange information and ideas, and to actively promote participation of all team members in decision-making processes.

Second, we propose that task-TMMs could be periodically assessed and compared to those of experts in order to monitor and improve their accuracy and subsequently improve team adaptability (Maynard et al., 2015). In this line, team leaders could use experts' referent solutions to guide teams to the generation and incorporation of accurate knowledge to their task-TMMs. Along this logic, several ways have been proposed to improve accurate TMMs (Smith-Jentsch, 2009). Specifically, the assistance during team briefing of experts may be beneficial to enhance accurate knowledge representations of the situation (Burtscher et al., 2011). Another alternative would be designing training programs for team members on the use and adoptions of previous specified accurate expert mental models (Smith-Jentsch, Campbell, Milanovich, & Reynolds, 2001). Teams with more accurate TMMs are increasingly able to identify and gather the contextual information needed for the task performance episode that better matches or contrast with what is already stored in such TMMs; thus, anticipating to possible changes and generating therefore, more accurate TSMs.

Limitations and Future Research

Despite our contribution in analyzing TSMs effects on team adaptive outcomes, there are some limitations that deserve consideration. Our research design consisted on a laboratory experiment using a computer-based simulation task widely used before to analyze team processes and performance (e.g., Uitdewilligen et al., 2013, 2018). Although this design allows collecting rich data (e.g., precise measures of adaptive outcomes, team cognitive structures, etc.) difficult to gather in the real context of teams, it has inherent restrictions due to its synthetic nature. Thus, we encourage future research to replicate our findings in more natural settings where teams have to manage real emergencies to see if the findings reported here hold and can be generalized.

Second, although we overcome limitations by focusing on a specific form of team knowledge (i.e., task-TMMs –Sander et al., 2015) there are other kinds of TMMs such as, team- and temporal-TMMs that were not examined in this study (Mathieu et al, 2000; Mohammed et al., 2015; Santos, Passos, & Uitdewilligen, 2015). In this regard, future lines of inquiry should examine if the accurate knowledge stored in team- and temporal-TMMs helps also on the generation of accurate TSMs. In addition, future studies should test the relationships found here but moving the focus over team- and temporal-based change triggers (Maynard et al., 2015; Christian et al., 2017).

Third, although we addressed several former calls for research on team adaption concerned with the need to tackle change characteristics on the analysis of adaptive outcomes (e.g., Baard et al., 2014; Christian et al., 2017), there are some limitations on how we examined magnitude of change. On the one hand, and in line with Hærem and coauthors (2015) we propose the use of a logarithm scale to use a continuous measure of the variable, instead of reducing information by dichotomizing experimental conditions (i.e., high vs. low magnitude of change). Additionally, our findings should be cautiously taken in to account as they refer to changes in increasing rather than radical changes in task complexity (Gersick, 1991). Thus, future research could aim to replicating our pattern of results with teams facing radical changes, where the essence of the task during the pre-change and post-change situations are completely different.

Conclusion

Empowering leadership behaviors and TMMs accuracy positively affect the generation of accurate TSMs after a task change, which impact team adaptive outcomes (i.e., the rate of improvement on post-change team performance) when teams face low magnitude changes. Given the increasing importance of team adaptation, we hope that the reported study here emphasizing the benefits of considering both long- and short-term team cognitive structures (TMMs and TSMs) helps advancing our knowledge about improving team adaptive outcomes.

CHAPTER 6

GENERAL DISCUSSION

1. Main Findings

In this doctoral dissertation we have reported three empirical studies aiming at analyzing from a longitudinal approach, the team variables that are beneficial or detrimental for team adaptation. With the first and third studies, we found team leadership to differentially impact team variables decisive for team adaptive outcomes. Overall, empowering-led teams showed more team behavioral interaction patterns and generated more accurate TSMs than directive-led teams. These results are important as we provided evidence on the direct effects of both team behavioral interaction patterns and accuracy of TSMs on team adaptive outcomes. Concretely, team behavioral interaction patterns although initially detrimental during the transition phase proved beneficial during the reacquisition phase. Similarly, TSMs were positive during the reacquisition too. Besides, we found the moderating role of magnitude of change on the relationships proposed. To be specific, both TSMs and team behavioral interaction patterns positive effects on team adaptive outcomes were particularly true under changes of low magnitude. With the second study, and concerning long-term team cognition, accuracy of task-related TMMs had general positive effect on team adaptive outcomes whereas similarity was particularly good for the reacquisition phase after changes of high magnitude. Similarity of team-related TMMs also affected positively reacquisition phase after changes of high magnitude whereas the effect of the accuracy were not significant (although with a positive tendency) As for team coordination, explicit coordination was positive during the transition when changes were of high magnitude and implicit coordination had an overall negative effect on team adaptive outcomes.

2. Theoretical Implications

The studies reported in this doctoral dissertation advance literatures on team leadership, team cognition, team interaction patterns of behaviors, team coordination and team adaptation in several ways. In relation with team leadership, directive and empowering styles have caught researchers' attention for decades (e.g., Fleishman et al., 1991; Lorinkova et al., 2013; Li, Liu, &

Luo, 2018). In this dissertation we underscore team leaders' role on adaptation (e.g., Burke et al, 2006), as precursors of processes directly impacting team adaptive outcomes (i.e., interaction among team members and shared cognition). Therefore, we support researchers and practitioners' general tendency to favor empowering over directive behaviors (e.g., Srisvatava, Bartol, & Locke, 2006; Lorinkova et al., 2013), and extend it for teams dealing with changing situations. These findings suggest that teams' success when confronting changing circumstances highly depends on team leaders' ability to select a determined style and promote behaviors within the team accordingly.

As for team cognitive structures, we complement previous research highlighting the importance of accurate and similar TMMs for team adaptation (e.g., Sander et al., 2015). Concretely, the more similar and accurate the TMMs during the pre-change stage will determine how well a team will adapt to changing situations. Concerning TSMs, they have been largely unattended in team cognition literature despite their verified benefits for teams, excluding some exceptions (Cooke, Kiekel, & Helm, 2001; Hamilton, 2009; van der Haar et al., 2015). Therefore, we procure a remarkable contribution to this research stream that still remains in early stages of development by validating TSMs' advantageous role to enhance team adaptive outcomes. Results from this doctoral dissertation provide support to the theory suggesting moving the focus over TSMs compared to TMMs when analyzing how teams cope with changing situations (Rico et al., 2008; Mohammed et al., 2017).

Additionally, despite the importance of accurate TSMs, we also join the ongoing debate as for the core role of team behavioral interaction patterns when managing disruptions (e.g., Zellmer-Bruhn et al., 2004; Lei et al., 2016). With this dissertation, we proffer evidence concerning the beneficial and detrimental effects of team behavioral interaction patterns on team adaptive outcomes, that aligns with extant research (e.g., Stachowski et al., 2009; Uitdewilligen et al., 2013). In doing so, we further contribute to the burgeoning research stream adopting the two-phase approach to analyze the adaptation process (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal & Zijlstra, 2015) and highlight its utility to clarify previous contradictions on the team adaptation literature (e.g., opposing views about the effects of team behavioral interaction patterns on team adaptive outcomes). In this sense, if we had follow a cross-sectional approach in our studies (e.g., focusing on the moment of the disruption) we would have partially understood the effects of team behavioral interaction patterns on post-change team performance by only supporting a direct negative impact on performance.

Concerning team coordination, with this dissertation with further provide support to the assumption that team coordination is a key process for team adaptation (Maynard et al., 2015; Burke et al., 2006). Because of the differential effects of explicit and implicit coordination on team performance in different moments of time, we also support the need of considering both kinds of team coordination as complementary (Rico et al., 2008). In addition, we further stimulate the ongoing debate about the potential effects of implicit coordination for team adaptation as it seemed to negatively impact team adaptive outcomes, whereas other studies proved its benefits for team adaptation (Marques-Quinteiro, Curral, Passos & Lewis, 2013)

Besides, our findings definitely align with recent theory suggesting that contextual factors moderate the relationship between team processes and team adaptive outcomes (Christian et al., 2017). Thus, this doctoral dissertation answers several calls on the need to examine magnitude of change on the analysis of team adaptation (e.g., Baard et al., 2014; Maynard et al., 2015). This is relevant due to the wide variety of changes teams constantly confront. In this sense, understanding how distinctive features of changes affect the relationship between processes and adaptive outcomes is crucial for teams to successfully manage changing circumstances.

3. Managerial Implications

The managerial pertinence of this doctoral dissertation lies in our recommendations for teams operating in changing contexts and therefore, in need of fostering their team adaptive outcomes. We recommend teams to identify the changing nature of their context so that they can chose the best strategy accordingly. If teams are repeatedly facing task-changes, they are expected to enter in consecutive phases of transition and the length of time that corresponds to the reacquisition phase will be short, as it will be truncated by more changes. In such cases, the best strategy is to increase their levels of transition adaptation (e.g., avoid behavioral interaction patterns). A positive recommendation in such cases would be to encourage team members to focus on task completion instead of exchanges of ideas and information (e.g., Lorinkova et al., 2013). According to Lorinkova and colleagues (2013), when teams adopt behaviors that focus on accomplishing the task, they improve their team performance in the short-term and consequently, it seems the best strategy for reducing decrease in team performance.

On the contrary, if teams have extended deadlines to adapt to task-changes they should focus efforts on increasing their levels of reacquisition adaptation because once they leave behind the transition their interest is to improve their recovery rates of team performance (e.g., encourage empowering leadership behaviors that positively affect the accurate generation of TSMs). A good choice is to encourage frequent interaction and exchanges of ideas and information among team members because we provided empirical evidence on their positive effects for the reacquisition of team performance. In line with Lorinkova and coauthors (2013), such behaviors need more time to positively impact team performance and will be more beneficial when facing isolated changes (i.e., the reacquisition phase will not be truncated by more changes).

