Instituto Universitário de Lisboa
Business Research Unit

Team Adaptation in Complex Work Environments

Pedro Marques Quinteiro

Tese submetida como requisito parcial para obtenção do grau de
Doutor em Gestão e Desenvolvimento de Recursos Humanos

Supervisores
Prof. Doutor Luís Curral, Prof. Auxiliar, Faculdade de Psicologia, Universidade de Lisboa

Prof. Doutor Ana Margarida Passos, Prof. Auxiliar, Instituto Universitário de Lisboa, ISCTE-IUL, Business Research Unit

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Júri:
Professor Ramon Rico, Associate Professor, Autonomous University of Madrid
Professor Travis Maynard, Associate Professor, Colorado State University
Professor Teresa D’Oliveira, Auxiliary Professor, ISPA-IU
Professor António Caetano, Full Professor, ISCTE-IUL
Professor Luís Curral, Auxiliary Professor, University of Lisbon
Professor Ana Margarida Passos, Auxiliary Professor, ISCTE-IUL

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Don't get set into one form, adapt it and build your own, and let it grow, be like water (…) my friends.

Adapted from *Bruce Lee: A Warrior’s Journey*

Prologue

The experience of doing a PhD is sometimes inexplicable and hard to put in words. To do it is a decision almost as perilous, adventurous, and naive as when Frodo decided to take the ring to Mount Doom. Fortunately for us and for Frodo as well, we gain many great friends along the way. Some are with us since the beginning while others joined along the way, hence helping us becoming better persons and scientists.

The decision of doing a PhD project on team adaptation was an unplanned one, but that now I know has been in my mind for a long time. The topic was already in my childhood plays, my teenager hobbies, and on my first work assignments at grad school. I fought against it for a while, but through the *ups and downs* that characterize the beginning of any PhD, it naturally emerged as an good solution.

This dissertation aims to contribute to theory and practice alike, and it tells about how individuals and teams adapt to changes in their work environment. It regards a compilation of empirical papers that try to clarify what we know about the causes and conditions that drive team adaption in the work place.

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À minha mãe, ao meu pai, à minha maninha e à minha avó por sermos familia.

À Catarina, que me dá vida e a quem quero amar sempre.

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1. Abstract

Resumo

A adaptação é fundamental para a eficácia do trabalho em equipa em ambientes complexos. A literatura sugere que as características dos membros da equipa, os processos episódicos e os estados emergentes contribuem para a capacidade de as equipas se comportarem de forma adaptativa. No entanto, as causas e condições em que estas variáveis se relacionam e contribuem para a adaptação em ambientes de trabalho complexos exige mais investigação. Nesta dissertação, vamos concentrar-nos nas dinâmicas multinível, transversais e longitudinais que caracterizam o processo adaptativo. Os participantes dos estudos feitos nesta dissertação foram estudantes universitários, e trabalhadores de diversos contextos organizacionais (e.g. gestão; saúde hospitalar; policia). O teste das hipóteses de investigação foi feito através de metodologias de regressão e equações estruturais. A metodologia de regressão foi utilizada para estimar os efeitos diretos, indiretos e condicionados. A modelagem com equações estruturais foi utilizada para estimar os efeitos indiretos, multinível e longitudinais. No geral, os resultados sugerem que a performance adaptativa contribui para a eficácia das equipas em ambientes de trabalho complexos. Os nossos resultados também clarificam a natureza das relações entre as características dos membros das equipas, os processos e estados emergentes. Esta dissertação contribui para a teoria e a prática, uma vez que amplia o conhecimento prévio sobre as dinâmicas de adaptação do trabalho em equipa, e tece recomendações de como e por que razões as práticas de GRH devem incorporar os resultados desta dissertação na gestão de pessoas.

Palavras-chave: Estudos longitudinais; estudos multinível; adaptação da equipa; estados emergentes; características dos membros da equipa; processos de equipa.

Abstract

Team adaptation is paramount for effective teamwork in complex work environments. Literature suggests that team member characteristics, episodic team processes, and emergent states contribute to collective ability to behave adaptively. However, we know very little about the causes and conditions under which these constructs relate to predict adaptation and effectiveness in complex work environments requires further clarification. In this dissertation, we focus on the multilevel, cross-level and longitudinal examination of the dynamics of team member characteristics, episodic team processes, and emergent states driving team adaptation in the work place. In this dissertation data collection was done in simulated and field settings. Participants were university students and professional workers from diverse organizational settings (e.g. business; healthcare; police). Hypotheses testing were done through regression and structural equations modelling. Regression was used to estimate direct, indirect, and conditioned effects. Structural equations modelling were used to estimate indirect, multilevel and longitudinal effects. Overall, the results suggest that team adaptation contributes to team effectiveness in complex work environments. Our results also contribute to clarify the entanglement between team member characteristics, processes and emergent states in teams. This dissertation contributes to theory and practice as it extends previous knowledge on the dynamics of team adaptation, and it makes recommendations of why and how HRM practices should incorporate our findings in people management.

Key-words: Longitudinal research; multilevel research; team adaptation; team emergent states; team member characteristics; team processes.

Sumário Executivo

A complexidade crescente dos ambientes organizacionais coloca à Gestão um grande desafio: Identificar e promover, junto das equipas de trabalho, as competências, comportamentos e conhecimentos mais relevantes para a eficácia colectiva em situações de imprevisibilidade. A adopção de equipas pelas organizações tem surgido principalmente pelos níveis de produtividade e eficácia que as equipas são capazes de alcançar. Um relatório da Fundação Europeia para a Melhoria das Condições de Vida e Trabalho mostrou, que em 2001, entre 55% e 64.9% das organizações Portuguesas tinham as suas pessoas organizadas em equipas de trabalho. Um outro estudo levado a cabo pelo Centro para o Estudo das Equipas de Trabalho revelou que, no início do milénio, 50% das organizações da lista Fortune 500 estavam a implementar modelos de gestão organizacional assentes no trabalho em equipa.

Um desafio particularmente relevante com o qual as empresas em geral, e a Gestão de Recursos Humanos em particular, têm de lidar frequentemente é a necessidade de promover comportamentos adaptativos (i.e. performance adaptativa) junto dos seus colaboradores e equipas de trabalho.

Nesta tese de doutoramento o objectivo foi o de aumentar o conhecimento existente sobre os factores facilitadores e inibidores da adaptação das equipas, tentando perceber por que razão algumas equipas se adaptam aos imprevistos e adversidades, enquanto outras fracassam. Para o efeito, realizaram-se 4 estudos onde se procurou compreender em que medida a coordenação, capacidade de refletir, e os sistemas de memória transitiva das equipas de trabalho contribuem para a adaptação e eficácia em contexto empresarial, policial e hospitalar. Para além da análise do impacto de variáveis de natureza comportamental e cognitiva, foi ainda considerado o impacto que a auto-liderança e a coesão dos membros das equipas têm nos mecanismos conducentes à adaptação.

A análise dos dados recolhidos através de questionários previamente validados e adaptados à população Portuguesa, e o cruzamento com medidas de objectivas de desempenho obtidas em alguns dos estudos realizados, revelou os seguintes resultados:

- Os processos de coordenação e reflexividade contribuem positivamente para a adaptação e eficácia das equipas de trabalho.
- A existência de sistemas de memória transitiva beneficia os processos de coordenação e a adaptação, mas quando em excesso torna-se prejudicial.

- Níveis elevados de coesão, no início de projetos em contexto empresarial, estão associados a quebras significativas na coordenação e adaptação das equipas ao longo do tempo.

Os resultados encontrados nesta tese de doutoramento vêm ajudar a clarificar a natureza das relações entre conceitos chave da literatura de trabalho em equipa. Estes resultados são igualmente importantes para informar os profissionais da GRH acerca de quais os processos e cognições a serem tidos em consideração aquando do desenho estratégico da gestão do capital humano nas organizações do século XXI.

Palavras-chave: Adaptação de equipas; auto-liderança; coordenação; eficácia; reflexividade; sistemas de memória transitiva.

Part I

2. Introduction

General overview of the dissertation

> “The marine research team had been submersed for six hours. Their mission was to collect organic samples from the ocean floor, ten thousand meters below the surface. The space available inside the submarine was limited, with only five square meters for three crew members to share. Team members were familiar with each other and had previous experience working together in similar assignments. Near the bottom of the ocean the submarine’s main spotlight was damaged during a particularly difficult manoeuvre, hence significantly reducing visibility in the area around the submarine. For ten minutes, the crew tried to think about what they knew they could do to solve the problem, and how they could avoid compromising the mission. But it was until one of the crewmembers remembered the backup illumination system that they had on board and how they could use it to get light outside again. As quickly as it came, the grimness that had installed between crewmembers disappeared. The crew members coordinated their efforts to fix the illumination system and the team continue the mission.”

The study of team adaptation is fundamental to enrich our understanding of how individuals collaborate to overcome obstacles to performance, and last beyond unexpected incidents. Understanding team adaptation in the workplace is important to help the design of training programs that will leverage human capacity to engage in collaborative action under social and economic crisis, and emergency situations.

This dissertation was developed within the scope of teamwork and team adaptation literatures, whose primary concern is to understand team adaptation in organizations. Research on team adaptation has been fruitful. However, in the words of authors such as Marks, Mathieu and Zaccaro (2001), Burke, Stagl, Salas, Pierce and Kendall (2006), or Maynard, Kennedy and Sommer (2015), what we know about team adaptation is still insufficient to give us a clear vision of what it is, and how it unfolds across levels and time. According with Marks and colleagues (2000) what determines a team's ability to sustain effective performance when confronted with novel elements in a performance environment is still unclear. Hence, this dissertation’s research questions is: *How do teams adapt to unpredictable events happening in the work place*? Plus, this dissertation tries to answer to a more specific research question: *why do some teams adapt more efficiently than others?*

Team Adaptation

The rationale behind this dissertation follows from Burke and colleagues' (2006)[1] conceptual model of team adaptation; hence we define team adaptation as "change in team performance, in response to a salient cue or cue stream that leads to a functional outcome for the entire team. Team adaptation is manifested in the innovation of new or modification of existing structures, capacities, and/or behavioural cognitive goal-directed actions" (Burke et al., 2006, pp. 1190)[2]. Similar to Burke and colleagues (2006) our framework regards the cross sectional, and longitudinal phenomena that shape group behaviour, and give particular emphasizes to the relation between group processes, emergent states and teamwork outcomes. This dissertation concerns the role of individual and shared team members' characteristics as contextual variables that shape the dynamics of team adaptation in the work place.

This dissertation is organized in 10 chapters, dived across three different parts.

In the first part, this dissertation regards chapters 1 to 4. Chapter 1 regards the abstract and executive summary of the dissertation. In chapter 2 we present our main research question and we briefly describe how we are going to answer it. In chapters 3 and 4, we present the main body of theory in which this dissertation is grounded. We present and discuss current views of what a work team is, and what team adaptation is. Throughout these two chapters we will introduce some of the most predominant theories of team adaptation.

In the second part of this dissertation, we present four empirical studies with team adaptation as the unifying topic. In chapter 5, we develop and validate the adaptive performance scale for individuals and teams. The development of this scale was motivated by the apparent lack of practical scales to measure adaptive performance in the field. Plus, the use of this scale was important to the concretization of all other studies in this dissertation. In chapter 6 we test whether team reflexivity mediates the relationship between team member self-leadership and team innovation, under conditions of high and low transitive memory systems. In this study team innovation is regarded as a particular form of team adaptation, as proposed by Burke and colleagues (2006).

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1 The ideas and results that emerge from this dissertation are also embedded in recent perspectives on team adaptation proposed by Baard and colleagues (2014), and Maynard and colleagues (2015). However, further considerations on both contributions will be developed in chapter 4.

[2] As Baard and colleagues (2014), we want to clearly state that in this dissertation we regard adaptation as response or the outcome of change regarding to a task, job, or work (rather than career or organizational change).

Table 1 - Summary of empirical studies.

Study	Research question	Reference
1 – Measuring adaptive performance in individuals and teams.	Do composition referent-shift aggregation models offer a good solution to measure adaptive performance in individuals and teams?	For this study please regard the published version under reference Marques-Quinteiro, P., Ramos-Villagrasa, P., Passos, A. M., & Curral, L. (in press). Measuring adaptive performance in individuals and teams. *Team Performance Management*.
2 – Self-leadership, reflexivity and innovation in teams: Transactive memory systems' moderating role.	Does team member self-leadership positively contributes to the relationship between team reflexivity and team innovation? Can transactive memory systems improve this relationship?	Marques-Quinteiro, P., Curral, L., Passos, A. M., Lewis, K., & Gomes, C. (waiting final decision). Self-leadership, reflexivity and innovation in teams: Transactive memory systems' moderating role. *Small Group Research*.
3 – And now what do we do? The role of transactive memory systems and task coordination in action teams.	Does team implicit coordination positively contributes to the relationship between team adaptive behaviour and team performance? Can transactive memory systems improve this relationship?	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*(3), 194.
4 – The higher they climb the harder they fall: A temporal examination of team adaptation	Is the temporal evolution of team adaptation sensitive to team initial conditions? Do team coordination trajectories mediate the relationship between team initial cohesion and team adaptation trajectories over time?	Marques-Quinteiro, P., Passos, A., Curral, L., & Rico, R. (under review). The higher they climb the harder they fall: A temporal examination of team adaptation. *Journal of Applied Psychology*

In chapter 7, we test if team adaptive behaviour mediates the relationship between team implicit coordination and team performance, under conditions of high and low transactive memory systems. Please not that although we have utilized the word "behaviour" instead of "performance", we regard them as synonymous (e.g. Baard, Rench & Kozlowski, 2014; Burke et al., 2006; Pulakos et al., 2000). Finally, in chapter 8 we examine how team coordination trajectories over time mediate the relationship between team initial cohesion and team adaptation. While in the tree first studies we have regarded adaptation as a change in behaviour, in the final study we regard adaptation as a change in results.

Table 1 summarizes these studies. The four empirical studies that encompass this dissertation expand Burke and colleagues (2006) “plan execution phase” during the adaptive cycle, and further extend the contribution a newer conceptual model of team adaptation proposed by Maynard and colleagues (2015).

Finally, in Part III we include chapter 9 and 10 (chapter 10 regards the references utilized across the dissertation). Chapter 9 is devoted to the general discussion and major conclusions that we can extract from this dissertation. In chapter 9, we also try to formulate the take-home message of this dissertation, and we point future directions for the thinking and doing of team adaptation research.

3. Teams and work groups

Teams and work groups

The Universe started with an inaudible bang. To the best of our knowledge, it all began with a cosmic explosion that 4.57 billion years ago led, among many other things, to what today we call Planet Earth (Sagan, 1980). It than took nearly 4.56 billion years of meteorite bombardment, acid rain, gigantic storms, Cambrian explosions, continental drifts, mass extinctions, lighting fires and dramatic climate changes for the first modern humans to walk on the planet (Dawkins, 2006, Sagan, 1980). Miraculously, 200.000 years later we are still here to tell a story. Humans have endured beyond wild beasts, dreadful climate, disease, starvation and war. Humans have invented *culture* and *religion*, created empires, travelled through space, and managed to become the dominant species on the planet so far. How was this possible? Somewhere along the way, individuals learned that either when hunting, fighting or harvesting, to collaborate with others often led to better outcomes than doing things alone (Dawkins, 2006). Indeed, working in groups increased the chances of success and those who have learned to collaborate and adapt have prevailed (Darwin, 1859).

Defining the construct of team

In this dissertation we adopt Hackman (1987) conceptualization of work teams as a "rule of thumb" to allow using the concepts of "work group" and "work team" interchangeably. We consider that both describe a collective of two or more highly interdepend individuals that share communal goals and that must work together to achieve their purpose (Hackman, 1987). Although several authors differentiate dyads from larger entities (Kozlowski, Gully, Nason, & Smith, 1999; Wegner, 1987), in this dissertation we will consider dyads as work groups as well. In this dissertation we regard work groups "as (a) two or more individuals who (b) socially interact (face-to-face or, increasingly, virtually); (c) possess one or more common goals; (d) are brought together to perform organizationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and outcomes; (f) have different roles and responsibilities; and (g) are together embedded in an encompassing organizational system, with boundaries and linkages to the broader system context and task environment" (Kozlowksi & Ilgen, 2006, p. 79).

Finally, we further think of teams as adaptive and dynamics systems that are influenced by interactions occurring within the work group, and between the group and the work environment; and teams are here regarded as loosely coupled systems of interacting and interdependent members, with a shared purpose and identity (Arrow, McGrath & Berdahl, 2000).

The team work imperative

From the multitude of human daily activities, work is one of the most time consuming and resource-demanding activities performed by any human being. If we take the average life expectancy in western countries to be 80 years and assume that most people work at least for 35 years before they can retire (http://www.pordata.pt/), we find that we spent around 43.75% of our lives working. In the year 2012 alone, 79.3% of the Portuguese population spent around 34.7 hours per week at work. This means that 28.9% of our weekly time was dedicated to work related activities.

Also worth of mentioning is a report by the European Foundation for the Improvement of Living and Working Conditions showing that between 55% and 64.9% of the Portuguese organizations were team based in 2001. Moreover, the United Kingdom (80.6%) and Italy (40.9%) were the European countries with the highest and lowest team work based organizations rates. Additionally, a study by the Center for the Study of Work Teams in the year 2000 has shown that 80% of the Fortune 500 companies reported they expected to have 50% of their work force organized in teams by the end of the year (www.workteams.unt.edu).

According to authors like Hackman (1987, 2012), LePine, Piccolo, Jackson, Mathieu, and Saul (2008) or Rico, Hera and Tabernero (2011), organizations have perceived work teams to be a more competitive asset in these *modern times*. Despite Taylors and Fords' approaches to the design of work in the beginning of the 20th century, the great World Wars and the advent of technology have brought the imperative of collectives back to organizations (Chambel & Curral, 2008). Work groups can achieve beyond isolated individuals and the outcomes that emerge from the dynamics between interdependent team members are far more effective than the actions of isolated individuals (Goodwin, Burke, Wildman, & Salas, 2009; D'Oliveira, Rodrigues & Vicente, 2014; Ilgen, Hollenbeck, Johnson & Jundt, 2005; Kozlowski & Ilgen, 2006; McGrath & Argote, 2001). Indeed, teams can allocate more resources, are more effective in solving complex tasks (Guastello & Guastello, 1998), and manage unexpected events better (LePine, 2005).

Team effectiveness in complex work environments

The devil is in the complexity

Embarking in an underwater mission to Mariana's Trench, engaging in a swift rescue mission inside a *Favela*, or responding to a hostile takeover from a rival company are all professional activities that are complex in the sense they are physically, cognitively and emotionally demanding (Goodwin et al., 2009; Manzey & Lorenz, 1998). Organizational scientists, and professionals acknowledge that many work environments these days are *charged* with complexity as tiny changes in the organizational system can cause dramatic transformations latter on (Hackman, 2012; Kozlowski & Ilgen, 2006; Mathieu, Maynard, Lucy & Gilson, 2008). This complexity seems to emanate from such factors as technology, unpredictability, and people exchanging information across organizational levels, and over time (Hackman, 2012; Marion, 1999; Pulakos et al., 2000). Indeed, complex work environments are those that "possess (…) physical, psychological, and interpersonal demands that require significant human adaptation for survival and performance" (Manzey & Lorenz, 1998, p.4). Furthermore, complex work environments characterize by self-organized and interdependent phenomena that unfold nonlinearly over time. Throughout this dissertation, we will examine the individual and team level characteristics that drive human adaptation in such environments.

The Input-Process-Output framework

Over the years, several path based models have been proposed to help researchers and practitioners understand team work dynamics (Hackman & Morris, 1975; Kozlowski et al., 1999; Ilgen et al., 2005; Marks, Mathieu & Zaccaro, 2001). Hackman and Morris (1975) proposed a model of Input-Process-Output (I-P-O) that was much based on the metaphor of the Human brain as a computer. The authors advocated that team behaviour (i.e. processes) would be enacted by stimulus (inputs) that would lead to results (outcomes). Although this approach was widely implemented and had great impact in many researches, scholars agree that it offers a limited perspective on teamwork because it disregards *time*, among other shortcomings (Ilgen et al., 2005; Marks et al., 2001). This assumption is based on three arguments: First, Marks and colleagues (2001) have stated that many constructs that are presented by researchers as being group processes are actually emergent cognitive or affective states (group processes and emergent states are defined in the following pages). Second, I-P-O models imply a single linear cycle of relation and give little space to the inclusion of other forms of causal relations like feedback loops. Third, I-P-O assumes linear relations from input to output, when the majority of the phenomena happening between I and O are less than linear (Ilgen et al., 2005). Interactions, as an example, are fairly common and it is not unlikely to observe that group variables like emergent states amplify or reduce the impact that certain group processes have on group outcomes when a certain input happens (Marks et al., 2001).

Single (team) level dynamics in teams

The limitations that characterize the I-P-O approach gave way to a model of episodic team processes proposed by Marks and colleagues (2001) that takes into account the role of team emergent states (i.e. “constructs that characterize properties of the team that are typically dynamic in nature and vary as a function of team context, inputs, processes, and outcomes; Marks et al., 2001, p. 357) (S): I-P-S-O. By including the role of team states in Hackman and Morris’ (1975) theoretical framework of team work, Marks and colleagues (2001) propose that team states persist over time until other processes change them or vice-versa (which introduces the notion of reciprocal relation between processes and emergent states).