Besides, we suggest targeting team trainings to improve team cognition and team processes required for adaptation (Salas et al., 2008). A plausible approach would be to place teams in hypothetical scenarios in which to develop behavioral repertoires to be incorporated into TMMs through guided practice and feedback (Salas, Prince, Baker, & Shrestha, 1995). Thus, as reported thorough the studies of this dissertation, these behaviors will fall into team behavioral interaction patterns as they are repeatedly perform among team members and also will contribute to the generation of accurate TSMs. In this line, cross-trainings (i.e., training team members to perform other roles of the team) are effective to increase shared knowledge among team members and therefore, can be used strategically to enhance team adaptive outcomes (Gorman, Cooke, & Amazeen, 2010).

In addition, we highlight the importance of team briefings because they enhance team communication (Marks et al., 2000; Leonard et al., 2004), which in turn benefit team adaptive outcomes during the transition phase. As we pointed out thorough the studies of this dissertation, we remind practitioners that the presence of experts during team briefings may also contribute to increase the accurate knowledge shared by team members. Consequently, teams may better know how to respond to changes by incorporating meetings and regular team briefings into their routines in order to both increase team coordination and team cognition.

4. Limitations and Directions for Future Research

Although this doctoral dissertation provides the team adaptation field with high valuable theoretical and managerial contributions, there are some limitations about our variables and our approach to team coordination and cognition that deserve attention.

In relation to team leadership, we exclusively implemented directive or empowering leadership according to teams assigned experimental condition. However, effective leaders adjust their behaviors depending on the kind of situation they are facing (Sims, Faraj, & Yun, 2009). For example, whereas research suggests that directive leadership is well suitable for routine situations because they maximize team efficiency (Martin et al., 2013; Li et al., 2018) we can infer from our studies that empowering behaviors are appropriate for enhancing team adaptive outcomes. Consequently, we encourage future research to consider how adaptive leaders are capable of transitioning between directive and empowering behaviors according to contextual demands (Yukl & Mahsud, 2010).

In relation to magnitude of change, several teams placed in the low-level magnitude of change condition perceived their task-changes as of high magnitude and vice versa, which might have complicated its moderating role to emerge. Indeed, complementary analysis suggested that when using the continuous measure of magnitude of change, we overcame the reduction of information derived from dichotomization of the experimental conditions allowing moderating roles to emerge (Hærem, Pentland & Miller, 2015). Therefore, to overcome this limitation we propose two plausible solutions. First, and because we followed recent studies that characterized post-change situations as an increase in task complexity (e.g., Uitdewilligen et al., 2018), we suggest future studies to use a logarithm scale to measure magnitude of change as proposed by Hærem and colleagues (2015). Second, we suggest accentuating and softening changes in high and low magnitude of change to maximize differences between conditions. By doing so, researchers might assure that teams placed in low (or high) magnitude of change experimental conditions would perceive the faced changes as low (or high).

With regards to team cognitive structures, we used a widely followed procedure to operationalize TMMs and TSMs accuracy (DeChurch & Mesmer-Magnus, 2010). For studies one and three we used the calculations of Euclidean Distances whereas for the second study we used the quadratic assignment proportion (QAP) correlations (e.g., Mathieu et al., 2000, 2005). However, extant research suggest using not only distances between team members' mental models but also correlations, as sometimes effects of cognitive structures on outcomes emerge when using one or the other way of operationalizing similarity and accuracy (e.g., Hamilton, 2009). Hence, we propose future studies to use both distances and correlations, as it might shed light on hidden effects not found thorough this dissertation.

With reference to team behavioral interaction patterns although we were innovative in the inclusion of non-verbal behaviors in our observation code, most of the considered behaviors were still verbal. In this sense, studies using the same simulation considered electronically gathered data to compute for team members' non-verbal actions (e.g., Uitdewilligen et al., 2013; Uitdewilligen et al., 2018). As we might have passed over behavioral interaction due to the limitations of our method, we recommend future studies to combine Uitdewilligen and colleagues (2013) procedure with the observational system of this dissertation to compute for team behavioral interaction patterns.

Last but not least, we want to point out future lines of inquiry derived from our approach to examine team coordination behaviors and team cognition in order to complement the findings of this doctoral dissertation. Concerning team coordination, as research attending the differentiation between explicit and implicit coordination is still scant, especially for implicit coordination (e.g., Marques-Quinteiro, Curral, Passos, & Lewis, 2013), future studies should analyze differential effects of explicit and implicit coordination on team adaptive outcomes. Besides, as both dimensions of coordination act in concert, studies could examine the effects of their relative weight on team adaptive outcomes during the transition and the reacquisition phase (Rietmüller, Fernandez Castelao, Eberhardt, Timmermann, & Boos, 2012).

Apart from coordination, we also recognize our limited point of view by focusing on composition forms of team cognition whereas excluding compilational forms such as transactive memory systems (TMS, a cognitive system composed of each team members' knowledge and awareness of who do what –Wegner, 1987). TMS are related to team performance (Ellis, 2006) also under changing situations (Marques-Quinteiro, et al., 2013). Future research should test if TMSs are positive for both phases of team adaptation (i.e., transition and reacquisition phase) or if they contribute to the generation of accurate TSMs. Besides, considering TMSs together with

TMMs in the examination of team adaptive outcomes would shed light on advantages of one form of team cognition over the other (Wildman, 2012).

7. General Conclusions

This doctoral dissertation highlights the importance of the study of team adaptation as all kinds of teams across organizations are increasingly operating in dynamic and turbulent contexts requiring them to adapt to changing situations (Baard et al., 2014; Maynard et al., 2015). In particular, we have seen that failures on team adaptation could irreversibly end in organizational bankrupt, property damage and even loss of human lives.

Thorough this doctoral dissertation we have highlighted the importance and the benefits of the use of discontinuous RCGM in order to study how teams deal with changing situations and improve their team adaptive outcomes. In particular, we have contributed to the burgeoning research stream adopting the two-phase approach to analyze how teams cope with unforeseen situations (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal & Zijlstra, 2015).

From the findings of the studies reported in this dissertation we support the convenience of the longitudinal two-phase framework (Lang & Bliese, 2009) as we shed light on equivocal results derived from previous studies that adopted a cross-sectional approach. First, it can be helpful to clarify previous contradictions on the team adaptation literature. For example, the first study of this dissertation would have confirmed previous assumptions concerning the negative effects of behavioural interaction patterns for team adaptation under a cross-sectional approach (e.g., (Stachowski, Kaplan & Waller, 2009). If we had focused our analysis on the specific moment of the transition phase, we could have mistakenly concluded that patterned interaction is negative for team adaptive outcomes. However, analysing the whole trajectory of team performance we solved the contradictions found in other studies claiming for both disadvantages (Stachowski, Kaplan & Waller, 2009) but also benefits (Uitdewilligen, Waller & Pitariu, 2013) of behavioral interaction patterns for team adaptation. Thus, under the two-phase approach (Lang & Bliese, 2009) we concluded that these kinds of patterned interactions were negative for transition adaptation but positive for the reacquisition adaptation.

Second, the two-phase model permits to shift the focus to different moments of the team adaptation process and answer questions related to the temporal nature of the adaptation process (Lang & Bliese, 2009). In our second study we found that different kinds of team coordination and team cognition were beneficial for team adaptation. Under a cross-sectional approach, if we had measured the post-change team performance in the moment of the transition, we could have mistakenly concluded that, for example, team-related TMM similarity was negative for team adaptation. In contrast, it proved beneficial but later on during the reacquisition phase. Similarly, if the post-change team performance measure had been later, we would have mistakenly interpreted that explicit coordination had no effect on team adaptation, whereas it proved positive for the transition. Consequently, this doctoral dissertation provides empirical evidence on the pertinence of longitudinally examining how teams can improve team adaptive outcomes.

Concerning our study variables, we have definitely contributed to the team leadership literature by placing team leaders as potential enhancers of team processes and emergent states that are key for team adaptation. In doing so, we have provided evidence on the effects of long-term and short-term team cognition on team adaptive outcomes as well as team coordination and team behavioral interaction patterns effects on team performance during the transition and the reacquisition phases. Besides, we have placed contextual factors (i.e., magnitude of change) as a relevant variable that will stimulate future research on this topic.

As highlighted in our opening example, enhancing team adaptive outcomes is crucial for teams to survive to the wide variety of changes they encounter. We hope this research advance our understanding on the role of team leaders' as enablers of coordination processes and team cognition directly related with team adaptive outcomes. And overall, we wish that this doctoral dissertation probed to be useful both for researchers and practitioners, by stimulating further work on the topic.

(BIS) CAPÍTULO 6

DISCUSIÓN GENERAL

1. Resultados Principales

Hemos encontrado que el estilo de liderazgo impacta de forma diferencial en variables de equipo que son decisivas para el rendimiento adaptativo. En general, los equipos con líderes participativos mostraron más patrones de interacción de equipo y generaron TSMs más precisos que los equipos con líderes directivos. Estos resultados son importantes ya que aportamos evidencia de los efectos directos tanto de los patrones de interacción como de la precisión de los TSMs en el rendimiento adaptativo. Concretamente, los patrones de interacción de equipo, aunque son inicialmente perjudiciales durante la fase de transición probaron ser beneficiosos durante la readquisición. De forma similar, los TSMs impactaron de forma positiva en el rendimiento durante la readquisición. Además, encontramos el rol modulador de la magnitud del cambio en las relaciones propuestas. Para ser específicos, los efectos positivos de los TSMs y de los patrones de interacción de equipo en el rendimiento fueron más fuertes cuando la magnitud del cambio fue baja. En cuanto a las estructuras cognitivas estables, la precisión de los TMMs de tarea tuvo un efecto general positivo en el rendimiento adaptativo mientras que la similitud fue particularmente buena para la fase de readquisición después de cambios de alta magnitud. La similitud de los TMM de equipo también afectaron positivamente a la readquisición después de cambios de alta magnitud mientras que el efecto de la precisión no fue significativo (aunque con una tendencia positiva). En cuanto a la coordinación, la coordinación explícita fue positiva durante la fase de transición cuando lo cambios fueron de magnitud alta y la coordinación implícita tuvo un efecto general negativo en el rendimiento adaptativo.

2. Implicaciones Teóricas

Los estudios de la presente tesis doctoral avanzan la literatura en liderazgo de equipos, cognición de equipos, patrones de interacción de equipos y adaptación de equipos de varias formas. Con respecto al liderazgo de equipo, los estilos directivo y participativo han llamado la atención de los investigadores durante décadas (p. ej., Fleishman et al., 1991; Lorinkova et al., 2013; Li, Liu, & Luo, 2018). En esta tesis, resaltamos el rol de los líderes de equipo en la adaptación (p. ej., Burke et al, 2006) como precursores de procesos que impactan directamente en el rendimiento adaptativo (interacción entre los miembros del equipo y cognición compartida). Por lo tanto, apoyamos la tendencia general por parte de investigadores y profesionales de favorecer los comportamientos participativos frente a los directivos (p. ej., Srivatava, Bartol, & Locke, 2006; Lorinkova et al., 2013) y los hacemos generales a situaciones donde se afrontan cambios. Estos resultados sugieren que el éxito de los equipos cuando se enfrentan a situaciones de cambio depende en gran medida de la habilidad del líder para seleccionar un determinado estilo y promover comportamientos de forma acorde dentro del equipo.

Con respecto a las estructuras cognitivas, hemos complementado investigaciones previas que resaltaban la importancia de la similitud y la precisión de los TMM para la adaptación de equipos (p. Ej., Sander et al., 2015). Concretamente, cuanto más similares y precisos son los TMMs durante la etapa previa al cambio, mejor será la forma en la que los equipos se adaptarán a los cambios. En cuanto a los TSMs, han quedado muy desatendidos en la literatura sobre cognición a pesar de sus probados beneficios para los equipos, excluyendo algunas excepciones (Cooke, Kiekel, & Helm, 2001; Hamilton, 2009; van der Haar et al., 2015). Así, aportamos una importante contribución a esta línea de investigación que está todavía en estadios iniciales de desarrollo, al validar los efectos positivos de los TSMs para mejorar el rendimiento adaptativo. Los resultados de esta tesis doctoral apoyan la teoría que sugiere mover el foco de los TMMs a los TSMs cuando se analiza cómo los equipos afrontan situaciones de cambio (Rico et al., 2008; Mohammed et al., 2017).

De forma adicional, a pesar de la importancia de la precisión de los TSMs, también nos unimos al debate del papel que juegan los patrones de interacción de equipo al manejar situaciones de cambio (p. ej., Zellmer-Bruhn et al., 2004; Lei et al., 2016). Con esta tesis, aportamos evidencia con respecto a los efectos positivos y negativos de los patrones de interacción en el rendimiento que se alinea con la literatura existente (p. ej., Stachowski et al., 2009; Uitdewilligen et al., 2013). Así, también nos sumamos a los estudios que han adoptado el modelo de dos fases para analizar el proceso de adaptación (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal & Zijlstra, 2015) y resaltamos su utilidad para clarificar contradicciones previas en la literatura académica (p. ej., las visiones opuestas respecto a los efectos de los patrones de interacción de equipo en el rendimiento adaptativo). En este sentido, si hubiéramos seguido una aproximación transversal en nuestros estudios (p. ej., centrándonos en el momento en el que los equipos afrontan el cambio), habríamos entendido parcialmente los efectos de estos comportamientos en el rendimiento después del cambio ya que solamente hubiéramos aportado evidencias de sus efectos negativos iniciales.

En cuanto a la coordinación de equipos, con la presente tesis damos soporte a idea de que la coordinación de equipos es un proceso clave para la adaptación (Maynard et al., 2015; Burke et al., 2006). Debido a los efectos diferenciales de la coordinación explícita e implícita en el rendimiento en diferentes momentos del tiempo, también apoyamos la necesidad de considerar ambos tipos de coordinaciones como complementarias (Rico et al., 2008). Además, también nos sumamos al debate sobre los efectos de la coordinación implícita en la adaptación ya que aparentemente impactó de forma negativa en el rendimiento adaptativo, aunque hay otros estudios que avalan sus efectos positivos para la adaptación (Marques-Quinteiro, Curral, Passos & Lewis, 2013).

Además, nuestros resultados apoyan totalmente la teoría que sugiere que los factores contextuales moderan la relación entre los procesos de equipo con el rendimiento adaptativo (Christian et al., 2017). Así, esta tesis doctoral responde a la necesidad de analizar la magnitud del cambio en la adaptación de equipos señalada anteriormente (p. ej., Baard et al., 2014; Maynard et al., 2015). Esto es relevante debido a la gran variedad de cambios a los que se enfrentan los equipos constantemente. En este sentido, entender cómo diferentes características del cambio afectan a la relación entre procesos y resultados es crucial para afrontar de forma exitosa situaciones de cambio.

3. Implicaciones de Gestión

La pertinencia de esta tesis doctoral se basa en nuestras recomendaciones para equipos que operan en contextos cambiantes y por lo tanto tienen la necesidad de mejorar su rendimiento adaptativo. Recomendamos a los equipos que identifiquen la naturaleza cambiante de sus respectivos contextos para elegir la mejor estrategia. Si los equipos están constantemente afrontando cambios, se espera que entren consecutivamente en fases de transición y que el tiempo de readquisición sea corto ya que estará truncado por nuevos cambios. En estos casos, la mejor estrategia es mejorar los niveles de adaptación durante la transición (p. Ej., evitar patrones de interacción de equipo). Por el contrario, si los equipos tienen plazos más largos para adaptarse a los cambios, deberían de centrar sus esfuerzos en incrementar sus niveles de adaptación durante la readquisición ya que una vez dejen atrás la transición su interés es mejorar su ratio de recuperación de rendimiento (p. Ej., fomentar comportamientos participativos que afecten positivamente a la generación de TSMs precisos).

Además, sugerimos mejorar los entrenamientos de los equipos para mejorar tanto la cognición como otros procesos que se requieren en la adaptación (Salas et al., 2008). Una aproximación plausible sería poner a los equipos en escenarios hipotéticos en los que desarrollar repertorios comportamentales para ser incorporados en los TMMs a través de prácticas y retroalimentación guiada (Salas, Prince, Baker, & Shrestha, 1995). Así, como se ha señalado anteriormente, estos comportamientos se transformarán en patrones cuando sean repetidos por los miembros del equipo y también contribuirán a la generación de TSMs precisos. En esta línea, los cross-trainings (entrenar a los miembros del equipo para desempeñar otros roles en el equipo) son efectivos para incrementar el conocimiento compartido de los miembros del equipo y por lo tanto, pueden ser usados de forma estratégica para mejorar los rendimiento adaptativo (Gorman, Cooke, & Amazeen, 2010).

4. Limitaciones y Futuras Líneas de Investigación

Aunque esta tesis doctoral aporta al campo de la adaptación de equipos importantes contribuciones teóricas y de gestión, hay algunas limitaciones que merecen atención sobre nuestras variables y nuestra aproximación a la coordinación y a la cognición de equipos.

Con respecto a nuestras variables manipuladas, sugerimos algunas formas de refinar la manera en las que tanto el liderazgo del equipo como la magnitud del cambio fueron analizadas. En relación al liderazgo del equipo, implementamos exclusivamente liderazgos directivos o participativos dependiendo de la condición experimental a la que fueron asignados los equipos. Sin embargo, los líderes efectivos ajustan sus comportamientos dependiendo del tipo de situación que están afrontando (Sims, Faraj, & Yun, 2009). Por ejemplo, mientras que la investigación sugiere que los líderes directivos son mejores para situaciones más rutinarias porque maximizan la eficiencia de los equipos (Martin et al., 2013; Li et al., 2018), podemos inferir por nuestros estudios que los comportamientos participativos son apropiados para mejorar el rendimiento adaptativo. Consecuentemente, animamos a que futuras investigaciones consideren cómo los líderes pueden adaptar sus comportamientos entre directivos y participativos acorde a las demandas del contexto (Yukl & Mahsud, 2010).

Con respecto a la magnitud del cambio, muchos equipos asignados a la condición de magnitud del cambio baja percibieron sus cambios como de magnitud alta y vice versa, lo cual puede haber dificultado que el rol modulador de esta variable. Es más, los análisis complementarios sugieren que cuando se utiliza la medida continua de la magnitud del cambio, se salva la reducción de información inherente a la dicotomización de variables y se permite por lo tanto que aparezca su efecto modulador (Hærem, Pentland & Miller, 2015). Por lo tanto, sugerimos que futuros estudios utilicen una escala continua tal y como proponen Hærem y coautores (2015) pero que también acentúen y suavicen los cambios en la magnitud del cambio alta y baja respectivamente para maximizar las diferencias entre condiciones experimentales.

Con respecto a las variables medidas, reconocemos las limitaciones en la forma en la que operativizamos tanto los patrones de interacción como las estructuras cognitivas para ayudar a los investigadores que quieran llevar a cabo estudios en esta temática. Con respecto a las estructuras cognitivas, hemos seguido procedimientos ampliamente conocidos en la literatura académica para calcular la similitud y la precisión entre los modelos mentales (DeChurch & Mesmer-Magnus, 2010). Para los estudios uno y tres nos basamos en el cálculo de las distancias euclidianas mientras que para el estudio dos utilizamos la correlaciones QAP (p. ej., Mathieu et al., 2000, 2005). Sin embargo, algunos estudios sugieren que no se utilice únicamente distancias sino también correlacione, ya que a veces el efecto de las estructuras cognitivas en los resultados pueden emerger en función de cómo se operativice la propia variable (p. ej., Hamilton 2009). Así, proponemos que los estudios en el futuro utilice ambas medidas, las distancias y las correlaciones para arrojar luz sobre efectos que hayan podido quedar escondidos en esta tesis.