According with Marks and colleagues (2001, p.357), team processes refers to “members’ interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioural activities directed toward organizing task work to achieve collective goals”. Team processes are the directly observable interactions between team members, and have different roles in the prediction and facilitation of adaptive behaviour. The episodic approach to the study of teamwork proposed by Marks and colleagues (2001), and later revised by LePine and colleagues (2008), has led to the identification and validation of three main clusters of groups’ processes, whose relevancy to team outcomes varies in time. According to Marks and colleagues (2001), performance episodes shift between a transition episode and an action episode. Transition episodes allude to the time interval in the team performance cycle during which team members prepare to change their current status quo, and define an action strategy (e.g. the beginning of a new project; a change in the action plan). Action episodes refer to the time interval in which work teams act upon the situation following any decisions made previously, during the transition episode. Along these episodes, whose duration can vary depending on the characteristics of the team (e.g. diversity; training) and its embedding context (e.g. task complexity; environmental traits), work teams can exhibit three main processes: Transition processes, action processes, and interpersonal processes. Transition processes involve team behaviours that contribute to group planning, and to the design of adequate strategies that guide the processes through which teams strive until they accomplish their objective(s) (Marks et al., 2001). As teams engage in problem solving, action processes take place and include those team behaviours that contribute directly to goal accomplishment (Marks et al., 2001). Interpersonal processes can coexist, and coevolve, with both transition and action processes providing teams with the necessary emotional and motivational tools to work together in a sustainable fashion (LePine et al., 2008).

Marks and colleagues (2001) also maintain that work group processes do not happen isolated from indirectly observable group properties such as emergent states. Team emergent states derive from team members' interactions, and manifest at multiple levels (e.g. dyads; groups), and over time. These result from a derived combination of individual team members' characteristics such as knowledge, skills, and attitudes, and often emerge as cognitions. Team cognition regards collectively shared mental representations of key elements of the team relevant environment (Klimoski & Mohammed, 1994) that contribute to group processes and outcomes. Team cognition describes knowledge that is equally shared across team members (i.e. shared mental models), and knowledge that is stored and shared across experts within the team (i.e. transactive memory systems) (Kozlowski & Ilgen, 2006; Zajac et al., 2013).

Ilgen and colleagues (2005) have later generalized Marks and colleagues' (2001) episodic approach to an Input-Mediator-Output-Input (IMOI) model of team work by proposing that processes and states can all be regarded as I, M or O. The authors suggest that a variable that starts as an input can become a mediator, a moderator, and even an output somewhere in the team life cycle.

Although this perspective might give the feeling that *everything goes* when it comes to understand what causes team adaptation in the workplace, in fact it illustrates the true nature of teamwork in complex environments. Indeed, Cronin, Weingart and Todorova (2011) have claimed that the two models together describe two characteristics that are paramount to the study of group dynamics: memory and recursion.

According to Cronin and colleagues (2011), the memory of a system is its capacity to store the effects of past experiences. It is *embodied* in a group's state (e.g. cognitions and affects) and in the idea that Y is an output (O) at time 1 but can later be an input at time 2. This notion also relates to Hackman's (2012) idea of sensitiveness to initial enabling conditions because memory brings path dependency. Path dependency means that current conditions will eventually have some degree of influence (e.g. mediate, moderate or both) in what happens next in the team performance cycle. Furthermore, it also means that a single variable can have multiple effects on a single group dynamics and that much depends on the conditions (e.g. time; context) it happened before (Hackman, 2012; Ilgen et al., 2005).

While path dependency (i.e. memory) is paramount to understand a sequence of events, recursion is all about reciprocity over time (Cronin et al., 2011). This means that path dependent systems might also have a reciprocal influence over time, with memory and feedback loops adding non-linearity to the longitudinal relation between path constituents. Together, the recursive relation between states and processes (Marks et al., 2001) and the looping relation between inputs, mediators and outcomes (Ilgen et al., 2005) incorporate the notions of non-linearity and time between constructs that are path dependent. Synthetizing the role of these two constituents: "whereas memory makes groups dynamic by inducing path dependence, feedback loops introduce nonlinearity and inertia into trajectories of group evolution" (Cronin et al., 2011, p. 580).

4. Team adaptation

Team adaptation

Until Burke and colleagues (2006), very few studies had made such a great contribution to our full understanding of what is team adaptation, how it is triggered, and what processes and emergent states compile across levels and time to restore balance in the team's system. Besides Burke and colleagues (2006), it took ten years until two other conceptual papers addressing team adaptation were out. One paper was developed by Baard and colleagues (2014) regarding a taxonomy of performance adaptation. The other paper was Maynard's and colleagues (2015) review of fifteen years of research on team adaptation, and how the field needs to adapt and move forward.

In this chapter we will start by presenting a synthesis of how team adaptation has been defined in the literature. We will than offer a synthesis of the debate and conclusions drew in the works described in the previous paragraph.

Definitions of team adaptation

Others before us have performed a comprehensive and extensive review of team adaptation definitions in the teamwork literature (for a deeper description of the existing definitions please see Baard et al., 2014; and Maynard et al., 2015). In order to avoid redundancy, we have decided to present a parsimonious collection of team adaptation definitions that are presented in chronological order, in Table 2.

Conceptual models of team adaptation

In this section we provide a summary of the most influential conceptual contributions on team adaptation in organizations. The works described next are also chronologically ordered.

Burke and colleagues (2006) input-throughput-output model of team adaptation

According to Burke and colleagues (2006), adaptation to unexpected events can be maximized through the implementation of teams because collectives possess a broader repertoire of capacities, experiences and networks to rely on when responding to change. As individuals in teams interact dynamically with each other, thus providing

Table 2. Definitions of team adaptation.

Authorship	Definition
Cannon-Bowers, Tannenbaum, Salas & Volpe (1995)	The process by which a team is able to use information gathered from the task environment to adjust strategies through the use of compensatory behaviours and reallocation of intra-team resources.
Kozlowski, Gully, Nason & Smith (1999)	Capability of the team to maintain coordinated interdependence and performance by selecting an appropriate network from its repertoire or by inventing a new configuration. Thus, adaptability refers to a metamorphic shift in the team network in the short term to deal with the performance demands of a nonroutine task.
Marks, Zaccaro & Mathieu (2000)	The ability to derive and use new strategies and techniques for confronting novel elements in their environment.
Klein & Pearce (2001)	Teams that are able to make the necessary modifications in order to meet new challenges.
Kozlowski, Toney, Mullins, Weissbein, Brown & Bell (2001)	The generalization of trained knowledge and skills to new, more difficult, and more complex task situations.
McGrath & Argote (2001)	Reciprocal changes in the group as a system, and in parts of its embedding contexts, that arise subsequently to actions and events in the embedding systems that have implications for the group.
Fleming, Wood, Dudley, Bader & Zaccaro (2003)	Functional change in response to altered environmental contingencies and a higher order process that emerges from an integrated set of individual attributes.
LePine (2003)	Reactive and no scripted adjustments to a team's system of member roles that contribute to team effectiveness.
Burke, Stagl, Pierce, Salas & Kendall (2006)	Change in team performance, in response to a salient cue or cue stream that leads to a functional outcome for the entire team. Team adaptation is manifested in the innovation of new or modification of existing structures, capacities, and/or behavioural cognitive goal-directed actions.
DeRue, Hollenbeck, Johnson, Ilgen & Jundt (2008)	It is a team-level behavioural change.
Marques-Quinteiro, Curral, Passos & Lewis (2013)	Those team behaviours that are enacted as a response to changes in the team task environment.

cues and information regarding the task, team members must coordinate both individual and collective action in order to be effective.

Burke and colleagues (2006) offer important insights regarding how such concepts as team learning, team innovation and team performance management are related, and can contribute to team adaptation.

Burke and colleagues (2006) regard team learning (i.e. the process through which relatively permanent changes occur in the behavioural potential of the group as a result of group interaction activities though which members acquire, share, and combine knowledge; Edmonson, 1999) as paramount to the team adaptive cycle because it helps updating team cognitions, hence facilitating future team adaptation. Team innovation is another concept that is close to team adaptation. It is defined as the creation and implementation of new ideas in the team setting for the purpose of improving the group and/or organization in some way, and an improvement on existing products or processes due to use or experience (West, 2002). Although both phenomenon are purpose driven, iterative, and the result of cognitive or behavioural actions carried out with the team´s goals as the overarching priority, they remain independent constructs. Not only team innovation in often described as more of a process rather than an output (Garcia & Calantone, 2002), as also innovation is an antecedent of adaptation (Katila & Ahuja, 2002) and, contrary to innovation, adaptation always leads to an effective outcome.

Burke and colleagues (2006) also mention the concept of adaptive team performance. According to Campbell, McCloy, Oppler & Sager, (1993), *performance* is neither the result nor outcome of action, but the action in itself. It is a proxy for team effectiveness (Cronin, Weingart & Todorova, 2011) and it regards the behaviours in which individuals, dyads and groups engage to reach a desirable outcome (e.g. adaptation). Burke and colleagues' (2006) conceptual model of team adaptation suggests that adaptive team performance is the temporal proxy of team adaptation. Adaptive team performance is defined as "*an emergent phenomenon that compiles over time from the unfolding of a recursive cycle whereby one or more team members use their resources to functionally change current cognitive or behavioural goal-direct action or structures to meet expected or unexpected demands"* (Burke et al., 2006: 1192). Adaptive team performance regards the multilevel and longitudinal dynamics occurring in the team, as team inputs (i.e. individual and job design characteristics), leading to team throughputs (i.e. emergent states and adaptive cycle's processes), and leading to team outputs (i.e. team adaptation, team innovation, and team modification). Burke and colleagues' (2006) adaptive team performance cycle sustains that team members' lower and higher-level properties dynamically interact over time and across levels to predict team adaptation. Rosen and colleagues (2010) further suggest that adaptive team performance emerges from the evolutionary dynamics occurring within individuals and dyads and that it is qualitatively distinct from individual and dyadic adaptive performances. Additionally, Burke and colleagues (2006) argue that adaptive team performance is a nonlinear process of continuous discontinuities of adaptation, where teams engage in cycles of adaptive performance until they achieve adaptation. In Burke and colleagues (2006), team adaptation is regarded the outcome of team adaptive performance.

Baard and colleagues (2014) taxonomy and architecture of adaptive performance

In Baard and colleagues (2014), the authors have identified more than twenty definitions of adaptation in the work place. Baard and colleagues (2014) made a first valuable effort to tackle the over-abundance of definitions available in the literature by putting forward one taxonomy of adaptation, hence developing an overarching constructed which they named: performance adaptation: the "*cognitive, affective, motivational, and behavioural modifications made in response to the demands of a new or changing environment, or situational demands*" (Baard et al., 2014, p.3). Baard and colleagues (2014) regard adaptation as a team output, and adaptive performance as the process that leads to team adaptation.

According with Baard and colleagues (2014), performance adaptation has been examined under two conceptually distinct (but complementary) approaches: The domain-general approach, and the domain-specific approach.

The domain-general approach perspective assumes that adaptation can be captured through relatively stable or isolated events that contribute as markers of adaptation, and that can be generalized across domains. This perspective regards performance adaptation as a configuration of attributes that generally describe the unit's (e.g. individuals; teams) ability to adapt. Additionally, the domain-general taxonomy approach to performance adaptation includes the study of adaptation as a performance construct (e.g. Pulakos and colleagues 2000), and the study of individual differences (e.g. adaptation as a trait or an acquired skill; Pulakos et al., 2002). Although it is more simple and practical to measure, the domain-general approach gives a less dynamic and realistic overview of the mechanisms that drive performance adaptation in the workplace.

Differently from the domain-general approach, the domain-specific approach proposes that performance adaptation cannot be generalized across domains because it is case specific. For instance, it argues that how adaptation oriented behaviours such as coordination and backup unfold may change between work contexts and within events. It can change between work contexts because coordination in decision making teams (e.g. top management teams; emergency management teams) can be different from coordination in action teams (e.g. fire fighters; police special forces). The domain-specific approach sustains that performance adaptation unfolds over time, as individual and groups interact. Furthermore, performance adaptation is regarded as dynamics phenomenon from which group processes (e.g. coordination) and emergent states (e.g. mental models) interact towards goal achievement (i.e. cope with change) (Baard et al., 2014); and it regards adaptation as a performance change (e.g. Burke et al., 2006), and a process (e.g. Maynard et al., 2015). On a personal interpretation of Baard and colleagues (2014) conceptual work, while domain-general approaches seem to be more often utilized in individual level research, domain-specific approaches are more prevalent in team level studies.

Finally, Baard and colleagues (2014) put forward a multilevel conceptual architecture for adaptation in which understating and theorizing about adaptation is proposed to be grounded in the triadic relation happening between a) focal level (i.e. individual, team, or unit), b) adaptive process mechanisms (i.e. cognitive, affective/motivational, or behavioural), and c) task complexity changes (i.e. component, coordinative, and dynamic). The authors acknowledge that the complexity that drives team adaptation can be better understood if researchers and practitioners are capable of theorizing and measuring team adaptation within this tree-dimensional architecture. Combining this approach with the taxonomy of performance adaptation would enhance the accuracy of the theoretical background that is used in research to create the arguments that lead to hypotheses and methodologies. Plus, the combination of both conceptual tool would reduce the current messiness in adaptation literature.

Maynard and colleagues (2015) nomological network of team adaptation

Building on Burke and colleagues (2006) conceptual model of team adaptation, and Baard and colleagues (2014) taxonomy, Maynard and colleagues (2015) put forward a timely contribution: to review fifteen years of team adaptation research, and to propose a nomological network of team adaptation. Maynard and colleagues (2015) suggest team adaptation as an overarching construct that is grounded both in Marks and colleagues (2001) episodic team processes model, and Ilgen and colleagues (2005) IMOI approach. Maynard and colleagues (2015) propose a nomological network of team adaptation regarding the constructs of team adaptability, team adaptation process, and team adaptation outcomes. Team adaptability is operationalized as “the capacity of a team to make needed changes in response to a disruption or trigger” (Maynard et al., 2015, p. 4). Adaptability can be regarded as an input to team adaptation, and as an attribute like feature of teams resulting either from previous experience, or team characteristics. Team adaptability is expected to feed in team adaptation process, which is the “adjustment to relevant team processes, in response to the disruption or trigger giving rise to the need for adaptation” (p. 5). Team adaptation processes regard action, transition and interpersonal processes that are likely to combine with team mediators (e.g. coordination; cognition) to produce team adaptive outcomes. Following the IMOI logic, team adaptive outcomes are “the consequences of the adaptation process” (p. 3), and might include other team adaptation processes (e.g. transition adaptation leading to action adaptation), mediators (e.g. shared mental models), and effectiveness (e.g. productivity).

In building a nomological network of team adaptation, Maynard and colleagues (2015) have also developed a series of propositions regarding some boundary conditions to the team adaptation process, and team adaptation outcomes. The authors have considered the role of triggers of team adaptation by suggesting that whether teams engage in action, transition, or interpersonal adaptation processes are contingent on what trigger (task-based versus team-based) is activated in the team environment. Maynard and colleagues (2015) further add to this model by stating that transitions between adaptation processes will depend on the severity of the triggers. However, and as Maynard and colleagues (2015) clearly stress, there is yet much to learn and explore regarding the nomological network of team adaptation.

A brief comment on team adaptation models

The entanglement between the works described in this section gives us a comprehensive understanding of the interconnectedness between complementary views of what is team adaptation. In Burke and colleagues (2006) we are presented with a perspective of adaptation as the outcome of an adaptive performance cycle of multiple inputs-throughputs-outputs that compile over time. Burke and colleagues (2006) argue that how teams adapt to unexpected situations is the result of the combined interaction between individual characteristics, processes within the adaptive cycle, and team emergent states. Maynard and colleagues (2015) add to our knowledge of what is team adaptation by expanding Burke and colleagues (2006) idea of team adaptive performance, and merging it with Marks and colleagues (2001) episodic view of performance. While in Burke and colleagues (2006) the role of time was shyly present, in Maynard and colleagues (2015) time is what gives structure to the nomological network of team adaptation. Team adaptation is regarded as one phenomenon that is sensitive to the team's past (i.e. adaptability), the team's present (i.e. team adaptation process), and the team's future (i.e. team adaptation outcomes). Finally, in Baard and colleagues (2014) we find a missing link that completes our view of team adaptation: the levels of adaptation. The work of Baard and colleagues (2014) is mostly centred on the multilevel nature of adaptation, hence describing adaptation as a phenomenon that happens at the individual, dyadic, and team level. In Baard and colleagues (2014) the role of time is not discarded, although it could be made more explicit and maybe, just maybe, it could be added as a fourth level or parameter that could be used to determine the nature of adaptation.

These three models of team adaptation offer us an overarching perspective on what is team adaptation, and how it happens. Throughout this dissertation we will ground our arguments in these rationales, and will try to add new knowledge to those.

Part II

5. Study 1: Measuring adaptive performance in individuals and teams

Abstract

This paper proposes and validates a multilevel measurement tool to assess adaptive performance in individuals and teams. Three studies were conducted to address this goal. In Study 1 we built on Pulakos, Arad, Donovan and Plamondon (2000) taxonomy to develop an individual level measure of adaptive performance. In study 2, we follow from our findings in study 1 and test a team level measure of adaptive performance using a composition referent-shift consensus model (Chan, 1998). Finally, in study 3 we cross-validate our measurement tools through multilevel analysis. The results across the three studies suggest that the adaptive performance scale is a reliable instrument to measure individual, as well as, team adaptive performance in organizational work environments.

Keywords: adaptive performance; composition models; scale development; teams.

Measuring adaptive performance in individuals and teams

The nature of work has changed. Fast pace evolving technologies, highly competitive business sectors, and worldwide economic crises have set the conditions for the emergence of complex work environments, in which having a work force that is capable of performing adaptively is fundamental to keep in business (Arrow, McGrath & Berdahl, 2000; Burke, Stagl, Salas, Pierce & Kendall, 2006). This has motivated an increase in the number of studies addressing adaptation in the work place (e.g. Baard, Rench & Kozlowski, 2014; Pulakos, Dorsey, & White, 2006).

Literature on adaptive performance regards it as a multidimensional construct (Baard et al., 2014). Hence, in this study we are specifically interested in the behavioral modifications that happen during adaptive performance (i.e. the context-generalizable individual and team level behaviors that are enacted as a response to change), and which are often more observable than cognitive or emotional changes. These behavioral modifications comprise such events has finding alternative strategies to problem solving and decision making, or handling stressful situations in an efficient manner (Pulakos et al., 2000). Researchers have been striving to understand the drivers of effective work in complex task environments, thus finding support for a causal relationships between adaptive performance, processes, cognitions, and work related outcomes in individuals and teams (e.g. Gevers, van Eerde & Rutte, 2009; Goodwin, Burke, Wildman, & Salas, 2009; Marques-Quinteiro, Curral, Passos & Lewis, 2013; Pulakos et al., 2006; Uitdewilligen, Waller & Pitariu, 2013).

Despite the relevance of the topic, one pitfall in team adaptation literature regards the lack of measurement tools to assess adaptive performance on a multilevel basis. In this particular research, our main goal is to develop a measurement tool to assess individual and team adaptive performance in organizational work environments.

To achieve this goal we will ground our theory and methods in current adaptive performance, multilevel, and scale development literatures (e.g. Baard et al., 2014; Chan, 1998; Chen, Bliese & Mathieu, 2005; Dyer, Hanges & Hall, 2005; Hinkin 1998), and we will conduct three compiling studies that address the development and validation of the adaptive performance questionnaire.

In study 1 we develop and validate an individual measure of adaptive performance. In study 2, we build on the individual adaptive performance scale developed in study 1 to create a team level measure of adaptive performance. In studies 1 and 2, we will consider Hinkin (1998) recommendations regarding what steps to take when developing and validating psychological instruments. We will address the validity and reliability of the measurement instruments trough exploratory and confirmatory factor analysis; and we will examine construct validity by testing how individual and team adaptive performance relate with other key constructs, and we test several models of causality.

Additionally, and although Hinkin (1998) has not regarded the multilevel dynamics that characterize higher order aggregated constructs, the validation of the team level adaptive performance scale cannot be completed without the examination of its multilevel factorial structure, and the test of multilevel causality relationships (Dyer et al., 2005; Muthén, 1994; Van de Vijver & Poortinga, 2002). Therefore, in study 3 the validation process of the team level adaptive performances scale is extended by examining the underlying multilevel structure of the measurement instrument, and by testing the cross level model dynamics between individual and team level adaptive performance.

Through this compilation of studies we will contribute to the adaptive performance literature because we propose a measurement scale that can be used for data collection at the individual and team levels of analyses, and we expand current knowledge on the level specific and multilevel dynamics of adaptive performance in the workplace (Kozlowski, Gully, Nason & Smith, 1999; Pulakos et al., 2000).

Study 1: Background and Hypotheses

Measuring individual adaptive performance at work

Over the past years, some authors have developed a collection of measurement tools to assess individual adaptive performance (Baard et al., 2014). One example is Griffin and Hesketh (2003), who developed a twenty-item instrument of adaptive career performance that were derived from the combination between Pulakos and colleagues (2000) taxonomy, and the Minnesota Theory of Work Adjustment. Griffin and Hesketh (2003) presented a more *parsimonious* description of the model by considering adaptive behaviors as being proactive (e.g. novel problem solving), reactive (e.g. interpersonal adaptability) and tolerant (e.g. coping with stress). Additionally, the authors found that adaptive career performance was positively correlated with task complexity and managerial support. Another example is Han and Williams (2008), who developed a twelve item scale of adaptive performance that was also based on Pulakos and colleagues (2000) taxonomy, and established a positive causal link between individual learning behaviors and adaptive performance. More recently, Charbonnier-Voirin and Roussel (2012) also developed an individual adaptive performance scale, which is parsimonious in size (nineteen items) and included five of Pulakos' and colleagues (2000) eight dimensions. Charbonnier-Voirin and Roussel (2012) found that individual adaptive performance was positively correlated with contextual performance and transformational leadership.