En referencia a los patrones de interacción de equipos, fuimos innovadores en la inclusión de comportamientos no verbales en nuestro código de observación, aunque la mayoría de comportamientos que tuvimos en cuenta fueron verbales. En este sentido, estudios que han utilizado la misma simulación han utilizado los datos de la simulación para analizar los comportamientos no verbales (p. ej., Uitdewilligen et al., 2013; Uitdewilligen et al., 2018). Como es posible que hayamos ignorado alguna interacción debido a las limitaciones de nuestro método, recomendamos que los estudios en el futuro combinen el procedimiento de Uitdewilligen y colaboradores (2013) con nuestro código de observación para analizar los patrones de interacción de equipo.

Last but not least, we want to point out future lines of inquiry derived from our approach to examine team coordination behaviors and team cognition in order to complement the findings of this doctoral dissertation. As research attending this differentiation is still scant, especially for implicit coordination (e.g., Marques-Quinteiro, Curral, Passos, & Lewis, 2013), future studies should analyze differential effects of explicit and implicit coordination on team adaptive outcomes. Besides, as both dimensions of coordination act in concert, studies could examine the effects of their relative weight on team adaptive outcomes during the transition and the reacquisition phase (Rietmüller, Fernandez Castelao, Eberhardt, Timmermann, & Boos, 2012).

Por último, queremos señalar futuras líneas de investigación que derivan de nuestra aproximación a los comportamientos de coordinación y a la cognición de equipos que pueden complementar los resultados de esta tesis. En relación a la coordinación, como los estudios que atienden a la diferenciación entre la coordinación explícita e implícita son escasos, especialmente para la coordinación implícita (p. ej., Marques-Quinteiro, Curral, Passos, & Lewis, 2013), futuros estudios deberían de continuar el análisis de los efectos de ambos tipos de coordinación en el rendimiento adaptativo. Además, y como ambas dimensiones de la coordinación actúan conjuntamente, deberían de llevarse a cabo investigaciones para examinar los efectos de los pesos relativos de los distintos tipos de coordinación en el rendimiento adaptativo durante las fases de transición y readquisición (Rietmüller, Fernandez Castelao, Eberhardt, Timmermann, & Boos, 2012)

Además de la coordinación, también reconocemos nuestra limitación en cuanto a la cognición al centrarnos en los TMMs mientras excluimos formas compilaciones como los sistemas de memoria transactiva (TMS, un sistema cognitivo compuesta del conocimiento de cada miembro del equipo y de la conciencia de quién hace qué –Wegner, 1987). Los TMS se relacionan con el rendimiento (Ellis, 2006) también en situaciones de cambio (Marques-Quinteiro, et al., 2013). Las investigaciones futuras deberían testear si los TMS son positivos en ambas fases de la adaptación de equipos (es decir, en la fase de transición y en la fase de readquisición) o si contribuyen a la generación de TSMs precisos. Además, considerar los TMSs junto con los TMMs en el análisis del rendimiento adaptativo ayudaría a entender mejor las ventajas de unos frente a los otros (Wildman, 2012)

5. Conclusiones Generales

Esta tesis doctoral resalta la importancia del estudio de la adaptación de equipos ya que todo tipo de equipos en todo tipo de organizaciones operan cada vez más en entornos dinámicos y turbulentos en los cuales tienen que adaptarse a situaciones de cambio (Baard et al., 2014; Maynard et al., 2015). Concretamente, hemos visto que los fallos en la adaptación de equipos podrían llevar de forma irreversible a la misma ruina de las organizaciones, causar importantes daños materiales o incluso costar vidas humanas.

A lo largo de la presente tesis doctoral hemos resaltado la importancia y los beneficios del uso de la metodología de RCGM para estudiar cómo los equipos lidian con situaciones de cambio con miras a mejorar su rendimiento adaptativo. Particularmente, hemos hecho una importancia contribución a la línea de investigación que ha utilizado el modelo de dos fases para analizar cómo los equipos se adaptan a situaciones de cambio (Lang & Bliese, 2009; Hale, Ployhart & Shepherd, 2016; Niessen & Jimmieson, 2016; Sander, van Doorn, van der Pal & Zijlstra, 2015).

A raíz de los hallazgos reportados en los estudios del presente trabajo, apoyamos la conveniencia de esta aproximación metodológica ya que hemos arrojado luz sobre resultados equívocos derivados de la adopción de aproximaciones transversales. Primero, la metodología de dos fases puede ayudar a clarificar contradicciones previas en la literatura sobre adaptación de equipos. Por ejemplo, el primer estudio de esta tesis habría confirmado hallazgos previos en cuanto a los efectos negativos de los patrones de interacción desde una aproximación transversal (p. ej., Stachowski, Kaplan & Waller, 2009). Si hubiéramos analizado solamente la relación entre los patrones de interacción y el rendimiento en la fase de transición podríamos haber concluido equivocadamente que los patrones de interacción son negativos para el rendimiento adaptativo. Sin embargo, al analizar toda la trayectoria de rendimiento hemos resuelto esas contradicciones previas que mantenían que los patrones de interacción eran tanto negativos (Stachowski et al., 2009) como positivos (Uitdewilligen, Waller, & Pitariu, 2013) para la adaptación de equipos. Por lo tanto, bajo la aproximación en dos fases (Lang & Bliese, 2009) hemos concluido que los patrones de interacción eran negativos durante la transición pero positivos durante la fase de readquisición.

El modelo de dos fases permite cambiar el foco a los diferentes momentos de la adaptación y dar respuesta a preguntas relacionadas con la naturaleza temporal del proceso de adaptación de equipos (Lang & Bliese, 2009). Por ejemplo, en el segundo estudio de esta tesis encontramos que diferentes formas de cognición y coordinación eran positivas para la adaptación de los equipos. Bajo una aproximación transversal, si hubiéramos medido el rendimiento después del cambio en el momento de la transición podríamos haber pensado de forma errónea que la similitud de los TMM de equipo eran negativos para la adaptación. Sin embargo, probó ser una variable beneficiosa más tarde durante la fase de readquisición. De forma similar, si hubiéramos medido el rendimiento más tarde, podríamos haber pensado que la coordinación explícita no tenía efecto en la adaptación, mientras que en realidad sus efectos emergieron durante la fase de transición. Por lo tanto, esta tesis doctoral aporta evidencia empírica que apoya el estudio de la adaptación bajo la aproximación longitudinal en dos fases con miras a analizar cómo los equipos mejoran su rendimiento adaptativo.

Con respecto a nuestras variables de estudio, hemos contribuido definitivamente a la literatura sobre liderazgo ya que hemos emplazado a los líderes como potenciadores de procesos y estructuras cognitivas que son claves en la adaptación. Al mismo tiempo, hemos aportado evidencia de los efectos de las estructuras cognitivas estables y dinámicas en el rendimiento adaptativo y también de los efectos de la coordinación y los patrones de interacción en el rendimiento durante las fases de transición y readquisición. Además, hemos resaltado la importancia de las variables contextuales (es decir, la magnitud del cambio) para animar que se lleven a cabo más estudios en esta materia.

Como resaltamos en el ejemplo de la introducción, mejorar el rendimiento adaptativo es crucial para que los equipos sobrevivan a los cambios que tienen que afrontar. Esperamos que esta tesis avance nuestro entendimiento del rol de los líderes como precursores de comportamientos de coordinación y cognición que mejoran el rendimiento adaptativo. Hemos esclarecido inconsistencias previas en los hallazgos referentes a los patrones de interacción de equipo y también resaltado la importancia de tener en cuenta tanto las estructuras cognitivas más estables como las dinámicas en el análisis de la adaptación de equipos. Esperamos que esta tesis doctoral sea útil para investigadores y profesionales y que anime la realización de más estudios en esta temática.

REFERENCES

Abrantes, A. C. M., Passos, A. M., Cunha, M. P. E., & Santos, C. M. (2018). Bringing team improvisation to team adaptation: The combined role of shared temporal cognitions and team learning behaviors fostering team performance. *Journal of Business Research*, *84*, 59–71.

Amundsen, S., & Martinsen, Ø. L. (2014). Empowering leadership: Construct clarification, conceptualization, and validation of a new scale. *The Leadership Quarterly*, *25*, 487–511.

Arizona State Forestry Division (2013). Yarnell Hill Serious Accident Investigation Report, Phoenix, AZ.

Arnold, J. A., Arad, S., Rhoades, J. A., & Drasgow, F. (2000). The empowering leadership questionnaire: The construction and validation of a new scale for measuring leader behaviors. *Journal of Organizational Behavior*, *21*, 249–269.

Audia, P. G., Locke, E. A., & Smith, K. G. (2000). The paradox of success: An archival and a laboratory study of strategic persistence following radical environmental change. *Academy of Management journal*, *43*, 837–853.

Ayoko, O. B., & Chua, E. L. (2014). The importance of transformational leadership behaviors in team mental model similarity, team efficacy, and intra-team conflict. *Group & Organization Management*, *39*, 504-531.

Baard, S. K., Rench, T. A., & Kozlowski, S. W. (2014). Performance adaptation a theoretical integration and review. *Journal of Management*, *40*, 48–99.

Badke‐Schaub, P., Goldschmidt, G., & Meijer, M. (2010). How does cognitive conflict in design teams support the development of creative ideas?. *Creativity and Innovation Management*, *19*, 119-133.

Bechky, B. A., & Okhuysen, G. A. (2011). Expecting the unexpected? How SWAT officers and film crews handle surprises. *Academy of Management Journal*, *54*(2), 239-261.

Bergström, J., Dahlström, N., Henriqson, E., & Dekker, S. (2010). Team Coordination in Escalating Situations: An Empirical Study Using Mid-Fidelity Simulation. *Journal of contingencies and crisis management*, *18*, 220-230.