Despite the quality of the contributions made available in the individual adaptive performance literature (Charbonnier-Voirin & Roussel, 2012; Griffin & Hesketh 2003; Han & Williams, 2008), none of the above instruments have simultaneously been developed to measure adaptive performance at the team level, or has been submitted to multilevel examination. This is an important topic because although research on team adaptive performance is flourishing, to the best of our knowledge there has been little effort regarding the development and validation of one team level adaptive performance scale. Research on team level adaptive performance has often used coding protocols (e.g. Burtscher, Wacker, Grote & Manser, 2010; Waller, 1999). However, these are not only time consuming as they often require that the observation and coding of key-behaviors is expert dependent. These *requirements* make the utilization of such protocols rather complex.

Our study addresses these limitations by building a multilevel measure of adaptive performance starting from the work of Pulakos and colleagues (2000, 2002). Indeed, Pulakos and colleagues (2000, 2002) have taken a significant effort to develop a reliable and generalizable tool to measure adaptive performance at work, thus making it valuable not only for research but also for training, assessment, and selection and recruitment proposes.

In their taxonomy of adaptive performance, Pulakos and colleagues (2000) were able to generalize their multidimensional model across 21 distinct professional activities (e.g. special-forces; managers; medical doctors). The adaptive performance dimensions were as follows: *a)* solving problems creatively (i.e. the resolution of atypical, ill-defined, and complex problems), *b)* dealing with uncertain or unpredictable work situations (i.e. the ability to adjust and deal with unpredictable situations, shifts focus, and take reasonable action), *c)* learning new tasks, technologies and procedures (i.e. the ability to anticipate, prepare for, and learn skills needed for future job requirements), *d)* demonstrating interpersonal adaptability (i.e. the ability to adjust interpersonal style to achieve goals working with new team members or teams, coworkers, and customers), *e)* demonstrating cultural adaptability (i.e. the ability to performs effectively in different cultures, learning new languages, values, traditions, and politics), *f)* demonstrating physical oriented adaptability (i.e. the ability to adjust to various physical factors such as heat, noise, uncomfortable climates, and difficult environments), *g)* handling work stress (i.e. the ability to remains calm under pressure, handle frustration, and act as a calming influence), and *h)* handling emergencies and crisis situations (i.e. the ability to reacts appropriately and decisively to life-threatening or dangerous situations).

In study 1, we start by developing an individual level scale to measure adaptive performance at work. This scale is built based on Pulakos and colleagues (2000) eight-dimensional model of adaptive performance and aims to create a base line for the development of a team level adaptive performance scale.

Item generation

In this particular study our main goal is to develop a short measure of adaptive performance. This has led us to select four out of Pulakos's and colleagues 8 dimensions of adaptive performance: Solving problems creatively; dealing with uncertain or unpredictable work situations; learning new tasks, technologies and procedures; and handling work stress.

Items were developed based on Pulakos and colleagues (2000, 2002) examples describing the behaviors that are expected to be observed for each sub-dimension of adaptive performance. For this process, we adopted a deductive approach because there is enough information available in the literature for item creation (Hinkin, 1998; Pulakos et al., 2002). Adopting a deductive approach helps assuring content validity from the start, which allowed us to proceed to questionnaire administration. Following Hinkin's (1998) recommendation regarding item development (e.g. statements simple and as short as possible; familiar language to target respondents), we developed 8 items to measure four sub-dimensions of adaptive performance (i.e. two items per sub-dimension).

Regarding the item response scaling, we adopted a Likert type scale. Participants were asked to rate how effective they believe they were in performing the behaviors described in the questionnaire. The response scale range varied between 1 (i.e. *totally ineffective*) and 7 (i.e. *totally effective*).

Factor analysis

We followed Conway and Huffcutt (2003) recommendations regarding high-quality decisions when it comes to the selection of the criteria and methodologies for EFA. We decided to use a common factors approach (i.e. maximum likelihood), combined with oblique rotation and eigenvalues estimation. While principal components analysis merely reduces the number of items or sub-dimensions (without interpretation), common factor analysis helps understanding the latent variables that account for relationships among each sub-dimension components. The decision to use oblique rotation (which delivers less biased results than varimax rotation), and number of factors estimation based on eigenvalues was motivated by the expectation that only a one factor solution would be found. This expectation was supported on previous findings regarding the factorial structure of the construct (Han & Williams, 2008; Marques-Quinteiro et al., 2013; Pulakos et al., 2000, 2002).

As an intermediate stage in the factorial analysis process, we examined scale reliability by considering the Cronbach Alpha reliability indicator (α). For the development of research and non-clinical assessment measurement tools it is recommended that it should be equal or above .70 (Hinkin, 1998).

Regarding the second stage of our factor analysis, we followed Byrne (2012) procedure for CFA when the goal is to validate a psychological scale. We randomly assigned participants to two independent sub-groups, forming the calibration sample and the validation sample. Additionally, we performed one multiple group confirmatory factor analyses (M_gCFA) by comparing the calibration and validation sub-groups. We gradually constrained several parameters to be equal across groups, and examined to what extent the goodness of fit of the unconstrained model was kept constant when adding several model constraints (e.g. partial invariance of factor loadings, residual variance and covariance and factor structure) (Byrne, 2012).

In the CFA and M_gCFA model fit was estimated by regarding variance's real value, the chi-square index (χ^2) (Hu & Bentler, 1999). Additionally, four other indices were used (Crocetti, Scharwtz, Fermani, & Meeus, 2010; Hu & Bentler, 1999): the root mean square approximated error (RMSEA), which measures the discrepancy between the hypothesized model and data by degrees of freedom (it has to be < 0.08 to suggest goodness of fit); the comparative fit index (CFI) that carries out the comparison between the fit of the hypothesized model and that of a basic model being represented by a null model (it can range between 0.90 and 1); the Tuker Lewis index (TLI; values between > .90 are acceptable); and the standardized root mean square of residual (SRMR) (that should be lower than .08 for good fit). Besides the above-mentioned goodness of fit indexes, the maximum likelihood $\Delta_{\chi 2}$ difference test ($\Delta\chi 2$ ML) was carried out to verify for non-invariance across the models (Byrne, 2012).

Construct validity

According to Keenan and McBain (1979), type A personality individuals are characterized by being hard driving, persistent, and involved in their work. Nevertheless, type A individuals have little tolerance towards uncertainty, and often experience high emotional and cognitive overload. As a consequence, type A personality individuals tend to be less satisfied with their job, and feel high levels of work related stress. In complex work environments, where change often happens unexpectedly and the ability to perform adaptively is a job requisite, type A individuals might be unable to cope with change. Therefore, we expect that:

Hypothesis 1: Type A personality is negatively associated with adaptive performance efficacy.

Differently from type A personality, individual general self-efficacy (i.e. one's judgment that he or she possesses the skills and abilities to accomplish a task or obtain a desired outcome) is positively related with adaptive performance (Bandura, 1977; Pulakos et al., 2002). For instance, Jimmieson, Terry and Callan (2004) found that individuals with high self-efficacy cope with stress better and feel more satisfied with their jobs after an organizational change process, than low self-efficacy individuals. Therefore, we expect that:

Hypothesis 2: Individual general self-efficacy is positively associated with individual adaptive performance efficacy.

Finally, the negative effect that type A personality might have on individual adaptive performance could also mitigate the positive causal relationship between general self-efficacy and individual adaptive performance (Keenan & McBain, 1979). By causing higher stress, and emotional and cognitive overload, type A personality might hinder individual perceptions of general self-efficacy, thus weakening its relationship with individual adaptive performance. Therefore, we expect that:

Hypothesis 3: Type A personality moderates the relationship between individual perceptions of general self-efficacy and adaptive performance efficacy.

Study 1: Method

Participants

Study 1 included 438 participants, from whom 66% were women, the average age was 33.80 years (*S.D* = 9.86), 18.9% had a degree, and 35% had a leadership role in their organization. Additionally, respondents came from several organizational contexts: Industry (9.3%), services (56.2%), fishing and agriculture (1.1%), social service (11.9%), education (4.2%), health (7.7%), science (4.5%), and others (i.e. unspecified, 5.0%).

Procedure

Study 1 is a field study in the sense that data collection was done with workers enrolled in their own daily professional activities. Participants received an email invitation asking whether they would like to collaborate in this study, by filling an online questionnaire. Those willing to participate could enroll by clicking on a link that was made available in the invitation email. Participants were made aware that participation was voluntary and their responses were anonymous.

Study 1: Results

The EFA was performed asking Mplus to estimate 4 alternative factor models (i.e. 1 factor model to 4 factor model). The results from the EFA delivered two factorial solutions regarding a 1-factor model [χ^2 (20) = 239.55, p < .001; RMSEA = .17; CFI = .81; TLI = .73; SRMR = .07], and a 2-factor model [χ^2 (13) = 103.03, p < .001; RMSEA = .13; CFI = .92; TLI = .83; SRMR = .05]. A $\Delta\chi^2$ ML difference test was then performed with the three factorial solutions. The results suggest no significant differences across the three factorial models ($\Delta\chi^2_{M1\text{-}M2}$ = 136.52 (8), p > .05), and for that reason we opted for the best fitting model solution (i.e. 2 factor model).

Table 3- Measures of studies 1, 2 and 3.

Study	Variable	Source	No. of items	Timing of data collection	Item examples	Cronbach alpha	R_{wg}	ICC1	ICC2
1	Individual adaptive performance.	Pulakos et al., (2000)	8	Cross sectional	"I find innovative ways to deal with unexpected events".	.84	-	-	-
	General self-efficacy.	Jex & Bliese (1999)	3	Cross sectional	"I have the necessary skills to perform well in this task".	.87	-	-	-
	Type A Personality.	Keenan & McBain (1979)	3	Cross sectional	"I usually become frustrated when I have to wait on a cue".	.51	-	-	-
2	Team adaptive performance.	Pulakos et al., (2000)	8	Week 2 (time 1)	"We devise alternative plans in very short time, as a way to cope with new task demands".	.94	.84	.06	.25
	Transactive memory systems.	Lewis (2003)	15	Week 1 (time 0)	"Each team member has specialized knowledge of some aspect of our project".	.88	.76	.28	.25
	Task conflict.	Jehn (1997)	3	Week 2 (time 1)	"There is conflict of ideas amongst team members"	.78	.76	.17	.43
	Task satisfaction.	Nagy (2002)	1	Week 3 (time 2)	"Everything accounted, and thinking of all aspects of your participation in this team, to what extent would you say you are satisfied".	-	.73	.10	.40
	Task performance.	Computer generated.	-	Week 3 (time 2)	-	-	-	-	-
3	Individual thought self-leadership.			Week 1 (time 0)	"I visualize myself performing well on important tasks".	.91	-	-	-
	Individual adaptive performance.	Study 1	8	Week 3 (time 2)	"I search and develop new competences to deal with difficult situations".	.87	-	-	-
	Team adaptive performance.	Study 2	8	Week 2 (time 1)	"We remain calm and behave positively under highly stressful events".	.91	.85	.15	.49

Additionally, and before proceeding to confirmatory factor analysis, we examined factor loadings in order to examine if any item scored below .40. Item 7 ("I remain calm and behave positively under highly stressful events") and item 8 ("I maintain focus when dealing with multiple situations and responsibilities") fell in these conditions and were removed from subsequent analysis in study 1 [χ^2 (4) = 28.13, p < .001; RMSEA = .13; CFI = .97; TLI = .90; SRMR = .02; Cronbach α = .84).

Table 4 - Factor loadings for team adaptive performance.

		F1	F2
Solving problems creatively.	I find innovative ways to deal with unexpected events.	**.91**	-.03
	I use creative ideas to manage incoming events.	**.69**	.15
Dealing with uncertain and unpredictable work situations.	I devise alternative plans in very short time, as a way to cope with new task demands.	**.51**	.23
	I adjust and deal with unpredictable situations by shifting focus and taking reasonable action.	**.49**	.29
Learning work tasks, technologies, and procedures.	Periodically, I update technical and interpersonal competences as a way to better perform the tasks in which I am enrolled.	-.01	**.91**
	I search and develop new competences to deal with difficult situations.	.06	**.68**

Single level confirmatory factor analysis

Participants in study 1 were randomly divided in two groups forming the calibration [N = 219; 55.7% were women; μ_{age} = 32.09, *S.D* = 9.43; and 22.7% had a degree] and validation [N = 219; 67.2% were women; μ_{age} = 35.49, *S.D* = 10.00; 14.8% had a degree] sub-samples.

Confirmatory factor analysis (CFA) was done using maximum likelihood. The results from the first order CFA performed with the calibration sub-sample delivered an acceptable model fit [χ^2 (8) = 26.31, p < .001; RMSEA = .10; CFI = .96; TLI = .93; SRMR = .03]. After establishing the base-line model, we continued our analysis by attempting to replicate these results with the validation sub-sample. The model fit statistics were very satisfactory, thus allowing us to proceed to M_gCFA to test factorial equivalence [χ^2 (8) = 48.61, p < .001; RMSEA = .15; CFI = .93; TLI = .86; SRMR = .06].

Single level multi-group confirmatory factor analysis

As a first step, we examined the configurational model that aims to test the invariance of the model across two different groups. It is expected that variation across groups is the same (Byrne, 2012). The results for the configurational model were acceptable [χ^2 (24) = 36.58, p = .05; RMSEA = .05; CFI = .99; TLI = .98; SRMR = .06].

The second step in our analysis was to test model fit for partially invariant factor loadings. We began by partially allowing factor loadings to vary freely across groups, thus obtaining a satisfactory model fit [χ^2 (22) = 36.04, p < .01; RMSEA = .05; CFI = .99; TLI = .98; SRMR = .06]. Next, we established model invariance by examining whether the configurational and measurement models were significantly different from each other. To do so we performed a $\Delta\chi^2$ ML test thus finding no significant differences between the models [$\Delta\chi^2$ $ML_{1\text{-}2}$ (2) = .54, p > .05]. This finding allowed us to assume that the configurational and measurement models were equivalence across groups (Byrne, 2012).

The third step in our analysis was to test model fit for partially invariant factor loadings and residual covariance. The model fit was satisfactory [χ^2 (23) = 39.89, p < .01, RMSEA = .05, CFI = .98, TLI = .97, SRMR = .08], and no significant differences were found between the models [$\Delta\chi^2$ $ML_{2\text{-}3}$ (1) = 3.85, p > .05].

Finally, we examined the invariance of the structural model by constraining the factor variance and covariance across groups to be equal. Again, an acceptable model fit was obtained [χ^2 (25) = 41.61, p < .001; RMSEA = .06; CFI = .98; TLI = .98; SRMR = .09], and no significant differences were found between the measurement and structural models [$\Delta\chi^2$ $ML_{3\text{-}4}$ (2) = 1.71, p > .05].

Construct validity

The correlation results (table 5) suggest that individual adaptive performance is positively correlated with general self-efficacy (r = .41, p < .001), and not correlated with type A personality behaviors (r = .09, p > .05). These findings offer partial support to a good scale convergent validity. Additionally, we also performed a CFA testing whether individual adaptive performance and general self-efficacy are distinct, yet related, constructs. We tested a one-factor model solution integrating both individual adaptive performance and general self-efficacy, and a two correlated factor solution with individual adaptive performance and general self-efficacy as separate constructs. The one factor model solution achieved a poorer fit [χ^2 (27) = 638.89, p < .001; RMSEA = .23; CFI = .65; TLI = .53; SRMR = .12] than the two-factor model solution [χ^2 (26) = 246.94, p < .001; RMSEA = .13; CFI = .87; TLI = .82; SRMR = .06]. Significant differences were found between both models [$\Delta\chi^2$ (1) = 391.95 *p* > .05], which suggest that individual adaptive performance and general self-efficacy are distinct (yet related) constructs.

Table 5 - Inter-correlations and descriptive statistics.

	1	2	3	4	5	6	*M*	*S.D*
1 Age.	1	-	-	-	-	-	33.80	9.86
2 Gender.	.04	1	-	-	-	-	1.66	.44
3 Business.	-.03	.18**	1	-	-	-	3.13	1.85
4 Education.	.22**	.19**	.27**	1	-	-	4.17	1.44
5 IAP.	.07	-.09	-.01	-.01	1	-	5.23	.59
6 Self-efficacy.	.15**	.00	.00	.02	.41**	1	6.18	.75
7 Type A.	.05	.10*	-.05	-.06	.09	.12*	4.57	1.13

Note. IAP is individual adaptive performance. ** *p* < .01, * *p* < .05.

Finally, our findings suggest that type A personality behaviors do not predict individual perceptions of adaptive performance efficacy (*β* = .17, *p* > .05; 95% CCLB = -.07 and 95% CCUB = .42). Hypothesis 1 was rejected. Our findings also suggest that general self-efficacy positively predicts individual perceptions of adaptive performance efficacy (*β* = .37, *p* < .001; 95% CCLB =.25 and 95% CCUB = .50). Hypothesis 2 was supported. This finding in line with previous work by Bell and Kozlowski (2008) suggesting that individuals who possess high self-efficacy tend to behave more adaptively in turn.

Table 6 - Results for the moderation analysis.

Steps	β	*S.E*	*p*	95% CILB	95% CIUB
IAP on Self-efficacy.	.37	.08	.00	.25	.50
IAP on Type A	.17	.15	.25	-.07	.42
IAP on interaction.	-.36	.5	.01	-.60	-.12
Partial effects of control variables on individual adaptive performance					
Age.	.03	.04	.43	-.03	.09
Gender.	-.12	.04	.00	-.18	-.05
Business.	-.01	.04	.74	-.07	.05
Education.	.03	.04	.45	-.03	.09

Note. Bootstrap sample size = 5000. IPA is individual adaptive performance.

Type A personality was found to negatively moderate the relationship between individual adaptive performance and general self-efficacy (β = -.36, p < .01; 95% CCLB = -.60 and 95% CCUB = -.12), thus supporting hypothesis 3. This finding might suggest that for tasks in which adaptive performance is required, having a work force with type A personality individuals might hinder adaptive capacity at work. Overall, these findings suggest good construct validity for the individual adaptive performance scale.

Study 2: Background and Hypotheses

A composition measure of team adaptive performance at work

Team work literature maintains that the way individuals contribute to higher order dynamics of adaptation can be understood through one of two multilevel aggregation models: Compilation models or composition models (Chen, 2005; Costa et al., 2013; Kozlowski & Klein, 2000).

Compilation models are developmental in the sense that they are often used to describe group phenomena that unfold across levels and time. These are particularly useful when examining adaptation within a domain-specific perspective (Baard et al., 2014). Compilation models describe content, processes and outcomes of team work dynamics that are important at different focal levels, and at different points along the developmental continuum, and which evolve from individuals, to dyads, to groups (Kozlowski et al., 1999). The compilation mechanisms underlying adaptive performance (e.g. continuous series of socialization, dyadic role negotiation, and network repertoire phases) are conceptually and functionally different across levels of observation. This means that the behaviors, cognitions and affects that characterize individual adaptive performance (e.g. IT consultant) are different from those driving dyadic adaptive performance (e.g. cockpit crew), and team adaptive performance (e.g. top management team) (Kozlowski et al., 1999; Rosen et al., 2011).

Differently from compilation models, composition models consider that team level constructs derive from the combination of individual and/or dyadic contributions (Chan, 1998). Composition models consider that team level constructs can *mirror* individual level constructs such as collective efficacy or thought self-leadership (Marques-Quinteiro, Passos & Curral, 2014). Individuals within teams are interdependent agents whose actions influence each other dynamically. As individuals perform, they implicitly and explicitly (e.g. coordination) adjust to other team members in such a way that the team ends up developing a performance of its own (Arrow et al., 2000; Marques-Quinteiro et al., 2014). As in sports teams, performing team members often behave in a manner that is aligned with other colleagues within the team (Ramos-Villagrasa, Navarro & García-Izquierdo, 2012), which gives momentum to the group and allows the emergence of higher order group processes like team adaptive performance.

Although we acknowledge that adaptive performance can manifest through both compilation and composition phenomena, in this study we put the emphasis on a composition model of adaptive performance and use this framework to develop and validate our team level measurement tool of adaptive performance.

The aggregation of individual responses to the team level using a composition model is frequently done using one of two procedures: direct consensus and referent-shift (Chan, 1998; Wallace et al., 2013). Direct consensus is focused on the "*I*" and assumes that higher order constructs derive from the aggregated scores of individual contributions to the team (e.g. group climate studies). The assessment of higher order constructs through referent-shift consensus is similar to direct consensus in the sense that it also considers the aggregate scores of individual respondents. However, whereas direct consensus regards the "I" part of the construct (i.e. "I" behave), the referent-shift consensus regards the "*We*" part of the construct (i.e. "We" behave) (Costa et al., 2013; Marques-Quinteiro et al., 2014).

Aggregating team members' individual perceptions of their own adaptive performances will only tell us how the average individual adaptive performance contributes to a collective *climate* about adaptive behavior in the team. In this particular situation, instead of assessing how the team behaves, one is assessing how interdependent agents perform independently from each other. Even if we consider that collective adaptation might emerge through compilation, examining team adaptive performance through the aggregation of individual team members' own adaptive performance gives a blurry view of collective behavior (Costa, Passos & Bakker, 2014). Alternatively, when asking team members about their team's adaptive behavior instead, we obtain a shared perception of the group's behavior. Rather than aggregating each *individual's perception of its own adaptive behavior*, this methodology allows aggregating each *individual's perception of their team's adaptive behavior*.

As in other team processes (e.g. coordination) and outcomes (e.g. efficiency), our argument is that team adaptive performance is more than the average of every team member individual adaptive performance, and for that reason should be assessed using a referent-shift framework.

Item generation and construct aggregation

The team adaptive performance items were derived from the individual adaptive performance items developed and validated in study 1. These were developed using a referent-shift consensus approach in which instead of asking participants about themselves (individual focused referent), these are asked about their team's (group focused referent) adaptive performance *(e.g. replacing "I take" for "We take")* (Chan, 1998; Chen, Bliese & Mathieu, 2005; Bliese & Jex, 1999).

Additionally, and before proceeding with data aggregation, we examined within-group agreement index ($R_{wg(j)}$) (James, Demaree, & Wolf, 1984), and intraclass correlation coefficients (ICC1 and ICC2) for transactive memory systems and team adaptive performance (Bliese, 2000), in order to decide whether to proceed with data aggregation (Kozlowksi & Klein, 2000). Table 3 shows the aggregation results for the variables being examined.

Factor analysis

In Study 2 we followed the same procedure used in Study 1 to validate our team level measure of performance adaption. We began by performing an EFA, followed by reliability analysis and CFA. Regarding the CFA, we also randomly assigned participants to two independent sub-groups forming the calibration sample and the validation sample, and these were submitted to M_gCFA (Byrne, 2012). For further detail on please consider the revision made in the previous section.

Construct validity

Transactive memory systems are a shared cognitive system that combines each team member's memory system with a shared understanding of which members know, and are responsible for, what knowledge (Lewis, 2003). Transactive memory systems predict team task performance (Ellis, 2006), and are expected to positively contribute to adaptive performance during the execution of complex tasks (Zajac et al., 2013). However, and despite recent findings on the relationship between transactive memory systems and adaptive processes such as team innovation (Peltorkopi & Hasu, 2014) and learning (Lewis, Lange & Gillis, 2005), this assumption has not been tested in the team work literature. During performance episodes, teams whose transactive memory system is well developed might retrieve expert information more easily and use it for from solving. This would increase the collective ability to perform adaptively and being effective. Based on this argumentation, we expect that:

Hypothesis 4: Team adaptive performance positively mediates the relationship between transactive memory systems and task performance.

Hypothesis 5: Team adaptive performance positively mediates the relationship between transactive memory systems and overall job satisfaction.

Research also suggests that conflict might emerge during action and transitions processes, as result of the interactions happening between team members (Passos & Caetano, 2005). Conflict might hinder adaptive team process and performance because it distracts team members from relevant tasks, and inhibits the emergence of functional behaviors and cognitions within the team. Furthermore, teams whose team members experience more conflict, and a consequent reduction in their ability to perform adaptively, might be less satisfied with their team (LePine et al., 2008). Therefore we expect that:

Hypothesis 6: Team task conflict negatively predicts team performance, thought team adaptive performance.

Hypothesis 7: Team task conflict negatively predicts team satisfaction, thought team adaptive performance.

Study 2: Method

Participants

1020 individuals (221 teams) were assigned to an online survey through a link attached to an email invitation. Team size varied between 3 and 5 members, with most teams (74.8%) having 5 members (μ = 4.61, *S.D* = 0.72). In this study, 33.4% of the participants were women, the average age was 29.89 years (*S.D.* = 8.89), 32.2% had degree.

Research Context

Data collection took place during the first stage of a management game competition entitled Global Management Challenge (GMC; http://www.worldgmc.com/).
The GMC is the biggest strategy and management competition in the world, and is organized by SDG which is a private company expert in the development of business simulations and serious games (http://www.sdg.pt). The simulator that runs the GMC

results from a partnership between SDG and EDIT 515 U.K (www.edit515.co.uk/), and was designed and developed by Partners of EDIT 515 U.K at the University of Strathclyde in Scotland (Key subject for a Master's in Business Administration of the Graduate Business School of this University).

The GMC is the largest international event based on business simulations, in which more than 500 000 university students and company managers from all over the world participate. The GMC consists of a management simulation in which each team runs a Company with the aim of achieving the highest investment performance. This criterion measures the investment 'return' for the original shareholders and not just the value of their shares at the end of the competition, but also after allowing for any shares purchased, or sold, and also any dividends received.

Initial conditions in the GMC are the same for all teams, and the business market in which they compete is identical. During GMC, teams experience real world-like unexpected events such as currency devaluation, a hostile takeover, or strikes. These events happen for all teams simultaneously and with equal seriousness.

In the GMC, participants compete within teams, with each team representing a full company. Team size ranges between 3 and 5 members. Participants receive all the necessary information about the simulation one month before the competition begins. Two weeks before the beginning of the competition, participating teams also enrol in two training sessions. This gives team members time to become familiar with the task, and with each other.

During the GMC, participants take top management decisions, are given the opportunity to analyse financial and economic indicators, interact with the different functional areas of a company (e.g. finance, human resource management, marketing), and are made aware of the impact their decisions have on the organization itself. The GMC normally consists of 4 stages: 1st Round, 2nd Round, National Final, and International Final. Each stage consists of five developing decision periods during the competition. Along the simulation, teams perform sixty-six decisions that must be delivered weekly. Each week, decisions are related to marketing, production, personnel, purchasing, and finance. Teams are also given a vast array of data to consider before making any decision. As in real financial markets, the competing companies' stock auctions are sensitive not only to the decisions made by the company's management team, but also to the decisions made by other competing companies. 24h after teams submit their decisions through the GMC online platform, they receive a report which informs them of the quality of their decisions plus their overall performance for that specific week. The winner is the team that finishes with the highest simulated share price.

This study was made possible due to an agreement between the company that runs the GMC, and the research team. The research team is given access to participants only during the 1st round of the GMC. Data can only be collected using online questionnaires, the research team has no influence on the course of the simulation; they have no way of knowing when unexpected events will occur, and are unable to exert any influence during the course of the simulation. Additionally, no video or audio recording can be made during decisions.

Data collection took place during GMC's 1st round. Teams were self-selected and applied together to the GMC. Before the start of the competition two emails were sent to participants by the GMC organizing committee and the research team together. Emails were sent one week before, and on the eve of the start of the competition. In both emails, participants were invited to enrol in the study.

Study 2: Results

Single level exploratory factor analysis

Participant teams in study 2 were randomly divided in two groups forming the calibration [N_{teams} = 110; $\mu_{\text{team size}}$ = 4.64, *S.D* = .68; $\mu_{\text{\% of women}}$ = 32.9% ; μ_{age} = 30.16, *S.D* = 9.01; $\mu_{\text{\% respondents with degree}}$ = 35.2%], and validation [N_{teams} = 111; $\mu_{\text{team size}}$ = 4.58, *S.D* = .77; $\mu_{\text{\% of women}}$ = 34.0%; μ_{age} = 29.61, *S.D* = 8.69; $\mu_{\text{\% respondents with degree}}$ = 31.0%] sub-samples.

The EFA was performed asking Mplus to estimate 4 alternative factor models. The results from the EFA delivered one single factor solution [χ^2 (20) = 99.6, p < .001; RMSEA = .13; CFI = .94; TLI = .92; SRMR = .04] (Cronbach α = .94).

Single level confirmatory factor analysis

The results from the first order CFA performed with the calibration sub-sample delivered an acceptable model fit [χ^2 (20) = 59.52, p < .001; RMSEA = .13; CFI = .94; TLI = .92; SRMR = .04]. We continued our analysis by attempting to replicate these results with the validation sub-sample. By allowing the items 6 and 7 residual covariances' to correlate, the model fit was also acceptable [χ^2 (19) = 42.07, p < .01; RMSEA = .11; CFI = .97; TLI = .95; SRMR = .04].

Table 7 - Factor loadings for team adaptive performance.

		F1
Solving problems creatively.	We find innovative ways to deal with unexpected events.	.72
	We use creative ideas to manage incoming events.	.85
Dealing with uncertain and unpredictable work situations.	We devise alternative plans in very short time, as a way to cope with new task demands.	.84
	We adjust and deal with unpredictable situations by shifting focus and taking reasonable action.	.91
Learning work tasks, technologies, and procedures.	Periodically, We update technical and interpersonal competences as a way to better perform the tasks in which we are enrolled.	.77
	We search and develop new competences to deal with difficult situations.	.75
Handling work stress.	We remain calm and behave positively under highly stressful events.	.71
	We maintain focus when dealing with multiple situations and responsibilities.	.73

Single level multi-group confirmatory factor analysis

As a first step, we examined the configural model, which aims to test the configural invariance of the model across two different groups. It is expected that variation across groups is the same (Byrne, 2012). The results for the configural model were acceptable [χ^2 (35) = 95.72, p < .001; RMSEA = .13; CFI = .96; TLI = .93; SRMR = .04].

The second step in our analysis was to test model partial invariance by modifying the measurement model (i.e. partial constraint of factor loadings). The fit results were acceptable [χ^2 (42) = 109.48, p < .001; RMSEA = .12; CFI = .95; TLI = .94; SRMR = .11]. Before continuing, we established model invariance by examining whether the configural and measurement models (with partially constraint factor loadings) were significantly different from each other. To do so we performed a $\Delta\chi^2$ ML test thus finding no significant differences between the models [$\Delta\chi^2$ ML (7) = 13.76, p > .05]. This finding allowed us to assume configural and measurement models equivalence across groups (Byrne, 2012).

As a third step we constrained the residual covariances to be equal across groups, thus obtaining an acceptable fit [χ^2 (43) = 109.62, p < .05; RMSEA = .12; CFI = .95; TLI = .94; SRMR = .11]. No significant differences between this model and the previous one were found [$\Delta\chi^2$ ML (1) = 0.14, p > .05].

Finally, we examined the invariance of the structural model by constraining the factor variance and covariance across groups to be equal, thus obtaining a poor, yet acceptable, model fit [χ^2 (44) = 110.27, p < .001; RMSEA = .12; CFI = .95; TLI = .94;

SRMR = .14]. No significant differences were found between the measurement and structural models [$\Delta\chi^2$ ML (1) = 0.64, $p > .05$].

Construct validity

The correlation results suggest that team adaptive performance is positively correlated with transactive memory systems ($r = .16$, $p < .01$), performance ($r = .20$, $p < .01$) and satisfaction ($r = .30$, $p < .001$), and negatively correlated with task conflict ($r = -.17$, $p < .01$).

Besides examining the correlation tables, we also run several CFA testing competing models regarding transactive memory systems and team adaptive performance. Our aim was to test to what extent team adaptive performance and transactive memory systems were independent (although related) constructs. We tested a one factor model solution integrating both team adaptive performance and transactive memory systems, and a two correlated factor solution with both constructs being separated. The one factor model solution achieved a poorer fit [χ^2 (230) = 2479.40, $p < .001$; RMSEA = .21; CFI = .38; TLI = .32; SRMR = .21] than the two factor model solution [χ^2 (229) = 1535.94, $p < .001$; RMSEA = .16; CFI = .64; TLI = .60; SRMR = .14]. Additionally, significant differences were found between both models [$\Delta\chi^2$ (1) = 967.12, $p > .05$], which suggest that team adaptive performance and transactive memory systems are distinct constructs.

Table 8 - Inter-correlations and descriptive statistics.

	1	2	3	4	5	6	7	*8*	*M*	*S.D*
1 Size.	1	-	-	-	-	-	-	-	4.49	.77
2 Age.	.17*	1	-	-	-	-	-	-	25.52	7.17
3 Gender.	-.12	.00	1	-	-	-	-	-	1.32	.29
4 Task experience.	-.05	.11	.09	1	-	-	-	-	1.00	.62
5 TMS.	.07	.05	.11	-.22	1	-	-	-	5.60	.72
6 Task conflict.	.22	.10	-.05	.11	-.20**	1	-	-	5.09	.41
7 TAP.	-.08	.08	-.05	.05	.16*	-.17*	1	-	5.70	.71
8 Task satisfaction.	-.02	.01	.00	-.00	.14*	-.03	.31**	1	5.57	1.91
9 Task performance.	-.20**	.20**	-.20**	.01	.02	.14*	.20**	.13*	4.31	.83

Note. TAP is team adaptive performance. TMS is transactive memory systems. ** $p < .01$, * $p < .05$.

Finally, we aimed at extending knowledge on the relationship between team adaptive performance, transactive memory systems, task conflict, and team effectiveness. Our findings suggest that transactive memory systems predict team adaptive performance ($\beta = .16$, $p = .06$; 95% CCLB =.06 and 95% CCUB = .10), and that team adaptive performance positively predicts team task performance ($\beta = .19$, $p <$

.01; 95% CCLB =.09 and 95% CCUB = .39) and team satisfaction (*β* = .30, *p* < .01; 95% CCLB =.09 and 95% CCUB = .27). Team adaptive performance fully mediated the relationship between transactive memory systems and team task performance (*β* = .03, *p* = .08; 92.5% CCLB =.002 and 95% CCUB = .06), and team satisfaction (*β* = .05, *p* = .06; 95% CCLB =.04 and 95% CCUB = .19). These findings offer support to hypotheses 4 and 5.

Table 9 - Results for the mediation analyses.

Steps	β	*S.E*	*p*	95% CILB	95% CIUB
TMS as the *X* variable and task performance as the *Y* variable.					
TAP on TMS.	.16	.29	.06	.05	.51
Task performance on TMS.	-.01	.27	.91	-.51	.41
Task performance on TAP.	.19	.09	.01	.16	.77
Indirect.	.03	.02	.08	.01	.06
Partial effects of control variables on team task performance.					
Size.	.17	.17	.01	.13	.68
Age.	.15	.01	.02	.01	.07
Gender.	.17	.41	.01	-1.78	-.44
Task experience.	.01	.23	.95	-.35	.41
TMS as the *X* variable and task satisfaction as the *Y* variable.					
TAP on TMS.	.17	.14	.04	.05	.52
Task satisfaction on TMS.	.09	.20	.37	-.14	.50
Task satisfaction on TAP.	.17	.06	.01	.09	.27
Indirect.	.05	.03	.06	.01	.09
Partial effects of control variables on team task satisfaction					
Size.	.01	.06	.92	-.09	.10
Age.	-.02	.01	.77	-.01	.01
Gender.	-.001	.16	.98	-.29	.24
Task experience.	-.002	.04	.71	-.08	.06
Task conflict as the *X* variable and task performance as the *Y* variable.					
TAP on task conflict.	-.17	.05	.03	-.20	-.03
Task performance on task conflict.	.04	.12	.59	-.13	.26
Task performance on TAP.	.19	.09	.01	.17	.78
Indirect.	-.03	.03	.07	-.06	-.003
Partial effects of control variables on team task performance.					
Size.	.16	.18	.03	.10	.67
Age.	.15	.02	.02	.01	.07
Gender.	-.17	.39	.01	-1.77	-.47
Task experience.	.00	.23	.99	-.37	.40
Task conflict as the *X* variable and task satisfaction as the *Y* variable.					
TAP on task conflict.	-.17	.05	.03	-.20	-.03
Task satisfaction on task conflict.	.04	.12	.59	-.13	.26
Task satisfaction on TAP.	.32	.05	.01	.17	.78
Indirect.	-.05	.03	.06	-.10	-.01
Partial effects of control variables on team task satisfaction.					
Size.	.01	.05	.86	-.08	.10
Age.	-.02	.01	.78	-.01	.01
Gender.	.01	.18	.86	-.28	.31
Task experience.	-.02	.04	.58	-.09	.05

Note. Bootstrap sample size = 5000. TAP is team adaptive performance. TMS is transactive memory systems.

Our findings also suggest that team task conflict negatively predicts team adaptive performance (*β* = -.17, *p* < .05; 95% CCLB = -.40 and 95% CCUB = -.09), and that team adaptive performance negatively mediates the relationship between team task conflict and team satisfaction (β = -.05, p = .06; 95% CCLB =-.10 and 95% CCUB = -.01). Finally, our results also suggest that team adaptive performance negatively mediates the relationship between team task conflict and team performance (β = -.03, p = .07; 95% CCLB =-.06 and 95% CCUB = -.003). Our findings support hypothesis 6 and 7.

Overall, these results are once again aligned with previous work (e.g. Mathieu et al., 2008) and offer good construct validity to the team adaptive performance scale.

Study 3: Background and Hypotheses

A multilevel approach to adaptive performance: The Adaptive performance Scale

Across studies 1 and 2 we developed and validated two measures of adaptive performance at work. In study 1 we have built on previous work to create a scale to assess individual adaptive performance (i.e. Pulakos and colleagues, 2000, 2002; Baard and colleagues, 2014). In study 2 we derived the items from study's 1 individual adaptive performance scale using a referent-shit methodology. This allowed us to create a team adaptive performance scale, built under the theoretical assumption that adaptive behaviors leading to full adaption are similar across levels of analysis (e.g. innovation; learning; coping with stress). However, there are several limitations associated with solely relying on single level EFA and CFA to determine the quality of model fit for aggregated constructs (Dyer et al., 2005; Muthén, 1994). In cases where data dependency is not accounted for, there might be overestimations of inter-item correlations or covariances. As a consequence, there might be misleading standard errors for parameter estimates, and model fit statistics (Costa et al., 2014; Cronbach, 1976; Dyer, et al., 2005; Muthén, 1994).

Therefore, in this final study we put forward a multilevel approach to the development and validation of the team adaptive performance scale.

Multilevel factor analysis

When examining the factor structure of a team level measure, researchers either run a factor analysis on the total covariance matrix derived from the entire data set (thus neglecting hierarchical structure of the data), or average the item responses to the group level and then perform a factor analysis on the sample between-group covariance matrix. However both approaches might yield biased interpretations (Dyer et al., 2005; Muthén, 1994). To tackle these shortcomings, and adequately test the multilevel nature of a psychological construct such as adaptive performance, Muthén (1994) developed a multilevel confirmatory factor analysis procedure that fits the within-group model (pooled-within group sample covariance matrix) and the between-group model (between group sample covariance matrixes) simultaneously (Dyer et al., 2005). Van de Vijver and Poortinga (2002) further developed a similar procedure for multilevel exploratory factor analysis.

In this final study we start by conducting an exploratory factor analysis to examine whether individual responses regarding individual and team adaptive performance differentiate from each other. We then build on both van de Vijver and Poortinga (2002), and Muthén (1994) to adopt an integrative approach to multilevel factor analysis. The procedure we adopted was as follows: Firstly, we aggregated the between-group data sample responses to obtain the team level aggregated mean scores for adaptive performance. This allowed us to run a multilevel exploratory factor analysis on the within-group model (pooled-within group sample covariance matrix) and the between-group model (between group sample covariance matrixes) (Dyer et al., 2005). The second step regarded performing a multilevel reliability analysis, which is particularly important to determine reliability for the within and between clusters of the multilevel measurement instrument simultaneously (Geldhof, Preacher & Zuphur, 2014). Additionally, estimating multilevel reliability is also particularly important when it is necessary to find evidence for true score variation at different levels of analysis. Geldhof and colleagues (2014) describe three alternative indicators to estimate scale reliability: Alpha (α), composite reliability (ω) and maximal reliability (H). From the three options presented by the authors, we choose α because 1) it is more robust and is most familiar to psychology and organizational behavior researchers (which facilitates understanding), 2) it accommodates one-dimensional factor structures for within- and between-cluster models (ω only allows for this kind of multilevel factorial structure), and 3) it is less prone to bias in both the within- and between-clusters (particularly when ICC are > .05) (Geldhof et al., 2014). Finally, after establishing an acceptable multilevel factor structure for adaptive performance, and determine whether this factor structure is reliable, we performed a multilevel confirmatory factor analysis on the adaptive performance scale. For multilevel confirmatory factor analysis, MUML estimation was used, and goodness of fit was determined through the qui-square index (χ^2), comparative fit index (CFI), the Tuker Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean of residual (SRMR) (Dyer et al., 2005; Muthén, 1994).

Construct validity.

Though self-leadership is a cognitive self-regulatory skill that regards self-evaluation of one's values and beliefs (i.e. identifying and changing dysfunctional values and beliefs), self-talk (i.e. engaging in inside head or outlook monologues as a way to systematize information, manage stress, and make decisions), and self-mental imagery (i.e. using visualization to generate multiple scenarios where behavioral responses are rehearsed) (Neck & Houghton, 2006). Thought self-leadership is expected to increase individual capacity to behave adaptively in the sense that it might optimize the cognitive processes (e.g. visualization of possible scenarios; mental rehearsal) that influence individual adaptive performance (Marques-Quinteiro & Curral, 2012). Therefore we expect that:

Hypothesis 8: Thought self-leadership positively predicts individual perceptions of adaptive performance efficacy.

Teamwork literature has been fruitful in showing how team level dynamics can influence lower level phenomena such as decision making (Hollenbeck et al., 1998), newcomer adaptation (Chen, 2005), and empowerment and performance (Chen, Kirkman, Kanfer, Allen & Rosen, 2007). Indeed, team processes dynamics function as a self-regulatory mechanism that not only impacts team level phenomena, but individual dynamics as well (Kozlowski et al., 1999). When coping with change, and using self-regulatory strategies such as though self-leadership, individuals might be influenced by how well their teams' adapt. Indeed, even when individuals who are good though self-leaders are capable of developing the adequate mind set to cope with change, their ability to perform adaptively might depend on how well the team behaves adaptively. In teams were adaptive performance is low; it is less likely that individual self-regulatory skills such as thought self-leadership have any impact on individual adaptive performance. Therefore, we expect that:

Hypothesis 9: Team adaptive performance positively predicts the direct relationship between thought self-leadership and individual perceptions of adaptive performance efficacy.