Bolici, F., Howison, J., & Crowston, K. (2016). Stigmergic coordination in FLOSS development teams: Integrating explicit and implicit mechanisms. *Cognitive Systems Research*, *38*, 14-22.

Burke, C. S., Stagl, K. C., Klein, C., Goodwin, G. F., Salas, E., & Halpin, S. M. (2006a). What type of leadership behaviors are functional in teams? A meta-analysis. *The Leadership Quarterly*, *17*, 288–307.

Burke, C. S., Stagl, K. C., Salas, E., Pierce, L., & Kendall, D. (2006b). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology*, *91*, 1189–1207.

Burtscher, M. J., Kolbe, M., Wacker, J., & Manser, T. (2011). Interactions of team mental models and monitoring behaviors predict team performance in simulated anesthesia inductions. *Journal of Experimental Psychology: Applied*, *17*, 257-269.

Butchibabu, A., Sparano-Huiban, C., Sonenberg, L., & Shah, J. (2016). Implicit coordination strategies for effective team communication. *Human factors*, *58*, 595-610.

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: Current issues:* 221-246. Hillsdale, NJ: Lawrence Erlbaum.

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on shared cognition. *Journal of Organizational Behavior*, *22*, 195-202.

Casarrubea, M., Jonsson, G. K., Faulisi, F., Sorbera, F., Di Giovanni, G., Benigno, A., Crescimanno, G. & Magnusson, M. S. (2015). T-pattern analysis for the study of temporal structure of animal and human behavior: A comprehensive review. *Journal of Neuroscience Methods*, *239*, 34–46.

Chang, H. T., Lin, C. C., Chen, C. H., & Ho, Y. H. (2017). Explicit and implicit team coordination: Development of a multidimensional scale. *Social Behavior and Personality: an international journal*, *45*, 915-929.

Chen, G., Thomas, B., & Wallace, J. C. (2005). A multilevel examination of the relationships among training outcomes, mediating regulatory processes, and adaptive performance. *Journal of Applied Psychology, 90*(5), 827.

Cheong, M., Spain, S. M., Yammarino, F. J., & Yun, S. (2016). Two faces of empowering leadership: Enabling and burdening. *The Leadership Quarterly, 27*(4), 602–616.

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.

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

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, 63-91.

Cooke, N. J., Salas, E., Cannon-Bowers, J. A., & Stout, R. J. (2000). Measuring team knowledge. *Human Factors*, *42*, 151-173.

Cooke, N. J., Gorman, J. C., Duran, J. L., & Taylor, A. R. (2007). Team cognition in experienced command-and-control teams. *Journal of Experimental Psychology: Applied*, *13*, 146-157.

Cooke, N. J., Kiekel, P. A., & Helm, E. E. (2001). Measuring team knowledge during skill acquisition of a complex task. *International Journal of Cognitive Ergonomics, 5*, 297-315.

Cooke, N. J., Kiekel, P. A., Salas, E., Stout, R., Bowers, C., & Cannon-Bowers, J. (2003). Measuring team knowledge: A window to the cognitive underpinnings of team performance. *Group Dynamics: Theory, Research, and Practice*, *7*, 179-199.

Dane, E. (2010). Reconsidering the trade-off between expertise and flexibility: A cognitive entrenchment perspective. *Academy of Management Review*, *35*, 579-603.

DeChurch, L. A., & Haas, C. D. (2008). Examining team planning through an episodic lens effects of deliberate, contingency, and reactive planning on team effectiveness. *Small Group Research*, *39*, 542–568.

DeRue, D. S., Hollenbeck, J. R., Johnson, M. D., Ilgen, D. R., & Jundt, D. K. (2008). How different team downsizing approaches influence team-level adaptation and performance. *Academy of Management Journal*, *51*, 182–196.

DeShon, R. P., Ployhart, R. E., & Sacco, J. M. (1998). The estimation of reliability in longitudinal models. *International Journal of Behavioral Development*, *22*, 493–515.

Dionne, S. D., Gupta, A., Sotak, K. L., Shirreffs, K. A., Serban, A., Hao, C., Dong, H. K., & Yammarino, F. J. (2014). A 25-year perspective on levels of analysis in leadership research. *The Leadership Quarterly*, *25*, 6-35.

Dionne, S. D., Sayama, H., Hao, C., & Bush, B. J. (2010). The role of leadership in shared mental model convergence and team performance improvement: An agent-based computational model. *The Leadership Quarterly*, *21*, 1035-1049.

Durham, C. C., Knight, D., & Locke, E. A. (1997). Effects of leader role, team-set goal difficulty, efficacy, and tactics on team effectiveness. *Organizational Behavior and Human Decision Processes*, *72*, 203–231.

Edwards, B. D., Day, E. A., Arthur Jr, W., & Bell, S. T. (2006). Relationships among team ability composition, team mental models, and team performance. *Journal of Applied Psychology*, *91*, 727-736.

Ellis, A. P. (2006). System breakdown: The role of mental models and transactive memory in the relationship between acute stress and team performance. *Academy of Management Journal*, *49,* 576-589.

Entin, E. E. & Serfaty, D. (1999). Adaptive Team Coordination. *Human Factors, 41*(2), 312-325.

Ericksen, J., & Dyer, L. (2004). Right from the start: Exploring the effects of early team events on subsequent project team development and performance. *Administrative Science Quarterly*, *49*, 438–471.

Espinosa, A., Lerch, J., Kraut, R., Salas, E., Fiore, S. M., & Cannon-Bowers, J. A. (2002). Explicit vs. implicit coordination mechanisms and task dependencies: One size does not fit all. *Team cognition: Process and performance at the inter-and intra-individual level.*

Fisher, D. M., Bell, S. T., Dierdorff, E. C., & Belohlav, J. A. (2012). Facet personality and surface-level diversity as team mental model antecedents: implications for implicit coordination. *Journal of Applied Psychology, 97,* 825.

Fleishman, E. A., Mumford, M. D., Zaccaro, S. J., Levin, K. Y., Korotkin, A. L., & Hein, M. B. (1991). Taxonomic efforts in the description of leader behavior: A synthesis and functional interpretation. *The Leadership Quarterly*, *2*, 245–287.

Gersick, C. J., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes, 47*, 65–97.

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of management review*, *16*, 10-36.

Gladstein, D. L. (1984). Groups in context: A model of task group effectiveness. *Administrative science quarterly*, 29, 499-517.

Gorman, J. C., Cooke, N. J., & Amazeen, P. G. (2010). Training adaptive teams. *Human Factors*, *52,* 295–307.

Grazer, B. (Producer) & Howard, R. (Director). (1995). *Apollo 13* [motion picture]. United States: Universal Pictures.

Grote, G., Kolbe, M., Zala-Mezö, E., Bienefeld-Seall, N., & Künzle, B. (2010). Adaptive coordination and heedfulness make better cockpit crews. *Ergonomics, 53*, 211–228.

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

Hale, D., Ployhart, R. E., & Shepherd, W. (2016). A two-phase longitudinal model of a turnover event: Disruption, recovery rates, and moderators of collective performance. *Academy of Management Journal, 59*, 906–929.

Hamilton, K. (2009). *The effect of team training on team mental model formation and team performance under routine and non-routine environmental conditions*. Unpublished doctoral dissertation, The Pennsylvania State University.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological bulletin*, *121*(1), 43.

Hollenbeck, J. R., Ellis, A. P., Humphrey, S. E., Garza, A. S., & Ilgen, D. R. (2011). Asymmetry in structural adaptation: The differential impact of centralizing versus decentralizing team decision-making structures. *Organizational Behavior and Human Decision Processes*, *114*, 64–74.

Horwitz, S. K., & Horwitz, I. B. (2007). The effects of team diversity on team outcomes: A meta-analytic review of team demography. *Journal of management*, *33*, 987-1015.

House, R. J. (1996). Path-goal theory of leadership: Lessons, legacy, and a reformulated theory. *The Leadership Quarterly*, *7*, 323–352.

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

James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, *69*, 85–98.

Johnson, M. D., Hollenbeck, J. R., Humphrey, S. E., Ilgen, D. R., Jundt, D., & Meyer, C. J. (2006). Cutthroat cooperation: Asymmetrical adaptation to changes in team reward structures. *Academy of Management Journal*, *49*, 103-119.

Jundt, D. K., Shoss, M. K., & Huang, J. L. (2015). Individual adaptive performance in organizations: A review. *Journal of Organizational Behavior, 36*, S53–S71.

Kanki, B. G., Folk, V. G., & Irwin, C. M. (1991). Communication variations and aircrew performance. *The International Journal of Aviation Psychology*, *1*, 149–162.

Klein, G. (2001). Features of team coordination. In M. McNeese, E. Salas, & M. Endsley (Eds.), New trends in cooperative activities: Understanding system dynamics in complex environments (pp. 68–95). Santa Monica, CA: Human Factors and Ergonomics Society.

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

Kolbe, M., Burtscher, M. J., & Manser, T. (2013). Co-ACT—a framework for observing coordination behaviour in acute care teams. *BMJ Quality & Safety*, *22*, 596–605.

Kolbe, M., Grote, G., Waller, M. J., Wacker, J., Grande, B., Burtscher, M. J., & Spahn, D. R. (2014). Monitoring and talking to the room: Autochthonous coordination patterns in team interaction and performance. *Journal of Applied Psychology*, *99*, 1254-1267.

Kozlowski, S. W., 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 performance: Implications for staffing, motivation, and development* (pp. 240–292). San Francisco, CA: Jossey-Bass.

Kozlowski, S. W., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological science in the public interest*, *7*(3), 77-124.

Lang, J. W., & Bliese, P. D. (2009). 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.

LeBreton, J. M., & Senter, J. L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods*, *11*, 815–852.

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*, 491–525.