Although adaptive performance dynamics have received very little consideration so far, it is plausible to think that how teams behave adaptively might have a direct impact on how individual team members evaluate their own adaptive performance efficacy. In teams whose ability to behave in an adaptive fashion when faced with novelty, team members might learn from others and even feel more adaptively *competent*. Differently, teams that are poor adaptors are more likely to have team members whose self-perceptions of adaptive performance efficacy are poorer. Therefore, we expect that:

Hypothesis 10: Team adaptive performance positively predicts individual perceptions of adaptive performance efficacy.

Study 3: Method

Participants

799 individuals (175 teams) were assigned to an online survey through a link attached to an email invitation. 32.1% of the participants were women, the average age was 28.80 years (SD = 8.61), and 58.5% had a degree.

Research environment

The research environment was identical to the one described in study 2 of chapter 5. For that reason, please consider the aforementioned description.

Item generation and construct aggregation

The team adaptive performance items regarded those developed and validated in study 2. Before proceeding with data aggregation, we examined within-group agreement index ($R_{wg(j)}$) (James, Demaree, & Wolf, 1984), and intraclass correlation coefficients (ICC1 and ICC2) for team adaptive performance (table 3).

Study 3: Results

As a first step on this final study we performed an exploratory factor analysis onto individual responses to the individual and team level adaptive performance scales to test whether respondents could differentiate between both constructs. The exploratory factor analyses yielded two factor models. Model 1 regarded a single factor solution, with individual and team adaptive performance items loading on the same factor [χ^2 (104) = 6991.00, p < .001; RMSEA = .29; CFI = .49; TLI = .41; SRMR = .31]. Model 2 regarded a two factor model with individual and team adaptive performance loading onto different factors [χ^2 (89) = 793.27, p < .001; RMSEA = .10; CFI = .95; TLI = .93; SRMR = .02]. These results suggested that individuals do differentiate between individual and team adaptive performance.

Secondly, we performed two separate exploratory factor analysis for the within and between level responses regarding team adaptive performance. At the within level of analysis, a two factor solution models resulted being the best fitting model [χ^2 (13) = 218.31, p < .001; RMSEA = .14; CFI = .97; TLI = .94; SRMR = .02]. At the between level of analysis, a one single factor solution was found [χ^2 (13) = 85.73, p < .001; RMSEA = .17; CFI = .96; TLI = .92; SRMR = .02].

Multilevel factor analysis

In this final study, our focus was on the multilevel nature of the team adaptive performance measurement scale. The results from the exploratory factor analysis yield a model with 2 factors at the within level and 1 factor at the between level. The model fit was acceptable [χ^2 (33) = 229.92, p < .001; RMSEA = .09; CFI = .97; TLI = .95; $SRMR_{within}$ = .02; $SRMR_{between}$ = .04].

The second step in the multilevel factor analysis procedure was to determine whether the multilevel factor structure was reliable. For that we performed a multilevel reliability analysis which delivered good reliability for the within and between clusters (Cronbach α_{within} = .91, p < .001; Cronbach $\alpha_{between}$ = .98, p <.001).

Finally, the multilevel confirmatory factor analysis was performed using the multilevel factorial structure found on the exploratory factor analysis. The results were satisfactory [χ^2 (41) = 264.22, p < .001; RMSEA = .08; CFI = .97; TLI = .96; $SRMR_{within}$ = .03; $SRMR_{between}$ = .04].

Table 10- Multilevel factor loadings for team adaptive performance.

		F1	F2
Within level			
Solving problems Creatively.	We find innovative ways to deal with unexpected events.	**.92**	-.06
	We use creative ideas to manage incoming events.	**.91**	-.08
Dealing with uncertain and unpredictable work situations.	We devise alternative plans in very short time, as a way to cope with new task demands.	**.71**	.15
	We adjust and deal with unpredictable situations by shifting focus and taking reasonable action.	**.84**	.06
Learning work tasks, technologies, and procedures.	Periodically, We update technical and interpersonal competences as a way to better perform the tasks in which we are enrolled.	**.89**	.00
	We search and develop new competences to deal with difficult situations.	**.84**	.05
Handling work stress.	We remain calm and behave positively under highly stressful events.	-.01	**.92**
	We maintain focus when dealing with multiple situations and responsibilities.	.20	**.74**

		F1
Between level		
Solving problems Creatively.	We engage in creative action to solve problems for which there are no easy or strait forward answers.	1.00
	We find innovative ways to deal with unexpected events.	.99
Dealing with uncertain and unpredictable work situations.	We adjust and deal with unpredictable situations by shifting focus and taking reasonable action.	.96
	We devise alternative plans in very short time, as a way to cope with new task demands.	.99
Learning work tasks, technologies, and procedures.	Periodically, we update technical and interpersonal competences as a way to better perform the tasks in which we are enrolled.	.97
	We search and develop new competences to deal with difficult situations.	.99
Handling work stress.	We remain calm and behave positively under highly stressful events.	.97
	We maintain focus when dealing with multiple situations and responsibilities.	.99

Cross-level results

The analysis of the correlations table suggests that team thought self-leadership and individual adaptive performance are positively correlated ($r = .10$, $p < .05$).

Table 11 - Inter-correlations and descriptive statistics.

	1	1	2	3	*M*	*S.D*
Within level						
1 TSL.	1	-	-	-	5.09	.76
2 IAP.	.14**	-	-	-	5.48	.80
Between level						
1 Size.	-	1	-	-	4.67	.61
2 Task experience.	-	.07	1	-	.48	.87
3 Age.	-	.14*	.23**	1	28.81	6.96
4 TAP.	-	.10**	.08*	.27**	5.63	.80

Note. IPA is individual adaptive performance. TSL is thought self-leadership. TPA is team adaptive performance. ** $p < .01$, * $p < .05$.

The results from the cross level test suggest that team thought self-leadership has no direct effect on individual adaptive performance (B = 1.70, $p > .05$; 95% CCLB =-1.58 and 95% CCUB = 4.98). This rejects hypothesis 8 and 9. Nevertheless, our findings also suggest that team adaptive performance predicts individual adaptive performance (B =.53, p < .001; 95% CCLB =.38 and 95% CCUB = .69), thus supporting hypothesis 10.

Table 12 - Cross-level effects.

	B	*S.E*	*p*	95% CILB	95% CIUB
Within level (Direct effects).					
TSL → IAP.	0.48	0.05	.00	.40	.55
Between level (Cross-level effects).					
TAP → Slope $_{\text{IPA on TSL.}}$	-.23	.23	.33	-.60	.16
TAP → IAP.	.59	.09	.00	.45	.72
Team size → Slope $_{\text{IAP on TSL.}}$	.03	.36	.72	-.10	.15
Task experience → Slope $_{\text{IAP on TSL.}}$	.04	.91	.37	-.03	.12
Age → Slope $_{\text{IAP on TSL.}}$	-.01	.00	.32	-.01	.01
Team size → IAP.	-.08	.04	.08	-.15	-.01
Task experience → IAP.	.02	.02	.49	-.02	.05
Age → IAP.	-.01	.03	.09	-.01	.00

***Note*. IAP is individual adaptive performance. TSL is thought self-leadership. TAP is team adaptive performance. TSL was mean centered prior to analysis.**

General Discussion

Grounded on previous research on adaptability in the work place (e.g. Pulakos et al., 2000; Baard et al., 2014; Burke et al., 2006), this chapter built on three compiling studies to develop a multilevel adaptive performance scale. This chapter further examined the level specific and multilevel dynamics of adaptive performance in individuals and teams.

In study 1 we followed from the existing literature to purpose an individual adaptive performance scale, thus finding support to an eight items two-dimensional measurement tool. Previous research on individual adaptive performance as found support to a one single factor structure (Pulakos et al., 2000), three-factor structure (Griffin & Hesket, 2003), and 5-factor structure (Charbonnier-Voirin & Roussel, 2012).

Study 1 further examined whether the individual adaptive performance scale had any relationship with general self-efficacy and type A personality behaviors. The results from the moderation analysis suggest that the extent to which general self-efficacy predicts individual adaptive performance is conditioned on individual type A personality. This suggests that having a type A personality might be detrimental to the positive causal relationship between self-regulation and adaptation in organizational work environments.

In study 2 a team adaptive performance scale was developed and tested by means of a referent-shift composition model approach. The scale items were adapted from the scale developed in study 1, with the major scale modifications being a change in referent (i.e. rather than asking about themselves, participants were inquired about their teams). The model fit results suggest that our team performance adaption measurement tool has a reliable factor structure as it holds across different sub-samples, even after controlling for factor and structural invariances. In the end, a nicely fitted eight item one factor model was obtained. This result mirrored the factorial structure also found in Pulakos and colleagues (2000).

In study 2 the research findings suggest that neither transactive memory systems nor team task conflict directly predict team effectiveness criteria. Nevertheless, the research findings also suggest that team adaptive performance fully mediates the relationship between transactive memory systems and team effectiveness, and between team task conflict and team effectiveness.

In study 3 the team adaptive performance scale was further examined through multilevel factor analysis. The use of a multilevel factor analysis approach allowed to simultaneously fit the within and between covariance matrixes, and determine whether the factorial structure at the within and between levels of analysis was kept constant. The results from the multilevel exploratory factor analysis offered good support to a distinct factor structure across levels. Indeed, the best fitting model suggested a two facto model structure at the within level, while at the between level a one single factor model structure was found. This finding was further supported by the multilevel reliability and confirmatory factor analyses performed after the exploratory factor analysis.

Finally, in study 3 the cross-level relationship between individual and team adaptive performance was also examined. The results suggest that, although individual level thought self-leadership does not predict individual adaptive performance, how teams perform adaptively might positively impact individual adaptive performance. This finding represents a first empirical step towards understanding the multilevel causal dynamics that drive adaptive performance in organizational work environments.

Theoretical and practical contributions

This compilation of studies represents a first effort towards the development of a multilevel adaptive performance scale, under a composition aggregation model framework. By conducting three studies that built on each other, this paper offers a theoretically and methodologically well-grounded measurement tool to measure adaptive performance in individuals and teams. The adoption of multilevel factor analysis also contributes to the existing literature as it suggest that the simultaneous examination of the factorial validity of team level constructs is paramount to fully test the adequacy of the measurement instrument.

Additionally, this study also significantly contributes to the literature because it examines the cross-level dynamics (Hitt, Beamish, Jackson & Mathieu, 2007) happening between individual and team level adaptive performance. This finding taps onto previous contributions (e.g. Han & Williams, 2008), and opens new research ground for multilevel analysis in the realm of adaptive performance in organizational work environments.

The measurement instrument that is here developed can also benefit professionals because it is easy to apply in the field, given its short dimension. Indeed, the small size of the individual and team level measures of adaptive performance makes it very easy to use, being little time consuming. Professionals can use it also for short lagged feedback during coaching sessions or assessment programs, for performance management proposes.

Limitations and future directions

One major limitation of this paper regards the fact that data collection in studies 2 and 3 were was conducted in a simulated context. Still, Peters, Vissers and Heijne (1998) suggest that the degree in which a simulation is useful for research depends on their validity, a concern that was regarded by Raser, Campbell and Chadwick (1970). Raser and colleagues (1970) proposed that the validity of simulated environments for research proposes can follow four criteria. These are (1) psychological validity, the degree in which participants believe they are part of a team and that members are interdependent; (2) structural validity, similarity between simulation and reality; (3) process validity, congruency between simulation and real relationships between variables and processes; (4) predictive validity, ability of the simulation to predict relationships in the real context. In the case of the GMC®, the study was developed on a real-world modeling management competition developed by a company specialized in business simulations. The competition is real, and the winner has the opportunity to face winners from other countries for the final prize. We thought that validity criteria proposed by Raser and colleagues (1970) are fulfilled in our case because simulation mimicked the reality of company management: participants are part of an real interdependent team; they have to take decisions closely matched to real-context; their degree of successful depends on their context (i.e. the other teams); and as part of a competition the results of simulation impacts their real life.

Another limitation regards the fact that the development of the multilevel adaptive performance scale was done on one single cultural context, which requires caution regarding the generalizations of the developed tool and consequent findings. Nevertheless, this limitation gives space to cross-cultural research on individual and team adaptive performance. Although there is little evidence regarding the relation between adaptive performance and culture, research as shown that cultural differences might lead to differences in the way individuals and work groups behave (Burke et al., 2009; House, Javidan, Hanges & Dorfman, 2002).

Finally, literature sustains that adaptation is a dynamic phenomenon that unfolds through time and across different levels of analysis (Arrow et al., 2000; Burke et al., 2006; Kozlowski et al., 1999). However, these claims need conceptual clarification and empirical verification. In future research it would be interesting to examine how the interplay between individual and team performance adaption co-evolve in time.

Conclusion

The study of adaptive performance is a timely topic as organizations across the world are learning to perform in the *age of uncertainty.* Over the past fourteen years, the psychology and management research have witness the development and validation of few measurement tools to assess adaptability in the work place. Through this collection of three studies, we have tried to contribute to the current literature not only by developing a multilevel measurement tool to assess adaptive performance in individuals and teams, but also by expanding what we know regarding the level specific and multilevel dynamics of adaptive performance.

We acknowledge that further work is required on the development of adequate tools to measure adaptive performance in lab and field conditions. Plus, we urge scholars and practitioners to build on the existing literature to lever our comprehension of adaptive performance within and across organizational levels.

6. Study 2: Self-leadership, reflexivity and innovation in teams: The moderating role of transactive memory systems

Abstract

We examine important antecedents of reflexivity to further understand how team innovation occurs, including team member self-leadership skills and transactive memory systems (TMS). We argue that when team members possess self-leadership skills they will reflect on their processes and goals more thoroughly, and this will positively impact team innovation. Furthermore, we propose that TMS will strengthen this relationship. We tested our hypotheses in a sample of 237 healthcare nurses (52 teams). Our findings show that the indirect effect of team members' self-leadership on team innovation through team reflexivity is conditioned on the team's TMS, but not in the manner hypothesized. As TMS increases, the conditioned indirect effect of team members' self-leadership on team innovation through reflexivity decreases. This study contributes to the literature by addressing how team capabilities and cognitive processes combine to affect innovation. This study makes practical contributions by offering ideas for organizing in healthcare settings.

Key-words: Healthcare teams; moderation; reflexivity; self-leadership; team innovation; transactive memory systems.

Self-leadership, Reflexivity and Innovation in Teams:

The Moderating Role of Transactive Memory Systems

Hospitals are dynamic and fast changing work environments where healthcare teams have to cope with unpredictability and find effective solutions out of crises (; Ortega, Van den Bossche, Sánchez-Manzanares, Rico & Gil, 2014; Salas, DiazGranados, Weaver & King, 2008; Tschan, Semmer, Gurtner, Bizzari, Spychiger, Breuer & Marsch, 2009). Such complexity has contributed to the growing interest in understanding the enabling conditions that foster team effectiveness in healthcare work environments, where healthcare professionals' performance is important to guarantee patient health and well-being during hospitalization (Bedwell, Ramsay & Salas, 2012; Borrill, West, Shapiro & Rees, 2000; Ortega et al. 2013).

Healthcare teams are expected to gather data about patients, accurately diagnose illnesses and injuries, determine necessary procedures, and deliver high quality patient care. Nevertheless it is often the case that clinical standard procedures or hospital policies do not provide the necessary conditions for delivering the best patient outcomes (West, 2002). Specialized equipment might not be immediately accessible or nearby, or a patient might require a non-routine combination of equipment or technologies. For example, imagine a situation where an epileptic patient is admitted for cardio-vascular distress. The patient would need not only an artificial respiratory system to relieve the cardio-vascular distress, but also a bed with padded straps and lateral supports in case of an epileptic episode. In this real-life situation, the cardio-vascular nursing team improvised a system of straps and supports using soft bandages, so that the patient did not need to be moved to a specially equipped bed. This innovation lessened the risk of a life-threatening seizure that might otherwise be caused by moving the patient. Other, more systemic problems (e.g. high wound reinfection rates) also require innovative action (e.g. developing new protocols for treating different types of wounds). As these examples suggest, innovation results from a complex combination of skills, processes and cognition that help the team to proactively adjust to unexpected events or deviations from the norm (Bell & Kozlowksi, 2008; West, 2002).

Team innovation is defined as the intentional introduction and application within a role, group or organization, of ideas, processes, products or procedures that are new and relevant to the team, and that significantly benefit the team and the systems in which it is embedded (West & Farr, 1990). Team innovation contributes to functional adaptations to technological, administrative, and ancillary change in organizational work environments such as hospitals (West, 2002; Damanpour, 1987). Additionally, team innovation contributes to higher team productivity, improved service quality and interpersonal processes (Curral, 2005; West & Lyubovnikova, 2013) in these settings. In their meta-analysis of team innovation, Hülsheger, Anderson and Salgado (2009) found that innovation is sensitive to input variables such as team goal interdependence and organizational support for innovation, and to team process variables such as task orientation, cohesion, and internal and external communication.

Understanding how individual skills and team processes and cognition combine in real work environments is important for deeper insights about the mechanisms leading to team innovation (Burke, Stagl, Salas, Pierce & Kendal, 2006a; Marks, Mathieu & Zaccaro, 2001; West, 2002). Although team processes such as reflexivity, and team cognition such as transactive memory systems (TMS) have been shown to have direct relationships with team innovation (Gino, et al. 2010; Peltokorpi & Hasu, 2014; Ren & Argote, 2013; West & Anderson, 1996), little is yet known regarding how these combine to predict team innovation. Furthermore, how team members' skills contribute to the processes leading to team innovation remains unclear (Stewart, Courtright & Manz, 2011). We argue that team members' self-leadership skills influence team innovation by increasing team reflexivity. We further propose that TMS will enhance the positive effects that reflexivity might produce, thus allowing teams to be more innovative. This study contributes to the literature by clarifying some important member characteristics and team processes driving team innovation in real healthcare teams.

Background and Hypotheses

Team member skills: Self-leadership

In this paper we examine team member skills in the form of self-leadership, defined as an individual's capacity for performance enhancement, through a repertoire of ongoing cognitive, motivational and behavioral self-regulation strategies (Manz, 1986). Research on self-leadership has shown support for a positive relationship between self-leadership and key constructs such as self-efficacy and task performance (Prussia, Anderson & Manz, 1998). We argue that team members' self-leadership skills also play an important role in team innovation.

Self-leadership is a self-regulatory set of skills through which individuals gain control of their own behaviors, thoughts and motivations, and thereby perform more effectively (Neck & Houghton, 2006). Self-leadership includes the combined utilization of the following three self-regulatory strategies: behavior focused strategies (BFS); natural reward strategies (NRS); and thought pattern strategies (TPS) (Manz, 1986). We discuss each of these strategies in turn, highlighting especially their potential effects on team innovation.

The BFS comprise self-monitoring (i.e. reflection about the effectiveness of individual performance in relation to the task, the team and the organization, and how to improve it), self-goal setting (i.e. the establishment of personal and professional goals that can be aligned with the team's or the organization's goals), self-reward administration (i.e. a contingency reward system through which individuals give themselves specific rewards once they have accomplished their objectives), and self-cueing (i.e. a set of personal strategies that individuals have developed for themselves to help them remember what they have yet to accomplish, and what rewards await them upon goal accomplishment) (Neck & Houghton, 2006). Empirical research shows that BFS such as self-monitoring are especially useful for adaptation-innovation problem solving (Gomes, Curral & Caetano, 2014). Indeed, using self-monitoring strategies facilitates individuals' decision making regarding whether to adopt an adaptation or innovation strategy to manage challenges efficiently. Furthermore, a study by Marques-Quinteiro and Curral (2012) found that BFS positively predict task and team directed proactive behaviors such as initiating better ways of doing core tasks or suggesting ways to improve team processes. Marques-Quinteiro and Curral (2012) also found BFS to positively interact with NRS and TPS to predict task and team directed individual proactive behaviors.

The NRS stimulate the seeking and promotion of pleasant and enjoyable feelings that are individual, team and organization oriented. These are aimed at energizing task oriented behaviors as a way to maximize performance, and can be achieved through positive job perspective (i.e. transform all job related negative cues into positive ones in order to increase the enjoyableness of the situation), and task affective modeling (i.e. consciously choosing either not to think about a negative aspect of the work environment or to focus solely on the positive aspects). NRS are likely to be relevant to reflection and innovation because they foster positive affect in individuals and teams.

Research by Shin (2014) suggests that positive group affective tone positively predicts creativity, and that this relationship is mediated by team reflexivity.

Finally, TPS encompass the regulatory mechanisms through which individuals manage the fit between thought and action. This cognitive regulatory function is achieved through the evaluation of one's values and beliefs (i.e. monitoring and adaptation of personal beliefs, in order to cope with changing situations), self-talk (i.e. a monologue performed either mentally or out loud, which contributes to increased self-awareness, better problem solving, and emotional control in challenging scenarios), and mental imagery (i.e. an individual's capacity to look ahead in order to cognitively simulate how tasks will be performed, and create a mental image of the desired outcomes) (Neck & Houghton, 2006). Marques-Quinteiro and Curral (2012) found that the use of TPS enhances the utilization of BFS in the prediction of proactive behavior. As individuals optimize thinking patterns (e.g. develop adequate mindsets), how they monitor individual and collective performance and whether it deviates from previously established standards might become more precise.