LePine, J. A. (2003). Team adaptation and post-change performance: Effects of team composition in terms of members' cognitive ability and personality. *Journal of Applied Psychology*, *88*, 27–39.

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.

LePine, J. A., Colquitt, J. A., & Erez, A. (2000). Adaptability to changing task contexts: Effects of general cognitive ability, conscientiousness, and openness to experience. *Personnel Psychology*, *53*, 563–593.

Leonard, M., Graham, S., & Bonacum, D. (2004). The human factor: the critical importance of effective teamwork and communication in providing safe care. *BMJ Quality & Safety*, *13*(suppl 1), i85-i90.

Li, G., Liu, H., & Luo, Y. (2017). Directive versus participative leadership: Dispositional antecedents and team consequences. *Journal of Occupational and Organizational Psychology, 91*, 645-664.

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.

Lorinkova, N. M., Pearsall, M. J., & Sims, H. P. (2013). Examining the differential longitudinal performance of directive versus empowering leadership in teams. *Academy of Management Journal*, *56*, 573–596.

MacMillan, J., Entin, E. E., & Serfaty, D. (2004). Communication overhead: The hidden cost of team cognition. *Team cognition: Process and performance at the interand intra-individual level. American Psychological Association, Washington, DC. Available at http://www. aptima. com/publications/2004_MacMillan_EntinEE_Serfaty. pdf*.

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

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

Manser, T., Howard, S. K., & Gaba, D. M. (2008). Adaptive coordination in cardiac anaesthesia: A study of situational changes in coordination patterns using a new observation system. *Ergonomics*, *51*, 1153–1178.

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, *26*, 356–376.

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.

Marques-Quinteiro, P., Curral, L., Passos, A. M., & Lewis, K. (2013). And now what do we do? The role of transactive memory systems and task coordination in action teams. *Group Dynamics: Theory, Research, and Practice*, *17*, 194

Martin, S. L., Liao, H., & Campbell, E. M. (2013). Directive versus empowering leadership: A field experiment comparing impacts on task proficiency and proactivity. *Academy of Management Journal*, *56*, 1372–1395.

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.

Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of applied psychology*, *85*, 273-283.

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*, 652–677.

Meh, M., Orr, B. (Producers), & Natali, V. (Director). (1997). *Cube* [motion picture]. Canada: Trimark Pictures.

Mohammed, S., & Dumville, B. C. (2001). Team mental models in a team knowledge framework: Expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior*, 22, 89-106.

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.

Mohammed, S., Hamilton, K., Tesler, R., Mancuso, V., & McNeese, M. (2015). Time for temporal team mental models: Expanding beyond "what" and "how" to incorporate "when". *European Journal of Work and Organizational Psychology*, *24*(5), 693-709.

Mohammed, S., Hamilton, K., Sánchez‐Manzanares, M., & Rico, R. (2017). Team mental models and situation awareness. The Wiley Blackwell Handbook of the Psychology of Team Working and Collaborative Processes, 369-392.

Moon, H., Hollenbeck, J. R., Humphrey, S. E., Ilgen, D. R., West, B., Ellis, A. P., & Porter, C. O. (2004). Asymmetric adaptability: Dynamic team structures as one-way streets. *Academy of Management Journal*, *47*, 681-695.

Niessen, C., & Jimmieson, N. L. (2016). Threat of resource loss: The role of self-regulation in adaptive task performance. *Journal of Applied Psychology*, *101*, 450–462.

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

Orasanu, J. 1990. *Shared mental models and crew decision making* (Technical Report No. 46). Princeton, NJ: Princeton University Cognitive Sciences Laboratory.

Pearce, C. L., & Sims Jr., H. P. (2002). Vertical versus shared leadership as predictors of the effectiveness of change management teams: An examination of aversive, directive, transactional, transformational, and empowering leader behaviors. *Group Dynamics: Theory, Research, and Practice*, *6*, 172–197.

Pearsall, M. J., Ellis, A. P., & 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.

Pulakos, E. D., Arad, S., Donovan, M. A., & Plamondon, K. E. (2000). Adaptability in the workplace: development of a taxonomy of adaptive performance. *Journal of Applied Psychology*, *85*, 612–624.

Rafferty, A. E., & Griffin, M. A. (2006). Perceptions of organizational change: a stress and coping perspective. *Journal of applied psychology*, *91*, 1154-1162.

Randall, K. R., Resick, C. J., & DeChurch, L. A. (2011). Building team adaptive capacity: the roles of sensegiving and team composition. *Journal of Applied Psychology*, *96*, 525-540.

Resick, C. J., Murase, T., Bedwell, W. L., Sanz, E., Jiménez, M., & DeChurch, L. A. (2010). Mental model metrics and team adaptability: A multi-facet multi-method examination. *Group Dynamics: Theory, Research, and Practice, 14*, 332-349.

Resick, C. J., Dickson, M. W., Mitchelson, J. K., Allison, L. K., & Clark, M. A. (2010). Team composition, cognition, and effectiveness: Examining mental model similarity and accuracy. *Group Dynamics: Theory, Research, and Practice*, *14*, 174.

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

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.

Riethmüller, M., Fernandez Castelao, E., Eberhardt, I., Timmermann, A., & Boos, M. (2012). Adaptive coordination development in student anaesthesia teams: a longitudinal study. *Ergonomics*, *55*, 55-68.

Rosen, M. A., Bedwell, W. L., Wildman, J. L., Fritzsche, B. A., Salas, E., & Burke, C. S. (2011). Managing adaptive performance in teams: Guiding principles and behavioral markers for measurement. *Human Resource Management Review*, *21*, 107–122.

Salas, E., Prince, C., Baker, D. P., & Shrestha, L. (1995). Situation awareness in team performance: Implications for measurement and training. *Human Factors, 37,* 123–136.

Salas, E., DiazGranados, D., Klein, C., Burke, C. S., Stagl, K. C., Goodwin, G. F., & Halpin, S. M. (2008). Does team training improve team performance? A meta-analysis. *Human factors*, *50*, 903-933.

Sánchez-Manzanares, M., Rico, R., Antino, M., & Uitdewilligen, S. (2018). The Joint Effects of Leadership Style and Magnitude of Change on Team Adaptation: A Longitudinal Experiment. *Manuscript submitted for publication.*

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*, 796–811.

Santos, C. M., Passos, A. M., & Uitdewilligen, S. (2015). When shared cognition leads to closed minds: Temporal mental models, team learning, adaptation and performance. *European Management Journal*, *34*, 258-268.

Schaubroeck, J. M., Shen, Y., & Chong, S. (2017). A Dual-Stage Moderated Mediation Model Linking Authoritarian Leadership to Follower Outcomes. *Journal of Applied Psychology, 102*, 203–214.

Schraub, E. M., Stegmaier, R., & Sonntag, K. (2011). The effect of change on adaptive performance: Does expressive suppression moderate the indirect effect of strain?. *Journal of Change Management*, *11*, 21–44.

Shah, J., & Breazeal, C. (2010). An empirical analysis of team coordination behaviors and action planning with application to human–robot teaming. *Human factors*, *52*, 234-245.

Sims, H. P., Faraj, S., & Yun, S. (2009). When should a leader be directive or empowering? How to develop your own situational theory of leadership. *Business Horizons*, *52*, 149–158.

Smith-Jentsch, K. A., Campbell, G. E., Milanovich, D. M., & Reynolds, A. M. (2001). Measuring teamwork mental models to support training needs assessment, development, and evaluation: Two empirical studies. *Journal of Organizational Behavior*, *22*, 179-194.

Smith-Jentsch, K. A. 2009. Measuring team-related cognition: The devil is in the details. In E. Salas, G. F. Goodwin, & C. S. Burke (Eds.), *Team effectiveness in complex organizations:* 491-508. New York: Routledge, Taylor & Francis Group.

Srivastava, A., Bartol, K. M., & Locke, E. A. (2006). Empowering leadership in management teams: Effects on knowledge sharing, efficacy, and performance. *Academy of Management Journal*, *49*, 1239–1251.

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.

Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of management Journal*, *43*, 135-148.

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.

Toups, Z. O., & Kerne, A. (2007). Implicit coordination in firefighting practice: design implications for teaching fire emergency responders. In *ACM Proceedings of the SIGCHI conference on Human factors in computing systems*, 707-716.

Uitdewilligen, S., Rico, R., & Waller, M. J. (2018). Fluid and stable: Dynamics of team action patterns and adaptive outcomes. *Journal of Organizational Behavior*, 1–16.

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

van der Haar, S., Segers, M., Jehn, K., & Van den Bossche, P. (2015). Investigating the relation between team learning and the team situation model. *Small Group Research*, *46*, 50-82.

van Ginkel, W. P., & van Knippenberg, D. (2012). Group leadership and shared task representations in decision making groups. *The Leadership Quarterly*, *23*, 94-106.

Vashdi, D. R., Bamberger, P. A., & Erez, M. (2013). Can surgical teams ever learn? The role of coordination, complexity, and transitivity in action team learning. *Academy of Management Journal*, *56,* 945–971.

Walker, G. H., Stanton, N. A., Salmon, P. M., Jenkins, D. P., Rafferty, L., & Ladva, D. (2010). Same or different? Generalising from novices to experts in military command and control studies. *International Journal of Industrial Ergonomics*, *40*, 473-483.

Waller, M. J., Gupta, N., & Giambatista, R. C. (2004). Effects of adaptive behaviors and shared mental models on control crew performance. *Management Science*, *50*, 1534–1544.

Wegner, D. M. (1987). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185-208). New York: Springer-Verlag.

Weiss, E. N. (2006). The Gazogle Case. *INFORMS Transactions on Education*, *6*(3), 46-47.

Wildman, J. L., Thayer, A. L., Pavlas, D., Salas, E., Stewart, J. E., & Howse, W. R. (2012). Team knowledge research: Emerging trends and critical needs. *Human Factors*, *54*, 84-111.

Yukl, G., & Mahsud, R. (2010). Why flexible and adaptive leadership is essential. *Consulting Psychology Journal: Practice and Research*, *62,* 81-93.

Yun, S., Faraj, S., & Sims, H. P. (2005). Contingent leadership and effectiveness of trauma resuscitation teams. *Journal of Applied Psychology*, *90*, 1288-1296.

Yun, S., Faraj, S., Xiao, Y., & Sims, H. P. (2003). Team leadership and coordination in trauma resuscitation. In *Advances in Interdisciplinary Studies of Work Teams* (pp. 189-214). Emerald Group Publishing Limited.

Zaccaro, S. J., Heinen, B., & Shuffler, M. (2009). Team leadership and team effectiveness. In E. Salas, G. F. Goodwin, & C. S. Burke (Eds.), *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches* (pp. 83–111). New York: Routledge.

Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2001). Team leadership. *The Leadership Quarterly*, *12*, 451–483.

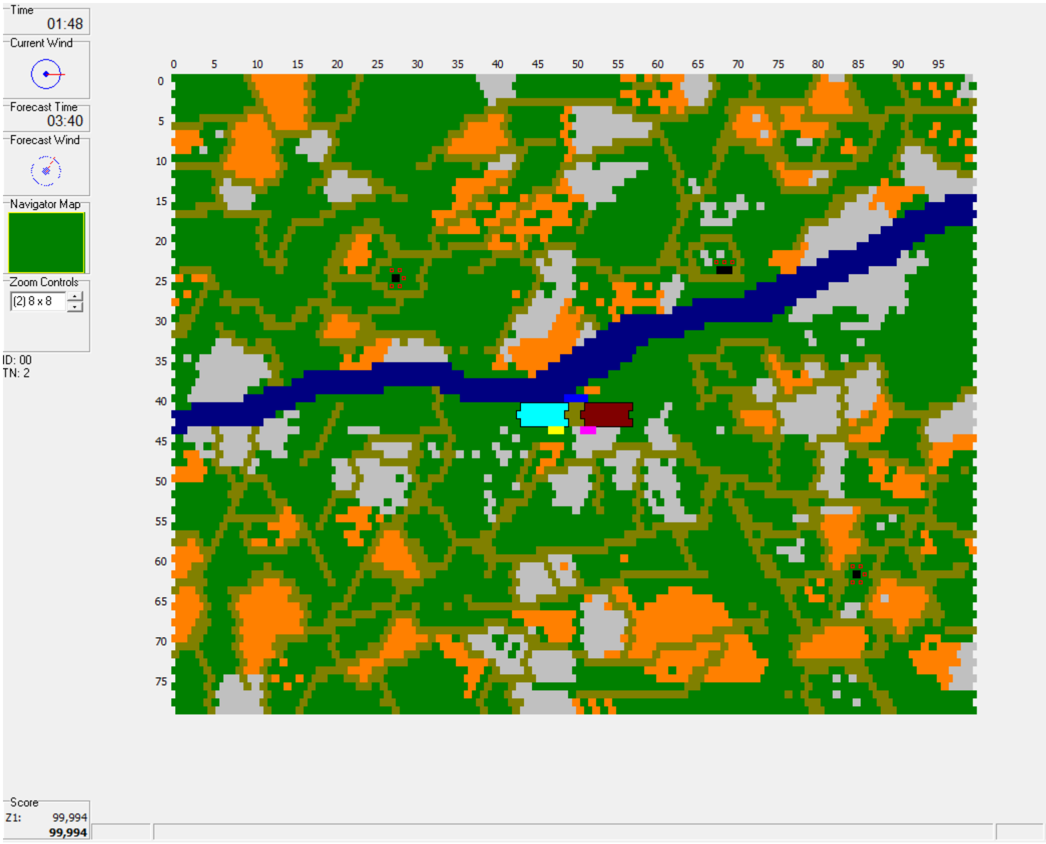
Zellmer-Bruhn, M., Waller, M. J., & Ancona, D. (2004). The effect of temporal entrainment on the ability of teams to change their routines. *Research on Managing Groups and Teams*, *6*, 135–158.

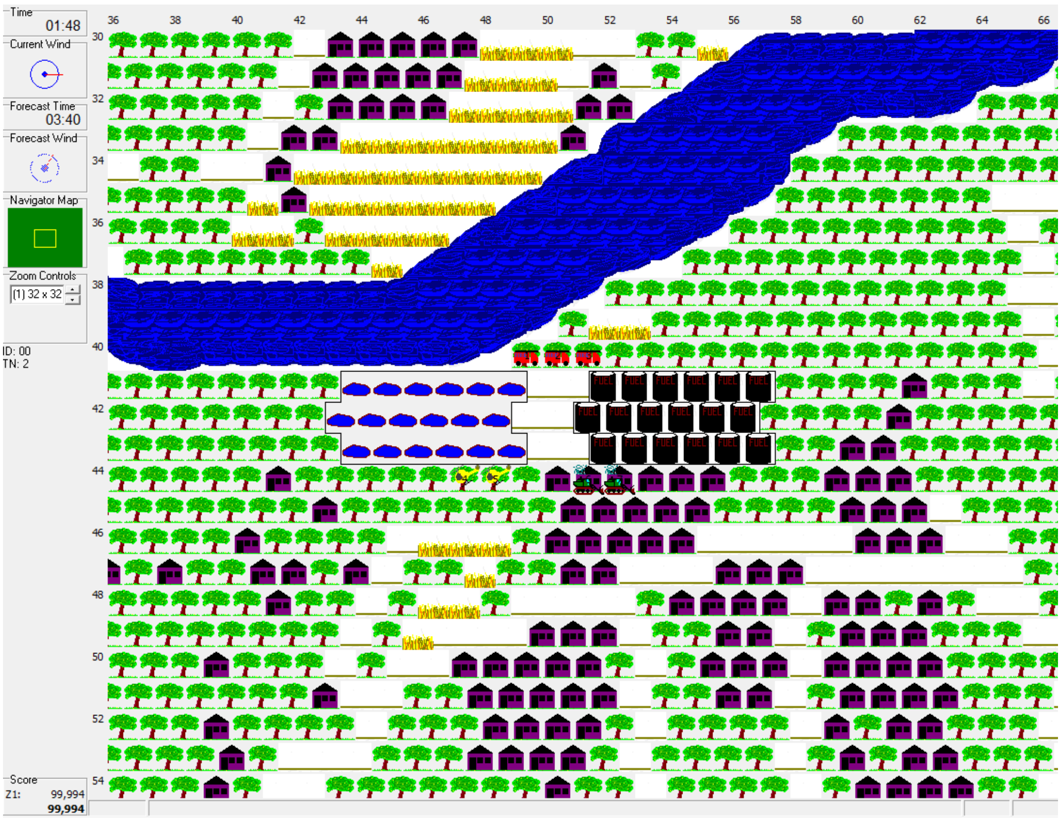
Zijlstra, F. R., Waller, M. J., & Phillips, S. I. (2012). Setting the tone: Early interaction patterns in swift-starting teams as a predictor of effectiveness. *European Journal of Work and Organizational Psychology*, *21*, 749–777.

APPENDICES

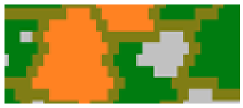
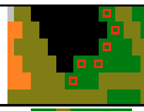
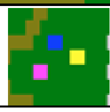
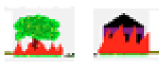
Appendix 1: Laboratory setting of the fire-fighting computer task and simulation environment

Simulation environment. General vision mode and zoom mode.



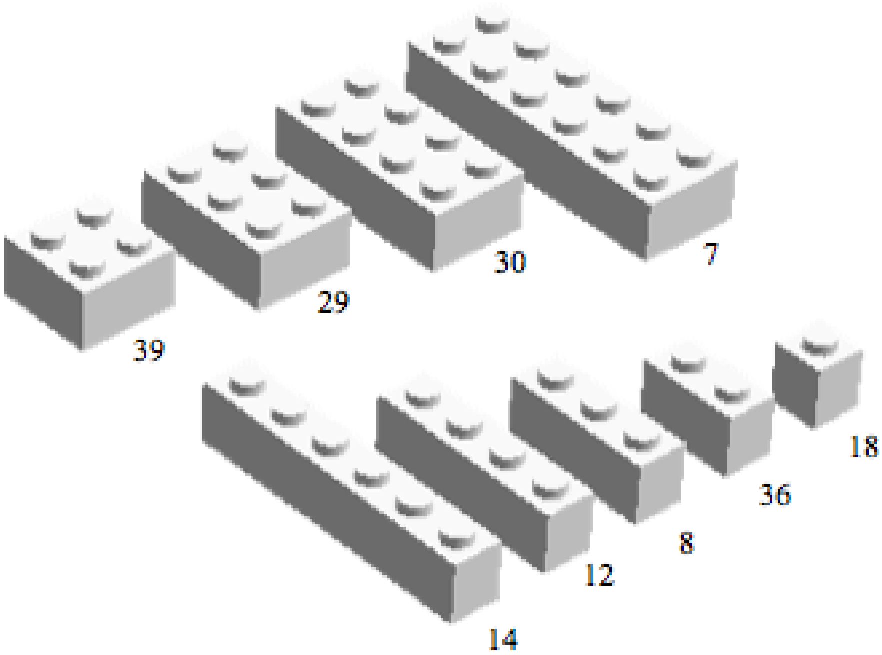


Appendix 2: Example of the instructions provided to participants on the use of the simulation