Despite the volume of research on self-leadership, very few studies have considered how individual self-leadership skills can contribute to team level phenomena (Hauschildt & Konradt, 2012; Marques-Quinteiro, Passos & Curral, 2014; Millikin, Hom & Manz, 2010). In one laboratory study by Hauschildt and Konradt (2012) the authors found that individual self-leadership positively predicts individual task performance, proficiency, proactivity and adaptability in team settings. A study by Millikin and colleagues (2010) showed that teams whose team members had higher self-leadership skills positively contributed more to team productivity than teams whose elements had less self-leadership skills. Another study, by Marques-Quinteiro and colleagues (2014), demonstrated a positive relationship between team member TPS and collective efficacy and effectiveness in self-managed teams.

In addition to the research findings described above, there is evidence that individuals high in self-leadership generate more creative ideas and are more capable of converting them into innovative solutions (Carmeli, Meitar & Weisberg, 2006; Gomes et al., 2014; Curral & Marques-Quinteiro, 2009). These results suggest that the more members with high self-leadership skills in a team, the more likely that creative ideas will be generated, discussed, and evaluated. Together with findings showing that self-leadership affects not only performance and effectiveness, but also proactivity and adaptability in team settings, we anticipate that members' self-leadership will affect a team's capacity to innovate.

Specifically, innovation requires team members to be able to: *(a)* identify and define problems, *(b)* pro-actively search and gather resources (human and non-human) for idea support and validation, and *(c)* present, test and validate the ideas developed (West, 2002). Self-leadership skills are likely to be useful for each of these collective activities. Specifically, self-leadership skills such as mental imagery will help the team identify and define problems by imagining whether current behavior will lead to desired outcomes, and to devise alternative strategies to cope with the situation (Marque-Quinteiro et al., 2014). Skills such as self-monitoring and self-talk will encourage team members to openly share their thoughts and communicate with each other. Through self-monitoring individuals become increasingly aware of whether individual and collective behavior is being adequately displayed in order to achieve previously established goals. Self-talk will promote open communication and reflection among team members (e.g. Neck & Houghton, 2006).

Finally, self-leadership skills focused on the evaluation of values and believes will motivate a member to proactively search for needed information and resources, and to challenge the status quo. Engaging in such behaviors will affect the team's ability to collectively assess ideas and test them through their collective activities. Therefore, we predict that:

Hypothesis 1: Team members' self-leadership is positively related to team innovation.

The above arguments suggest there is a positive relationship between members' self-leadership and team innovation. We posit that the mechanism by which this relationship unfolds is through team reflexivity, described next.

Team processes: Team reflexivity

Team reflexivity regards team members collectively reflecting upon the team's objectives, strategies and processes, as well as their wider organizations and environments, and adapting them accordingly (West, 2002). Team reflexivity involves activities such as engaging in reflection (e.g. questioning), planning (e.g. short and long term planning), and adaptive action (e.g. cycles of adaptation, planning and action). Team reflexivity facilitates team environmental awareness and the amount of task-relevant information that is shared among team members during problem solving (Carter & West, 1998; DeDreu, 2002; Gabelica, Van den Bossche, Segers & Gijselaers, 2014). Reflexivity also stimulates the discussion of team and task relevant topics that might otherwise be ignored, and helps keep team members continuously updated regarding goal accomplishment, team strategy, and (un)anticipated change (Tjosvold, Tang & West, 2004).

Prior research has established a strong and direct link between reflexivity and innovation (Carter & West, 1998; Müller, Herbig & Petrovic, 2009; Schippers, West & Dawson, 2012; Tjosvold et al., 2004). For instance, Müller and colleagues (2009) conducted an experimental study in which the authors found that group processes such as reflexivity facilitate team innovation in complex tasks. Another study by Schippers and colleagues (2012) with 98 primary health care teams, found that the amount of reflexive behaviors in which health care teams engaged positively predicted team innovation. Therefore we expect that:

Hypothesis 2: Team reflexivity is positively related to team innovation.

We argued earlier that team members' self-leadership is related to the team's capacity to develop innovative solutions to problems. This likely happens because the self-regulation strategies involved in self-leadership invite discussion and reflection not only about individual activities, but also about the team's task and task environment, and about the collective objectives and processes of the team (Manz, 1986; Marques-Quinteiro et al., 2014; Stewart et al., 2011). In addition, self-leadership increases the personal capacity for monitoring cues that signal dysfunctional behavior, cognition and emotion (Neck & Houghton, 2006). Should a team reach a moment in which performance or interpersonal dynamics falter, self-leading team members might more easily identify these deviances and promote collective reflection (Hauschildt & Konradt, 2012; Stewart et al., 2011). Self-leaders are also apt to be more aware of team goals and goal achievement and more able to encourage other team members to proactively reflect about the situation, and develop a new strategy when needed (Marques-Quinteiro & Curral, 2012; Stewart et al., 2011).

Together, these arguments suggest that team members with high self-leadership skills will enact strategies that promote and encourage *collective* reflection. It is through collective reflexive processes that self-leadership promotes team innovation. Therefore, we hypothesize:

Hypothesis 3: Team member's self-leadership has an indirect effect on team innovation, through team reflexivity.

In the next section we explore how team cognition, in the form of a team's transactive memory system (TMS) interacts with team member skills and team reflexivity to influence innovation.

Transactive memory systems

A TMS is a shared cognitive system that combines each member's memory system with a shared understanding of which members possess and are responsible for what knowledge (Moreland, 1999; Wegner, 1987). Research on TMS shows it is positively related to team learning and performance (Lewis, Lange & Gillis, 2005; Marques-Quinteiro, Curral, Passos & Lewis, 2013). Recent research also suggests that in helping members to integrate diverse knowledge, a TMS can foster the development of creative (Gino et al., 2010) and innovative (Peltorkopi & Hasu, 2014) solutions to complex problems.

A TMS reflects how individualized knowledge is combined to influence team processes and team related outcomes (Littlepage, Hollingshead, Drake, & Littlepage, 2008; Moreland, 1999), and can develop from team members' experience when training or working together (Lewis et al., 2005; Liang, Moreland & Argote, 1995). When collaborating, team members divide the cognitive labor for a task such that different members become responsible for learning, remembering, and communicating information about different aspects of the team's task. Trusting other team members for certain task-relevant knowledge frees up each member to deepen expertise in a specific area, rather than worry about learning new information that is already possessed by other members (Lewis, 2003). This gives the whole team greater access to a large amount of task-relevant knowledge that can be brought to bear on team tasks (DeChurch & Mesmer-Magnus, 2010; Moreland, 1999; Zajac, Gregory, Bedwell, Kramer, & Salas, 2014).

The innovative process is often sensitive to deviances that generate noise (e.g. information biasing) inside the team (West, 2002). During the development and implementation of innovative solutions, more effective teams might be those whose information-processing and management capacity are enhanced by TMS. In particular, reflexivity is likely to be most effective when specialized knowledge possessed by different members is used during *collaborative group processes* (West, 2000). Team reflexivity is grounded on how team members use their knowledge to reflect about team's strategy and status quo, and to decide whether there is any need for change in team dynamics (West, 2000). When teams have stronger TMS, a greater amount of knowledge is accessible and available to the team during task processing. Greater knowledge and increased accessibility might further improve the team's reflexive processes, by helping the team making more informed decisions concerning team's goals and progress towards innovation. Conversely, without a TMS, less information is available for collective scrutiny. In complex work environments such as hospitals, the absence of distributed knowledge structures such as TMS can be detrimental to team processes and outcomes because it reduces the knowledge that teams use during reflection (Marques-Quinteiro et al., 2013). Based on these arguments, we hypothesize that:

Hypothesis 4: The indirect effect of team members' self-leadership on team innovation through reflexivity is conditioned by TMS, such that the indirect effect is stronger when TMS is high rather than low.

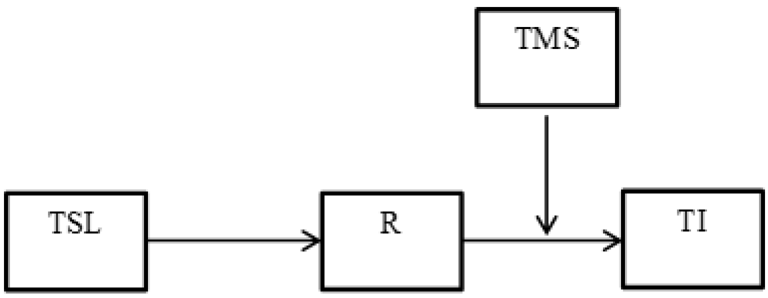

Figure 1 - The research model (TSL: team member self-leadership; R: reflexivity; TMS: transactive memory systems; TI: team innovation).

Method

Participants

Fifty-two healthcare hospital nursing teams (237 individuals) from an integrated health care unit in the Portugal participated in this study. Team membership and team structures are stable among these teams, and work is organized in shifts.

Nursing teams in this hospital are responsible for performing such tasks as taking patients' clinical histories, measuring vital signs, verifying heart rate and body temperature, administering medicine, performing cardio-pulmonary resuscitation, preparing patients for surgery, and assisting in all medical interventions (e.g. surgery; checkup visits to patients; clinical analysis). Nursing teams are also expected to deliver social care (e.g. providing emotional support to patients and their families), prepare patients for discharge, and arrange for patients to be transferred to another facility (Silva et al., 2013).

From the 79 teams (296 individuals) that were invited to participate in this study, 27 teams returned incomplete questionnaires and for this reasons these teams' responses were excluded from the study's sample. The size of the participating teams varied between 3 and 7 members, with an average of 4.55 individuals per team. The age average of team members was 32.31 years (*S.D* = 4.97 years) and 73% of the participants were female. On average, participants had 6.75 years of experience working together in the same team and worked an average of 38 hours per week.

Procedure

After contacting the Hospital Administration, we presented to the hospital's ethics committee a detailed description of the study's objectives and how we intended to treat the data. As soon as we obtained authorization from the hospital's ethics committee, we emailed each department's director to ask for his/her permission to collect data on site, by inviting nurses to participate in the study. Three researchers visited the hospital on five occasions. Data were collected by visiting each sub-unit of the hospital, and by inviting each member of the in-shift nursing team to complete an anonymous paper and pencil questionnaire. Team members responded to questions regarding self-leadership skills, team reflexivity and TMS. Team leaders were asked to rate team innovation.

Measures

All the measurement instruments used in this study have been previously adapted and validated to the Portuguese context, and have been published elsewhere.

Self-leadership was measured using the Houghton and Neck (2002) revised self-leadership questionnaire (RSLQ), translated and adapted by Marques-Quinteiro, Curral and Passos (2012). From the original 24 items validated by Marques-Quinteiro and colleagues (2012) (e.g. "I visualize myself performing well on relevant tasks."), three items with poor factor loadings were removed, resulting in a 21-item scale (Cronbach α

= .87; χ^2 (189) = 396.427, $p < .001$; χ^2/d.f = 2.1; RMSEA = .06; CFI = .92; TLI = .90 ; SRMR =.06). Participants gave their responses on a 5-point scale ranging from *totally disagree* (1) to *totally agree* (5).

Team reflexivity was measured using Swift and West's (1998) team reflexivity scale, translated and adapted by Curral (2005) (Cronbach α = .77; χ^2 (34) = 125.415 , $p < .001$; χ^2/d.f = 3.7; RMSEA = .09 ; CFI = .91 ; TLI = .90; SRMR = .05). The scale had 12 items (e.g. "the team often reviews its approach to getting the job done") and participants gave their responses on a 5-point scale ranging from *totally disagree* (1) to *totally agree* (5).

Transactive memory systems were measured using Lewis' (2003) TMS scale. Because questionnaire space (and respondent time) was limited, we used 9 items of the original 15-item scale. A similar procedure was used by Marques-Quinteiro and colleagues (2013). In that study, the items with the highest factor loadings on each of the specialization, coordination, and credibility subfactors of the scale were retained. Example items include (e.g. Specialization: "Each team member has specialized knowledge of some aspect of our work", Credibility: "I know which team members have expertise in specific areas", and Coordination: "Our team had very few misunderstandings about what to do"; Cronbach α = .74; χ^2 (24) = 60.877, $p < .001$; χ^2/d.f = 2.5; RMSEA = .07; CFI = .95; TLI = .93; SRMR = .5). Participants gave their answers on a 7-point scale Likert scale, ranging from *totally disagree* (1) to *totally agree* (7).

Team innovation was assessed using West, Shackleton, Hardy and Dawson (2001) team innovation scale, translated and adapted to the healthcare context by Curral (2005) (Cronbach α = 0.94). The scale had 5 items (e.g. "to what extent did your teams introduce new methodologies to facilitate goal accomplishment?"), and team leaders gave their responses on a 5-point scale ranging from *never* (1) to *always* (5). Our approach to measuring team innovation by team leaders' ratings follows previous studies advocating the use of supervisor ratings to examine job related effectiveness criteria (e.g. Ziegler, Hagen & Diehl, 2012).

As *control measures* we used team size (i.e. the number of individuals in the team), and team tenure (i.e. the time team members have been working together as a team). These control variables were selected based on existing literature that suggests that these might influence reflexivity, TMS and outcomes in workgroups (e.g., Curral, Forrester, Dawson, & West, 2001; Lewis, 2004).

Aggregation procedures

In this study we used a composition approach to aggregate our variables to the team level (Chan, 1998; Costa, Graça, Marques-Quinteiro, Santos, Caetano, & Passos, 2013). We tested within group agreement by considering the Rwg index (James, Demaree & Wolf, 1984). The estimation of inter-rater reliability was done using the intraclass correlation indexes 1 and 2 (ICC1 and ICC2) (Bliese, 2000; Kozlowksi & Klein, 2000). The mean $R_{wg\,(j)}$ values for team member self-leadership, reflexivity and TMS were .91 (ranged between .70 and .98), .82 (ranged between .38 and .99), and .87 (ranged between .58 and .97) respectively. The ICC1 values for team member self-leadership, reflexivity and TMS were .18, .12 and .15, respectively. The ICC2 values for team member self-leadership, reflexivity and TMS were .58, .40 and .45, respectively. These results suggest that aggregation to the team level is justified, and also show that there was significant variability between teams.

Results

Table 13 provides the correlations, means and standard deviations for the variables of interest. Team innovation was not significantly correlated with team member self-leadership (r = .12, p > .05). The absence of a significant correlation between both constructs suggests the absence of a direct relationship between them. Hypothesis 1 was rejected.

Team reflexivity was positively correlated with team innovation (r = .31, p < .05), team member self-leadership (r = .39, p < .01) and TMS (r = .54, p < .01). The correlation between TMS and team innovation was not significant (r = .14, p >.05).

Table 13 - Intercorrelations and descriptive statistics.

	1	2	3	4	5	6	*M*	*SD*
1. Team tenure.	-	-	-	-	-	-	6.76	3.91
2. Team size.	.02	-	-	-	-	-	4.55	.90
3. Team member self-leadership.	.03	-.12	-	-	-	-	4.53	.89
4. Team reflexivity.	-.11	.18	.39**	-	-	-	3.44	.36
5. Transactive memory systems.	-.17	.05	.40**	.54**	-	-	5.40	.62
6. Team innovation.	-.07	-.01	.12	.31*	.14	-	3.36	.74

Note[1]. ** p < 0.01, * p < 0.05

To test hypotheses 1 through 4, we used PROCESS 2.13 (Hayes, 2012-2014), which is a computational tool to analyze "conditional process models" that are path analysis based, and that estimate direct and conditioned effects, controlling for at least one variable. PROCESS estimates the coefficients of a model using OLS regression (for continuous outcomes) and allows the estimation of the interaction effects using bootstrap analysis, for the 10th, 25th, 50th, 75th and 90th percentiles at a 95% confidence interval. It allows for the estimation of all paths in the model and for the utilization of the bootstrap method, which is considered a more powerful technique than the three-step multiple regression approach (Baron & Kenny, 1986) for estimating conditional indirect effects (Hayes, 2013). PROCESS also estimates an index of moderated mediation (δ) which describes the total conditional indirect effect (i.e. the slope moderated mediation) (Hayes, 2013).

Table 14- Results for indirect effects.

Predictor variable	B	*SE*	*t*	*p*	LLCI	ULCI
DV: Team reflexivity (Mediator variable model) $R^2 = .22$, $p < .01$						
Constant.	-1.81	.53	-3.40	.001	-2.88	-.74
Team member self-leadership.	.27	.08	3.27	.002	.10	.43
Team tenure.	-.01	.01	-1.07	.29	-.04	.01
Team size.	.10	.05	1.86	.07	-.01	.20
DV: Team innovation (outcome variable model) $R^2 = .10$, $p = .28$						
Constant.	1.47	1.29	1.14	.26	-1.11	.24
Reflexivity	.66	.32	2.05	.05	.01	1.30
Total effect of team member self-leadership.	.16	.19	.84	.40	-.22	.54
Direct effect of team member self-leadership.	-.02	.20	-.09	.93	-.42	.39
Indirect effect of team member self-leadership.	.18	.12	-	-	.01	.47
Team tenure.	-.01	.03	-.20	.85	-.06	.05
Team size.	-.06	.12	-.46	.65	.30	.19

Note. N = 52. DV = Dependent variable. Bootstrap = 5.000. Variables and interactions were mean-centered.

The research findings show that team members' self-leadership has a positive relationship with team reflexivity (B = .27, S.E = .08, $p < .01$, 95% CI [.10, .43])**.** This finding suggests that members' self-leadership skills contribute to team reflexive processes.

Team reflexivity was positively related with team **i**nnovation (B = .66, S.E = .32, $p < .05$, 95% CI [.01, 1.30]). This finding supports hypothesis 2 and reinforces previous research showing evidence of a positive link between reflexivity and innovation in teams (e.g. Carter & West, 1998; Müller et al., 2009; Schippers et al., 2012; Tjosvold et al., 2004**).** The results also show that there is an indirect effect of team members' self-leadership on team innovation through reflexivity **(**B = .18, S.E = .12, 95% CI [.01, .47]). This finding supports hypothesis 3 and suggests that the effects of self-leadership on team innovation are transmitted through team reflexivity (table 15).

Table 15 - Results for conditional indirect effects.

Predictor variable	B	*SE*	*t*	*p*	LLCI	ULCI
DV: Team reflexivity (Mediator variable model) R^2 = .22, p < .01						
Constant.	-1.81	.53	-3.40	.001	-2.88	-.74
Team member self-leadership.	.27	.08	3.27	.002	.10	.43
Team tenure.	-.01	.01	-1.07	.29	-.04	.01
Team size.	.10	.06	1.86	.07	-.01	.20
DV: Team innovation (outcome variable model) R^2 = .24 , p = .05						
Constant.	4.27	1,28	3.34	.002	1.70	6.85
Reflexivity	.79	.33	2.34	.02	.12	1.47
Team member self-leadership.	-.08	.20	-.40	.70	-.48	.32
Transactive memory systems.	.01	.19	.04	.97	-.38	.40
Interaction.	-1.18	.41	-2.84	.007	-2.01	-.34
Team tenure.	.01	.03	.24	.82	-.05	.06
Team size.	-.09	.11	-.77	.45	-.31	.14
Conditional indirect effects of team member self-leadership on team innovation trough reflexivity, at five percentile values of transactive memory systems.						
10^{th} % = -.90	.50	.23	-	-	.12	1.02
25^{th} % = -.40	.34	.16	-	-	.07	.72
50^{th} % = .05	.20	.12	-	-	.03	.51
75^{th} % = .38	.09	.11	-	-	-.05	.40
90^{th} % = .72	-.01	.12	-	-	-.20	.29
Index of moderated mediation						
	δ	*SE*	LLCI	ULCI		
Reflexivity	-.32	.15	-.70	-.07		

Note. N = 52. DV = Dependent variable. Bootstrap = 5.000. Variables and interactions were mean-centered.

TMS was expected to have a positive conditional indirect effect on team innovation. It was hypothesized that at higher levels of TMS, the relationship between team members' self-leadership and team innovation, mediated by team reflexivity, would be stronger for teams with high rather than low TMS. Contrary to our predictions, TMS negatively moderated the relationship between team reflexivity and innovation ($B_{interaction}$ = -1.18, S.E = .41, p < .01, 95% CI [-2.01, -.34])**.** In addition, TMS negatively moderated the indirect effect of members' self-leadership on team innovation through reflexivity. This effect is evidenced by the negative slope describing the mediating role of reflexivity as TMS increases (δ = -.32, S.E = .15, 95% CI [-.70, -.07]) (Hayes, in press). These findings reject hypothesis 4 (table 10). These findings suggest that as TMS increases, the conditioned indirect effect of team member self-leadership on team innovation, through reflexivity, decreases and becomes non-significant. Further inspection showed that at certain values of TMS, however, the moderating effect of TMS on these relationships is significant. At low to moderate levels of TMS, reflexivity significantly and positively mediates the relationship between team members' self-leadership and team innovation. However, at higher levels of TMS, the strength of this mediated relationship decreases and becomes no significant.

The results in tables 9 and 10 show that none of the control variables (i.e. team size and team tenure) significantly contributes to team innovation in our sample.

Discussion

Understanding teamwork dynamics and how team innovation emerges in healthcare work environments is fundamental for identifying the drivers and inhibitors of patient care quality (Bedwell et al., 2013). In this study, our aim was to extend previous knowledge on the psychological mechanisms driving team innovation in hospital settings. To address this goal, we have integrated team members' skills with team processes and team cognition literatures to examine to what extent the combined self-regulatory and information-processing capacities of team member self-leadership (Stewart et al., 2011), team reflexivity (Schippers, Edmonson & West 2014) and TMS (Lewis & Herndon, 2011) predict team innovation in healthcare nursing teams.

Hypothesis 1 proposed that team members' self-leadership skills would have a positive relationship with team innovation. This hypothesis was not supported because no significant direct relationship was found between constructs. One possible explanation might be that self-leadership skills alone might be insufficient to drive team innovation. Despite the enhanced self-regulatory capacity of individual self-leaders, team innovation might be insensitive to individual contributions alone. Being a complex emergent process, team innovation might depend on collective and highly interdependent team processes such as reflexivity (West, 2002).

As expected, our findings show that team reflexivity positively contributes to team innovation in healthcare nursing teams. This finding is in line with previous research showing evidence of the importance of team reflexivity to achieve innovation in a variety of teamwork contexts such as healthcare (e.g. Schippers et al., 2012), services and industry (e.g. Carter & West, 1998; Peltorkopi & Hasu, 2014; Tjosvold et al., 2004). Through the meta-reflexive capabilities of team reflexivity, teams reflect about their goals, strategy and processes, and adjust them accordingly (Graça & Passos, 2012). By being able to continuously adapt, teams are able to maintain optimal functioning, which then facilitates their capacity to innovate (West, 2000).

Hypothesis 3 suggested that team members' self-leadership skills could have a positive indirect effect on team innovation, through team reflexivity. We argued that the action and reflection capacities of individual self-leaders (Neck & Houghton, 2006; Stewart et al., 2011) would feed team reflexive processes positively. This positive relationship would then have a positive influence on team innovation. Our findings support this argument, suggesting that it is through collective reflection that individual self-regulation strategies influence team innovation.

Finally, TMS was hypothesized to have a conditioned indirect influence on the relationship between team members' self-leadership skills, team reflexivity and team innovation. It was expected that for teams with higher TMS, the relationship between team reflexivity and team innovation would be strengthened. Contrary to our expectations, the reflexivity to innovation relationship was strengthened at low, rather than high levels of TMS. Higher levels of TMS appear to weaken the effect of team reflexivity on team innovation and weaken the indirect effect of team member self-leadership on innovation through reflexivity. One possible explanation might be that when team members are well aware of the location of expert knowledge within the team, and they actively use such knowledge, the need to engage in reflexive behaviors is perceived as being less relevant. This argument finds support in research that shows that experts tend to be less inclined to think about and accept ideas that contradict or are different from those they hold as true (Castel, McCabe, Roediger III & Heitman, 2007). Furthermore, individual members with a large amount of domain knowledge may confine their search for information and ignore alternative explanations. When striving for innovation, teams with high-expertise team members might feel less inclined to reflect, thus achieving poorer innovation outcomes compared to teams that do reflect. This line of arguments also finds support in recent work by Peltorkopi and Hasu (2014). The authors found a "U shaped" curvilinear relationship between TMS and team innovation. According with Peltorkopi and Hasu (2014) the most innovative teams are the ones with moderate levels of TMS. Additionally, the authors found that while too little TMS turned out to be insufficient to the development of innovation (patents), too much of it caused poor team process that harmed innovation.

Theoretical and Practical Implications

In healthcare work environments, team member skills and team processes are fundamental in the prediction of team innovation. Nevertheless, our findings suggest that team cognitive structures such as TMS can hinder the benefits of reflexivity when it comes to predicting team innovation. These findings launch new research opportunities as they open space for research and debate. Although so far TMS have often been positively associated with relevant team processes (e.g. learning, coordination), and outcomes (e.g. performance) (Austin, 2003; Lewis et al., 2005; Marques-Quinteiro et al., 2013), the results of this study suggest that there might be a darker side for TMS. Given this we encourage researchers to further explore this finding.

Research on the drivers of team reflexive and innovative behavior in the work place has paid little attention to the influence of team member characteristics and collective cognition. The empirical findings from this study shed new light on the dynamics of team innovation in the workplace, particularly in healthcare. Our findings suggest that team member characteristics such as self-leadership skills are positively related with team reflexivity, and indirectly influence team innovation. These findings extend previous work on the relationship between team members' self-leadership skills and teamwork phenomena (e.g. Marques-Quinteiro et al., 2014; Millikin et al., 2010), by showing evidence of a positive relationship between self-leadership and key team processes. Our findings further suggest that under conditions of high TMS, the indirect influence that team members' self-leadership skills have on team innovation through reflexivity is reduced. Such hindering effect may be due to the overreliance on the team TMS. The knowledge team members with high self-leadership skills have about the skills of the other members of the team may inhibit their engagement in overt coordination acts like reflexivity. This interpretation is grounded in research by Peltokorpi and Hasu (2014) showing that TMS produce an incremental effect on team innovation up to a point where they start having a detrimental relationship. Furthermore, the meta-resourcefulness provided by TMS is intimately related with implicit communication and action (Marques-Quinteiro et al., 2013), hence reducing the need for explicit behaviors such as reflexivity. It would then be plausible to say that high TMS reduce the need for explicit team behavior/process as it gives the team an implicit response mechanism.

Limitations and Future Research Directions

One limitation of this study is its cross-sectional design. Although cross-sectional research is useful for examining the relationships between constructs, it gives a limited understanding of how the variables of interest influence each other over time or across levels of analysis. Another limitation is the use of a measurement scale to assess team innovation. Although the scale has good reliability and had been previously adapted to the sample population it would have been helpful to also assess innovation based on objective ratings, such as the amount of modifications that had been successfully introduced.

Future research should extend these findings within a longitudinal framework by *dynamically* examining the conditions under which reflexivity and TMS interact over time. Indeed literature has provided research supporting that team processes and cognitions influence each other over time (Santos & Passos, 2013). Using a longitudinal approach, researchers could examine which factors trigger work teams to engage in reflexive behavior and which factors trigger the use of TMS, and how these combine to influence team innovation over time.

7. Study 3: And now what do we do: The role of transactive memory systems and task coordination in action teams

Abstract

For emergency response teams such as SWAT (special weapons and tactics) or police tactical teams, team performance comes with life or death consequences. Nevertheless, research gives little attention to the dynamics particular to teams performing in extreme, dangerous, and stressful situations. In teams like police tactical teams the ability to coordinate members' actions and expertise, while adapting to evolving circumstances, is paramount. This study examines the combined effects of team implicit coordination and transactive memory systems on team adaptive behaviours and performance in a sample of 42 real police tactical teams. Contrary to predictions in the literature, our findings suggest that team implicit coordination can benefit performance even for teams performing non-routine tasks. Moreover, we found that the relationship between team implicit coordination and team adaptive behaviours is strengthened by transactive memory systems. In the end, we discuss the implications of these findings and point new directions for future research.

Keywords: Moderated mediation; Police tactical teams; Team adaptive behaviour; Team implicit coordination; Transactive memory systems.

Publication note

This study is published under the reference "Marques-Quinteiro, P., Curral, L., A., 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* (3), 194".

And now what do we do? The role of transactive memory systems and task coordination in action teams

Team performance in complex and dynamic environments is a growing area of research with theoretical and practical relevance (Cronin, Weingart, & Todorova, 2011). Teams performing in complex environments frequently have to adjust their behaviours to dynamic contexts and unanticipated situations (Burke et al., 2006; Rico, Sánchez-Manzanares, Gil, & Gibson, 2008). Examples of teams that operate in such environments include cockpit crews (Grote, Kolbe, Zala-Mezo, Bienefeld-Seall, & Künzle, 2010), military teams (Dalenberg, Vogelaar, & Beersma, 2009), medical teams (Burtscher, Wacker, Groyte, & Manser, 2010), and emergency response teams such as *SWAT* (special weapons and tactics) teams or *police tactical teams* (PTT). Such teams work under the most extreme, dangerous, and stressful task environments, in which they often encounter unexpected events that force them to perform adaptively (Grabarino et al., 2012; Ishak & Ballard, 2001; Bechky & Okhuysen, 2011).

Research regarding team performance in complex task environments suggests that performance might depend on the ability of team members to implicitly coordinate their activities, because this is often critical in emergency situations where explicit coordination through verbal commands may be impossible or ill-advised (e.g. Burtscher et al., 2010; Ishak & Ballard, 2011; Rico et al., 2008). *Implicit coordination* refers to team members' abilities to anticipate the actions and needs of their colleagues, and of their task, and dynamically adjust their own behaviour accordingly without having to communicate directly with each other or plan the activity (Rico et al., 2008). Research suggests that team implicit coordination should positively affect team performance more strongly when the task is routine (Rico et al., 2008; Riethmüller, Castelao, Eberhardt, Timmermann & Boos, 2012). While team implicit coordination is desirable in PTTs, the tasks encountered by PTTs are rarely routine. We argue that PTTs with the capability to coordinate implicitly will be better able to adapt performance to non-routine environments when they also have developed a transactive memory system (TMS).

A transactive memory system (TMS) is a shared cognitive system that combines each member's memory system with a shared understanding of which members know, and are responsible for, what knowledge (Moreland 1999; Wegner 1987). Much of the research on

TMSs has shown that teams with a TMS perform at higher levels than do teams without a TMS, especially on tasks with which the team already has experience (Lewis & Herndon 2011; Ren & Argote 2011). For emergency response teams such as PTTs, the particular expertise needed cannot be predicted in advance and may differ from one situation to another. We argue that a TMS can benefit PTTs by helping members quickly locate and utilize expertise of the team's members. In so doing, a TMS can become a critical resource upon which members can draw during non-routine and dynamic task environments.

We investigate the relationships between team implicit coordination, TMS, team adaptive behaviours, and performance in a sample of real police tactical teams (PTT), whose tasks can include responding to bomb threats, rescuing civilians from hostage situations, and stopping riots. For these PTTs, the ability to perform effectively plays a fundamental role in guaranteeing law and order. Our findings shed new light on the relationships between implicit coordination, TMS, and adaptive behaviours, and how these contribute to our understanding of team performance in action teams.

Background and hypotheses

Team Implicit Coordination, Adaptive Behaviours, and Performance

Imagine a PTT entering a bomb-threat situation in a building. The team's performance depends on completing the mission while minimizing casualties and injuries. In preparing to enter the building, the team reviews all the available information about the building infrastructure, so an action and escape route can be devised in case something goes wrong. The team's strategy and team members' roles have been previously set so everyone knows exactly what to do when arriving at the mission location. When entering the room in which the bomb is hidden, the team finds not a typical detonation device, but a detonation device that is attached to a civilian whose cardiac rhythm is the trigger. Faced with this unanticipated situation, the team immediately has to rethink its strategy, as common procedures to dismantle bombs cannot be used. Calming the civilian, without making him unconscious, becomes the first priority. The team leader recalls that there is someone in the team who is an expert on anxiety management and looks to that team member; the anxiety expert simultaneously recognizes that his expertise is relevant to the situation and nods his assent to the team leader. In the same instant, and without saying a word, two other team members go forward and start devising an alternative way to dismantle the bomb.

In complex and dynamic task environments such as this, being able to coordinate is a necessary requisite for team performance (Kozlowski & Ilgen, 2006). Team coordination can be understood as either explicit or implicit (Espinosa, Lerch, & Kraut, 2004; Okhuysen & Bechky, 2009). Explicit coordination refers to behaviours such as team members openly providing feedback to each other about the task environment and performance achievements, or communicating performance goal adjustments to meet unexpected situations (Perry & Wears, 2011). Explicit coordination also refers to group members sharing information aloud or via electronic devices, as a way to provide information needed for making sense of the situation. While explicit coordination can be useful for planning and redefining goals and strategy, explicit coordination may not be especially useful when split-second decisions are required. Some reasons for this are that explicit coordination takes time and expends cognitive resources that could otherwise be dedicated to detecting possible risks or making effective decisions in a timely manner (e.g., Serfaty, Entin, & Deckert 1993).

In contrast, implicit coordination does not depend on verbal communication and may thus conserve cognitive resources for attending to immediate decisions and actions. The capability to coordinate implicitly incorporates both anticipation (i.e. those behaviours that are performed without a third party's request, and that are motivated by personal beliefs regarding task requirements or other team member needs) and dynamic adjustment (i.e. ongoing actions being displayed by team members as a way to adjust their behaviour to changes in the team structure or task) (Rico et al., 2008). Teams with the capability to coordinate implicitly are more likely to be able to adapt their activities, and to perform well in unexpected and stressful environments.

Recent research (Burtscher et al., 2010; Entin & Serfaty, 1999; Goodwin et al., 2009; Manser, Howard, & Gaba, 2008) on team coordination shows that implicit coordination is a capability critical to achieving adaptation and performance of complex tasks. For example, Entin and Serfati (1999) found that teams in stressful and high-workload situations were more likely to perform well when members used implicit rather than explicit coordination strategies. In that study, team members were trained in both implicit and explicit modes of coordination and were told to shift between modes as the task demanded. Results showed that under increasing levels of stress, teams that had received the training outperformed those who did not receive the training. Moreover, the highest performing teams were those that reduced explicit coordination processes and shifted to implicit coordination as stress increased. Burtscher, et al. (2010) found that anaesthesia teams implicitly shifted behaviours towards task management (e.g., prioritizing, delegating, clarifying, assisting) after the occurrence of non-routine events. Doing so resulted in higher team performance. Manser et al. (2008) found that surgery teams displayed different coordination patterns depending on task complexity and interdependence. The researchers found that implicit coordination was commonly displayed in critical moments of the surgical process leading to higher team performance.

The above studies show that implicit coordination can benefit team performance in stressful and complex environments. Moreover, the studies show that implicit coordination in particular is associated with certain *adaptive behaviours* that facilitate team performance. Drawing on the work of Pulakos, Arad, Donovan, and Plamondon (2000), we define adaptive behaviours as those team behaviours that are enacted as a response to changes in the team task environment.[3] Illustrated in the studies described above are adaptive behaviours relating to creative problem solving, dealing with uncertain and unpredictable work situations, and handing work stress, which are three dimensions of adaptive behaviours described by Pulakos et al. (2000) that are especially relevant to the performance of emergency response teams such as PTTs (p. 617).

That adaptive behaviours follow from a team's ability to implicitly coordinate is also consistent with recent theoretical frameworks describing the cycle of behaviours and emergent states that lead to adaptation and subsequent performance (Burke et al., 2006; Rosen et al., 2011). These frameworks suggest that coordination is part of a team's adaptive cycle (Burke et al., 2006), meaning that teams use coordination to facilitate the emergence of adaptive behaviours (e.g. solving unexpected tasks, or mobilizing additional resources to find creative ways of solving problems) that lead to group performance. Based on the above

[3] Adaptive behaviors are not to be confused with adaptation, which is the *outcome* of adaptive behaviors. According to Burke et al. 2006, team adaptation is "a change in team performance, in response to a salient cue or cue stream that leads to a functional outcome for the entire team." (p. 1190).

evidence, we expect that when a PTT possesses the capability to implicitly coordinate, it will produce adaptive behaviours that subsequently increase performance in non-routine tasks. Therefore we hypothesize:

Hypothesis 1a: Team implicit coordination is positively related to team performance.

Hypothesis 1b: The relationship between team implicit coordination and team performance is mediated by adaptive behaviours.

Transactive memory systems

According to Burke and colleagues (2006), team adaptive behaviours are sensitive to group level emergent cognitive structures such as shared mental models (i.e., team members' shared knowledge structures regarding task, equipment, time or interpersonal relations), and TMS (DeChurch & Mesmer-Magnus, 2011). Specifically, Burke and colleagues suggest that the ability of a team to adapt depends on how group emergent cognitive structures interact with team behaviours, to either promote or hinder adaptability and group-level performance. Consistent with this suggestion, we posit that having developed a TMS will enhance the effects of team implicit coordination on adaptive behaviours and subsequent performance.

A TMS can develop among members of a team as a result of shared experiences such as training or practice (Lewis, Lange, & Gillis 2005; Liang, Moreland & Argote, 1995). While working together, team members implicitly divide the cognitive labour for a task, such that different members become responsible for learning, remembering, and communicating information from different aspects of the team's task. Relying on other members allows each individual to focus on deepening expertise in a specific area, rather than worry about learning new information that is already possessed by other members. This gives the whole team greater access to a large amount of task-relevant knowledge that can be brought to bear on team tasks. Empirical research has shown that groups with a TMS perform at higher levels (e.g., Austin 2003; Kanawattanachai & Yoo 2007; Lewis 2003, 2004; Moreland, Argote & Krishnan, 1996, 1998; Peltokorpi & Manka 2008; Zhang, Hempel, Han, & Tjosvold, 2007), produce more creative outcomes (Gino, Argote, Miron-Spektor, & Todorova, 2010), and learn more (Akgün, A., Byrne, J., & Keskin (2005); Lewis et al., 2005) than do groups without a TMS.

For PTTs, quickly locating expertise can help members devise creative solutions and apply critical knowledge if changes in the task situation demand. Unlike the teams that are typically studied in TMS research, PTT teams engage non-routine tasks that require changes in how members interact and process information. Ironically, however, the fact that PTT tasks are non-routine might make a TMS even more useful, as a TMS can help members locate specialized expertise suited to a particular situation, even if that expertise has not recently been used in prior situations encountered by the team. Moreover, a TMS is all the more important when members rely on implicit communication to guide adaptive behaviours. Relying on implicit coordination can be harmful if teams mindlessly apply prior knowledge and routines to novel situations (Rico et al., 2008). However, if members can rely also on their shared knowledge about “who knows what” when working under extreme or novel conditions, their adaptive behaviours can be more mindful and more appropriate to the task. This is illustrated by the PTT bomb-defusing mission we described earlier. Without being asked, the team member expert in anxiety management looked at the team leader, as a way to signal that he was ready to go. The team leader authorized his intervention with no need to use verbal communication. Understanding that one team member had expert knowledge in a relevant domain helped the leader, the expert, and other team members jointly enact adaptive behaviours.

Together, the above arguments suggest that teams that have already developed a TMS (e.g., through training or practice) are more able to identify the location of critical knowledge in real time, allowing them to adapt mindfully to non-routine situations. We therefore predict that a well-developed TMS will amplify the benefits of team implicit coordination on adaptive behaviours and subsequent team performance:

Hypothesis 2: The conditional indirect effects of team implicit coordination in predicting team performance via adaptive behaviours will be stronger for those teams with a well-developed TMS.

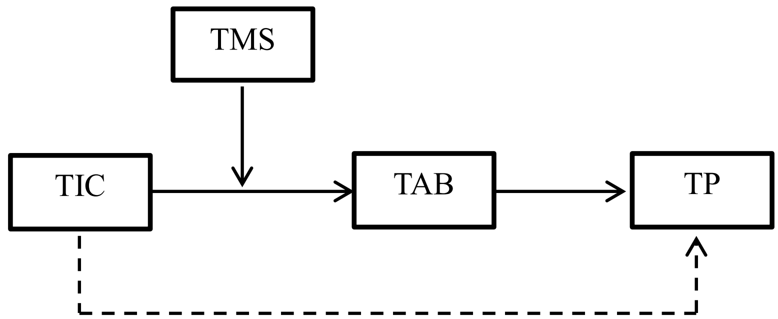

Figure 2 - The research model (TIC: team implicit coordination; TMS: transactive memory systems; TAB: team adaptive behaviour; TP: team performance).

Method

Participants

A total of 42 teams, comprising 200 individuals participated in this study. Teams were tactical teams from the Portuguese police special unit. In a PTT, team members' duties include the following: performing hostage rescues and counter-terrorism operations; serving high risk arrest and search warrants; subduing barricaded suspects; and engaging heavily-armed criminals. PTTs are also expected to perform a variety of tasks, including: hostage rescue; riot control; perimeter security against snipers for visiting dignitaries; providing superior assault firepower in certain situations; rescuing officers or citizens endangered by gunfire; counter-terrorist operations; resolving high-risk situations with a minimum loss of life, injury, or property damage; resolving situations involving barricaded subjects (specifically covered by a hostage barricade team); stabilizing situations involving high-risk suicidal subjects; providing assistance on arrest warrants and search warrants; providing additional security at special events; and providing special training to recruits.

The size of the teams ranged from 2 to 11 members, with an average of 6.87 individuals per team. The age average of team members was 36.2 years (*S.D* = 4.2 years), and all participants were men (100%). On average, participants had 5.8 years of experience working together in the field (i.e. missions), and worked around 46 hours per week.

Measures

Implicit coordination. Team implicit coordination was assessed with six items that we developed based on descriptions of anticipatory behaviours and dynamic adjustment behaviours described by Rico et al., (2008). Items for anticipatory behaviours are: “Team members articulate information regarding their situation, needs and objectives, only as much as necessary (and no more than that)”; “Team members share relevant information efficiently and in the right moments; “Team members synchronize their work during task performamce. Items for dynamic adjustment behaviours are: “Team members sequence their work in order to reduce time wasted between the performance of interdependent tasks”; “Team members anticipate what other team members are going to do in precise moments”; “Team members adjust behaviour in anticipation of the actions of anticipation members.” anticipation of the actions of other team members.” The six-item scale was translated to Portuguese by three authors of this article independently. Afterwards, the three versions were compared and differences were discussed to find a common version. Finally, an English native speaker back-translated the items and compared them with the original items proposed by Rico et al., (2008). Team leaders responded to these six items using a seven-point Likert scale *(1 = totally disagree to 7 = totally agree)* (α = *.79;* X^2/d.f = 1.809, RMSEA = .057, CFI = .985, SRMR = .036).