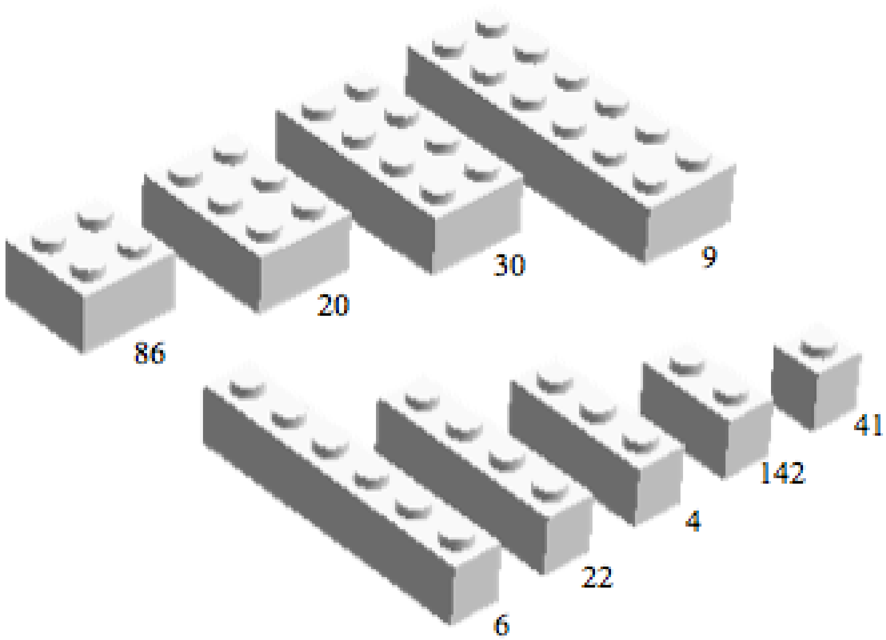
Moverse en el mapa de navegación	Pincha en el rectángulo amarillo del mapa de navegación, mantenlo pinchado y muévelo para desplazarte por el terreno. **Coordenadas:** para comunicarte con tus compañeros puedes hacer uso de las coordenadas para señalar la localización de los fuegos. 
Uso del Zoom	- Pincha en la flecha superior en "zoom controls". Cuando indique "8x8" pincha en el mapa de navegación y verás una vista completa del terreno. - Pincha en la flecha inferior en "zoom control". Cuando indique "32x32" pincha en el sitio específico del mapa de navegación que quieres acercar y verás una versión ampliada del terreno. **Para poder moverte en el terreno es necesario desactivar el Zoom** 
Identifica los terrenos	- Área verde claro: son árboles, que pueden arder - Área naranja: son pastos, que arden muy rápido. - Área verde oscuro: es tierra, que no puede arder. - Área gris: son casas - Áreas blancas/rosa: son zonas excavadas, por las que el fuego no puede extenderse. 
Localiza los fuegos	- Área negra: son zonas ya quemadas. s, que pueden arder - Recuadros rojos: son fuegos activos, pueden ser grandes o pequeños. - Cuadrados rojos intermitentes: señalan que va a iniciarse un fuego. 
Vehículos	- Cuadrados azules: camiones de bombero - Cuadrados amarillos: helicópteros - Cuadrados rosa: bulldozer 
Mueve los camiones	Pincha (y mantén pulsado) en un camión, arrástralo hasta su destino y suéltalo. Si pinchas en el camión o el marcador de destino mientras se está moviendo, el camión se parará. **Movimiento rápido:** pincha en un vehículo y arrástralo hacia el del mapa de navegación.
Extingue un fuego con un camión	Cuando el camión de bomberos esté en el fuego, pincha el botón izquierdo del ratón una vez.  Tu camión de bomberos puede extinguir pequeños fuegos pero no fuegos grandes. Los fuegos grandes pueden ser extinguidos con un helicóptero. 
Comprueba el estado de los recursos de tus vehículos	Mueve el cursor sobre un vehículo (no tienes que pinchar en él). En la barra gris al final de la pantalla se indica qué está haciendo el vehículo y qué cantidad de cada recurso le queda. Cuando el vehículo se queda sin recursos debe repostar antes de volver a usarlo. 
Recarga los vehículos	No puedes repostar los vehículos con agua o gasóleo tú solo, por lo que tendrás que pedir a otro miembro del equipo que lo haga por ti. 
Comprueba el tiempo de juego y el viento	En la parte izquierda de tu pantalla puedes ver el tiempo de la actual misión. Puedes ver la dirección actual del viento (el viento sopla en la dirección de la línea roja) y la fuerza actual del viento (el tamaño del punto azul indica la fuerza del viento). También puedes ver el viento pronosticado y el momento en el que se dará el cambio de viento. 

Appendix 3: Set of LEGO bricks given to participants during experimental sessions of the second study and models they had to build each round.

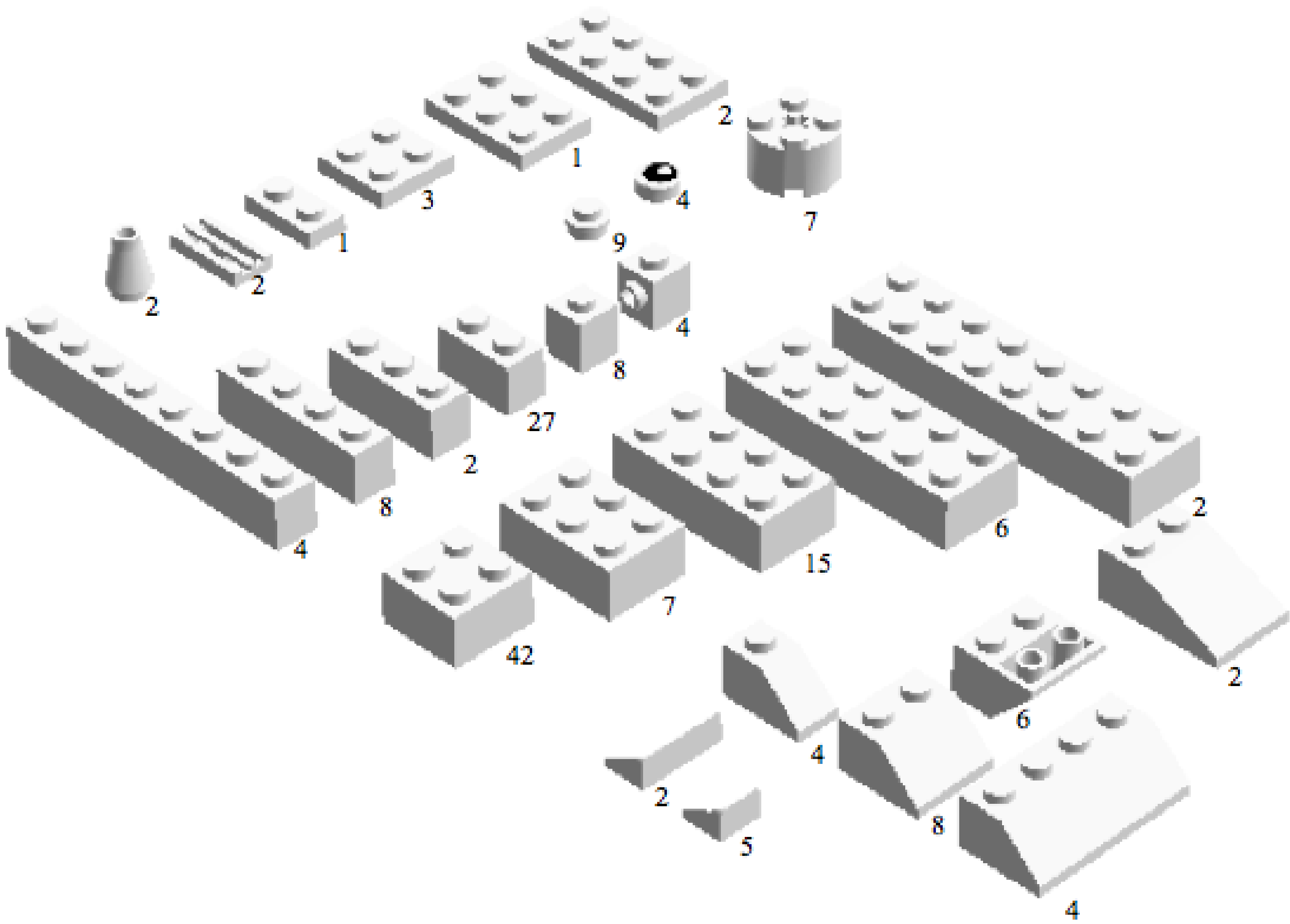
Set of LEGO® bricks given to participants during the pre-change tasks.



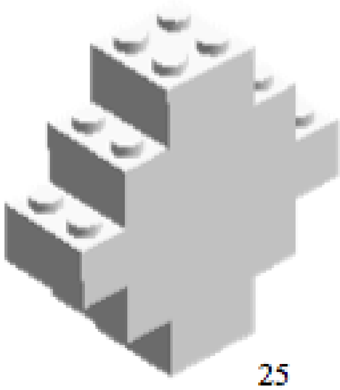
Set of LEGO® bricks given to participants during the post-change tasks in the low level magnitude of change condition.



Set of LEGO® bricks given to participants during the post-change tasks in the high level magnitude of change condition.

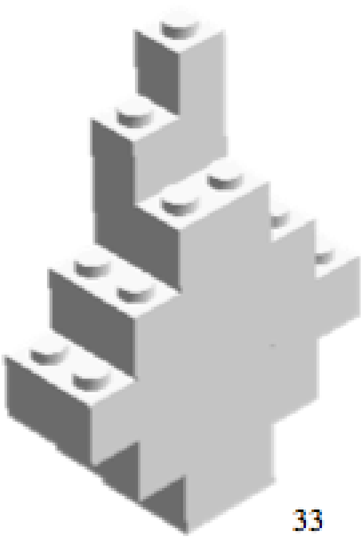


Model participants had to replicate during the pre-change tasks and maximum number of copies they could build.



25

Models participants had to replicate during the post-change tasks in the high level magnitude of change experimental condition and maximum number of copies they could build.



33

Models participants had to replicate during the post-change tasks in the high level magnitude of change experimental condition and maximum number of copies they could build.