Adaptive behaviour. We developed a measure of adaptive behaviour based on Pulakos et al.’s (2000, 2002) taxonomy of adaptive behaviours. Three items for each of three types of adaptive behaviours were created. Participants were asked to rate how well their teams solve problems creatively (“solving problems for which there were no easy or strait forward answers”, “using new ideas to overcome any challenges”, and “finding innovative ways to deal with unexpected events”), deal with uncertain and unpredictable situations (i.e. adjusts and deals with unpredictable situations, shifts focus, and takes reasonable action) (“dealing with delays in the delivery of fundamental information for finishing the mission”, “devising alternative plans in very short time as a way to cope with new task demands”, “trying to overcome the obstacles that emerged during task performance”), and handle work stress (i.e. remain calm under pressure, handles frustration, and acts as a calming influence) (“remaining calm and behaving positively under highly stressful events, “performing tasks for which they consider to have had less time than the time necessary to performance such tasks in a proper way", and "maintaining focus when dealing with multiple situations and responsibilities") (α = 96; X^2/d.f = 3.163, RMSEA = .093, CFI = .975; SRMR = .025). Participants rated how much they agreed with each sentence on a seven-point Likert scale *(*1 = *totally disagree* to 7 = *totally agree).*

Transactive memory systems. To assess TMS, we used a shortened version of Lewis´ (2003) TMS scale. Items included: "Each team member has specialized knowledge of some aspect of our project", "Different team members are responsible for expertise in different areas", "I know which team members have expertise in specific areas", "Team members were comfortable accepting procedural suggestions from other team members", "I trusted that other team members knowledge about the mission was credible", "I did not have much faith in other members expertise" (reverse-coded), "Our team had very few misunderstandings about what to do", "We accomplished the tasks smoothly and efficiently" and "Our team worked well in a coordinated fashion") (9 items) (α = .75; X^2/d.f = 1.86, RMSEA = .059, CFI = .937, SRMR = .063). Participants rated how much they agreed with each sentence, rating their answers on a seven-point Likert scale (1 = *totally disagree* to 7 = *totally agree).*

Team performance. We measured team performance using supervisor ratings of overall team performance. Our approach to measuring team performance is consistent with prior research advocating the use of supervisor ratings and of job effectiveness (e.g., Hackman, 1987; Ziegler, Hagen & Diehl, 2012). We asked each team leader to evaluate the quality of their teams' current performance (i.e. "How would you rate your team's overall performance, so far?"). Team leaders were asked to think of the same performance criteria used in the Portuguese police special unit evaluation system. Team leaders gave their answers on a 1 to 4 Likert scale, ranging from totally ineffective (1) to totally effective (4).

Control variables. Control variables were chosen based on existing literature that provides evidence for the positive significant effects they have on coordination processes, TMS development, group efficiency, and adaptive behaviour. These are team size (i.e. the number of individuals forming the team; Curral, Forrester & West, 2001), and team tenure (i.e. the amount of time individuals have been working together, as a team; Humphrey, Morgeson & Mannor, 2009).

Aggregation Procedures

For this study, we used a composition model (i.e. data from a lower level being used to establish the higher level construct) to aggregate our variables to the team level (Chan, 1998; Kozlowski & Kline, 2000). We followed Chan's (1998) recommendations for a referent-shift consensus model as it allows for assessing higher-level constructs that are derived from, yet conceptually different from, the consensus between lower-level units (i.e. team members).

Following Bliese (2000), Chan (1998) and Kozlowski and Klein (2000), we tested within group agreement by considering the $R_{wg(j)}$ and the ICC(1) indices (James, Demaree & Wolf, 1984). Because sample size was considerably low, the reliability of the group mean ICC (2) was not considered. The $R_{wg(j)}$ for adaptive behaviour ranged between -.21 and 1, with a median of .94 (average = .87); and the $R_{wg(j)}$ for TMS ranged between .54 and 1, with a median of .96 (average = .95). ICC (1) for adaptive behaviour was 0.08, and was 0.05 for TMS. In general, these tests indicate that aggregation to the team level is justified (i.e. $R_{wg(j)} > .70$; and ICC(1) > .02). Plus, F-tests for adaptive behaviour, F (62,182) = 1.637, $p < .01$) and TMS, F (62,182) = 1,375 $p < .05$ also show that there was significant variability between teams.

Results

Table 16 shows the inter-correlations and descriptive statistics for all observed variables.

As expected, team implicit coordination was positively correlated with adaptive behaviour (r =.44, $p < .01$), and team performance (r = .32, $p < .01$). Consistent with previous research, TMS was also positively correlated with team performance (r = .50, p <.01). Given the relatively high correlations between variables, we performed a confirmatory factor analysis (CFA) to confirm that the team implicit coordination, adaptive behaviour and TMS scales were empirically distinct (Anderson & Gerbing, 1988; Byrne, 2010).

Table 16 - Inter-correlations and descriptive statistics.

	Mean	*S.D.*	1	2	3	4	5
1. Team size.	6.87	3.85	1				
2. Team tenure.	5.79	4.88	-.02	1			
3. Team implicit coordination.	4.40	.87	.35*	09	1		
4. Team adaptive behaviour.	4.89	.37	-.49**	.09	.44**	1	
5. Transactive memory systems.	3.43	.21	-.34*	-.08	.38*	.61**	1
6. Team performance.	2.22	.77	-.00	-.25	.32**	.53**	.50**

Note. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

We tested five conceptual models (the anticipated 3-factor model, a 1-factor model, and 3 versions of a 2-factor model) and compared their relative fit with the data. Table 17 shows the results for each model. The fit outcomes suggest that team implicit coordination, adaptive behaviour and TMS are independent constructs.

Table 17 - Confirmatory factor analysis.

	$\chi 2$	d.f	$\chi 2$/d.f	CFI	RMSEA	SRMR
Model 1	654.0	249	2.63	.88	.08	.07
Model 2	821.5	251	3.27	.83	.09	.08
Model 3	967.3	251	3.85	.79	.11	.10
Model 4	958.0	251	3.81	.79	.11	.10
Model 5	1244.1	253	4.91	.70	.13	.12

Note. Model 1 (3 factor model); Model 2 (2 factor model with team implicit coordination and transactive memory systems correlating with adaptive behaviour); Model 3 (2 factor model with transactive memory systems and adaptive behaviour correlating with team implicit coordination); Model 4 (2 factor model with team implicit coordination and adaptive behaviour correlating with transactive memory systems); Model 5 (1 overall factor model containing transactive memory systems; adaptive behaviour and team implicit coordination).

To test hypotheses 1 and 2, we used PROCESS, which is a computational tool to analyse “conditional process models” that are path analysis-based (Hayes, 2013). PROCESS estimates the coefficients of a model using OLS regression (for continuous outcomes) and allows the use of bootstrap analysis. Bootstrapping is a method that uses repeated sampling of the data to estimate the sampling distribution of a test statistic. According to Hayes (2012), regression model analysis using bootstrapping offers several advantages over traditional regression (OLS) approaches, such as (a) allowing for the test of multiple mediators simultaneously; (b) not requiring the assumption of a normal sampling distribution; (c) reducing the number of inferential tests and, as a consequence, the likelihood of Type 1 errors; and (d) performs better than the traditional Sobel’s test when sample size is small.

Table 18 - Results for mediation analyses (Hypotheses 1a and 1b).

Steps	*B*	*S.E*	t	*p*
Direct and total effects	R^2 = .45; p <.05			
Team performance regressed on team implicit coordination (c path).	.36	.14	2.56	.01
Team adaptive behaviour regressed on team implicit coordination (a path).	.12	.06	2.10	.04
Team performance regressed on team adaptive behaviour, controlling for team implicit coordination (b path).	1.52	.33	4.64	.00
Team performance regressed on team implicit coordination, controlling for team adaptive behaviour (c' path).	.18	.12	1.51	.14
Partial effects of control variables on team performance				
Team size.	.09	.03	2.86	.01
Team tenure.	-.05	.02	-2.74	.01

	Unstandardized value	SE	LL 95% CI	UL 95% CI	p
Bootstrap results for indirect effect					
Effect	.18	.08	.056	.377	<.001

Note. Listwise N = 42. LL = lower limit; CI = confidence interval; UP = upper limit. Bootstrap sample size = 5000. All predictor variables were mean-centered.

Hypothesis 1b proposes that team implicit coordination processes lead to adaptive behaviour, which, in turn, should lead to higher team performance. As expected, team implicit coordination had an indirect significant effect on team performance through adaptive behaviour (B =.18, 95% CI: .06 to .38) (see table 18). When adaptive behaviour was added to the model, the direct effect of team implicit coordination on team performance became no significant; suggesting that adaptive behaviour fully mediates the path from team implicit coordination to team performance. These findings support hypotheses 1a and 1b.

Hypothesis 2 proposes that TMS interacts with implicit coordination processes such that teams with well-developed TMS and higher team implicit coordination should behave more adaptively. As expected, the two-way interaction between TMS and team implicit coordination was significant (B = .30, *p* = .04), and a significant conditional indirect effect was found for higher levels of TMS (B =.28, 95%CI: .03 to .68) (see table 19). These results offer support for hypothesis 2.

Discussion

Integrating team process research and team cognition research, this study examined how TMS can condition the mediation effect of team adaptive behaviour on the relationship between team implicit coordination and team performance. Moreover, this study stresses the importance of TMS in explaining how team implicit coordination positively predicts adaptive behaviour in non-routine task scenarios.

Table 19 - Results for moderated mediation analysis (Hypothesis 2).

Predictor variable	*B*	SE	t	p
DV: Team adaptive behaviour (Mediator variable model) $R^2 = .75$; p <.001				
Constant	5.02	.10	50.26	.00
Team implicit coordination	.12	.06	2.07	.05
Transactive memory systems	.88	.21	4.19	.00
Team implicit coordination * transactive memory systems	.30	.14	2.05	.04
DV: Team performance (Dependent variable model) $R^2 = .70$; p <.001				
Constant	-6.35	1.63	-3.69	.00
Team adaptive behaviour	1.52	.33	4.64	.00
Team implicit coordination	.18	.12	1.51	.14
Team size	.07	.03	2.86	.00
Team tenure	-.05	.10	-2.74	.01
Transactive memory systems	Unstandardized boot indirect effects	Boot SE	Boot LLCI	Boot ULCI
Conditional Indirect effect at transactive memory systems = M± 1 SD				
-1 SD (.-.21)	.08	.06	-.115	.315
M (.00)	.18	.03	.027	.446
+1 SD (.21)	.28	.16	.033	.685

Note. Listwise N = 42. DV = Dependent variable. Bootstrap sample size = 5,000. All predictor variables were mean-centered.

The findings offer empirical support to the idea that team implicit coordination positively contributes to predict adaptive behaviour in PTTs, and that adaptive behaviour in turn positively influences group performance. In addition, this study shows that the positive effect of team implicit coordination on team performance through adaptive behaviour strengthens when a team has a well-developed TMS. These findings align with some previous studies. For instance, Bechky and Okyhusen (2011) found that team members in SWAT action teams adapt to new situations by reinforcing or defining task activities (a form of coordination), and by fostering team member awareness of the location of expertise within the team.

The findings from the current study suggest that teams with more developed TMSs make better use of implicit coordination mechanisms to perform adaptively. Our findings also confirm that team implicit coordination influences performance through its effect on adaptive behaviours, which as far as we know, has not been empirically established.

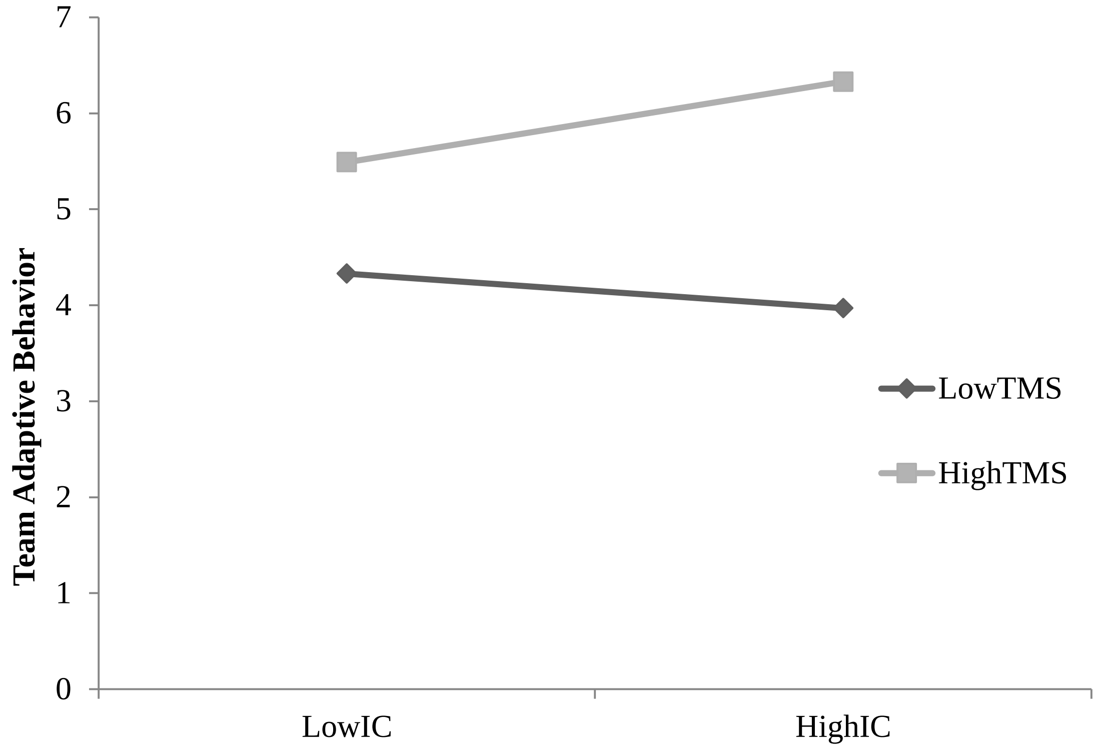

Figure 3- The graph for the 2 way interaction at high and low levels of the moderators and predictor variables (IC: implict coordination; TMS: transactive memory systems).

Importantly, these results emerged in complex and unpredictable task scenarios, where coordinating implicitly could be problematic (Rico et al. 2008). When a TMS is also present, however, the effects of team implicit coordination seem to be beneficial for adaptation and performance. One possible explanation is that, for teams who have more developed TMS, it is easier to locate specialized knowledge that is distributed within the team, to retrieve that knowledge and use it more effectively for implicit coordination behaviours. For instance, Littlepage, Hollingshead, Drake and Littlepage (2008) have found that, during task performance, the allocation of specific tasks to the more proficient team member (regarding that specific task) translates in better group performance. By knowing whom the expert is, team members can directly ask for information or encourage team experts to play a more relevant role on the team for a limited period. Knowing the location of expertise would also be helpful if the team needs to quickly redefine goals and strategies, as team members and team leaders would be better able to select a team member with the right expertise for taking the lead in a specific task or situation. Our findings offer empirical support to the idea that managing unexpected situations and performing adaptively can be maximized when teams are able to use their TMS and to coordinate group behaviours with little verbal communication (Cannon-Bowers & Salas, 2001; Espinosa et al. 2004).

Theoretical and Practical Implications

Our study contributes to the teams' literature in several ways. First, although research on implicit coordination shows a positive relationship between team implicit coordination and performance, that research has not explicated the mechanisms for this relationship. Second, team implicit coordination is often regarded as a group capability that is mostly effective in routinized tasks (Rico et al. 2008). However, this study opens new debate as it suggests team implicit coordination can positively impact adaptive behaviour and performance in non-routine task environments. Third, prior research on team implicit coordination has emphasized the roles of shared mental models and situational awareness in producing implicit coordination, adaptive behaviour, and performance. Our findings advance research on team implicit coordination and social cognition by showing how the effects of implicit coordination may depend on the strength of a team's TMS. When performing in stressful conditions, PTTs might experience high cognitive load. Having a well-developed TMS may free cognitive resources for attention processes (i.e. task, team, and environmental monitoring), and effective communication. Finally, the results from our study show that developing a TMS can be useful not only for stable or highly related tasks (Lewis et al., 2005), but also for tasks that are dynamic and unpredictable.

Although our findings can be generalized to other team contexts it is important to understand that coordination is a major component of the training that is given to PTT. Also, being aware of the location of expertise and being able to use that knowledge is another major component of the PTT training program. Given that, we suggest that organizations whose teams operate in complex environments would benefit from investing in training their teams to the use of implicit coordination strategies (e.g. adapting coordination strategies, and to be able to alternate between task coordination strategies, depending on task requirements) (e.g. Rico et al., 2008; Stout, Salas & Fowlkes, 1997). By doing so, organizations would enhance team performance by increasing team members´

awareness of the procedures and the best strategy for any given situation. To achieve this, organizations should not only train their teams on how and why to use such coordination strategies, but they should also develop specific training programs in which individuals are specifically asked to coordinate either implicitly and explicitly. Through such training sessions, teams could then receive specific feedback and develop their ability to shift their coordination processes accurately and swiftly. Finally, our findings suggest that action teams also benefit from fostering the development of TMSs. This could be accomplished by promoting a) specialized training (assigning specific individuals to specific training programs and then help individuals to identify experts within teams; b) encouraging reliance on specialized knowledge; and c) assigning intact teams to the same training program (Ren & Argote, 2011).

Limitations and Future Research Directions

This study has three primary limitations. First, scholars like Stone-Romero and Rosopa (2008) stress that *true* mediational effects can only be identified using experimental designs. According with Stone-Romero and Rosopa (2011, p. 641), “the legitimacy of inferences about actual causal connections between variables hinges on experimental design” and is far beyond the use of statistical methodologies. This means that testing indirect models in non-experimental settings provides necessary, but limited, basis for inferring causal relations between variables. Nevertheless, Stone-Romero and Rosopa (2011) also state that using path analysis methodologies like the one we used here are appropriate for testing indirect models. Using covariates (e.g. tenure; size) and multisource data (e.g. team leaders; team members) further avoids spurious associations in non-experimental studies, as these control variables can also account for confounding and epiphenomenal associations between mediator and dependent variables (Hayes, 2013). Other limitations of the study are that data were collected cross-sectionally and using self-reports. Indeed, the cross-sectional design gives a limited understanding of the true dynamic behaviour of the analysed model. Future extensions of this study should examine how these relationships may unfold over time.

General Conclusion

Team processes such as coordination and adaptation are crucial for effective team performance. Knowing where to locate expert information within a team can significantly influence the efficacy of team processes, and consequently team performance. The findings from this study show the important role of TMS for facilitating the link between team implicit coordination and adaptive behaviour and performance. Building on our findings, future research can be aimed at further clarifying the *timing* and *conditions* under which TMS and implicit coordination are most effective in non-routine task environments.

8. Study 4: The Higher they climb the harder they fall: A temporal examination of adaptive performance in teams

Abstract

Work teams are challenged with the need to adapt. Teamwork literature suggests that cohesion and team coordination might contribute to team adaptation. The literature on teamwork dynamics also acknowledges the role time plays in understanding the relationship between team coordination and team adaptation. In this study, we adopt a parallel latent growth mediation modelling approach to test whether initial team cohesion predicts team adaptation mediated by team coordination over time. Participating in the study were 179 teams enrolled in a management competition. Data collection was conducted across five consecutive weeks. Contrary to what was expected, the results suggest that initial cohesion negatively predicts team coordination and team adaptation over time. Team coordination over time did not mediate the relationship between initial cohesion and team adaptation over time. These findings suggest that initial conditions are important with regard to predicting teamwork dynamics over time, and to extending our knowledge of how cohesion contributes to teamwork. Implications and future directions for the science of teams are discussed.

Keywords: Cohesion; latent growth models; team coordination; team adaptation; time.

The Higher They Climb the Harder They Fall:

A Temporal Examination of Team Adaptation

The business sectors in which many teams operate are unpredictable, and companies are often compelled to restructure, redefine their business strategy, and reduce costs. These factors, together with the increasingly temporary nature of teams, are creating a challenging environment where behaving adaptively is paramount for team effectiveness. Team adaptation describes how teams organise themselves to cope with change, implement their strategy, and learn from results (Maynard, Kennedy & Sommer, 2015). Team adaptation is sensitive to team members' beliefs and personality traits, to team processes, and to team cognitions (Marques-Quinteiro, Curral, Passos & Lewis, 2013). Additionally, team adaptation is considered a temporal phenomenon and, as such, is deemed as a cyclic team event (Burke et al., 2006). It is our contention that the evolution of team adaptation will be sensitive to initial enabling conditions. These are team states or characteristics, such as leadership, team composition, and team processes and emergent states that exist at the beginning of a performance episode and benefit team effectiveness (Hackman, 2012).

Despite many contributions acknowledging the importance of time in team adaptation, there is still scant knowledge regarding which conditions promote, or inhibit, team adaptation trajectories over time (LePine, 2005; Maynard et al., 2015). With that in mind, extant literature points to two particular team variables that have been regarded as fundamental to the collective ability to cope efficiently with change: team cohesion (i.e. the tendency for a team to stick together and remain united in its pursuit of instrumental objectives and/or for the satisfaction of members' affective needs; Carron, Brawley, & Widmeyer, 1998), and team coordination (i.e. how team members exchange task and group related information during problem solving and goal directed action; Rico, Sánchez-Manzanares & Gibson, 2008). When engaging in a task that requires adaptation, initial cohesion will help team members be more capable of coordinating and adapting (Kozlowski & Chao, 2012).

However, there is a gap in the literature that makes it impossible to establish a clear theoretical and empirical link between these constructs. Although cohesion is considered important for team processes, trajectories such as team coordination and team adaptation (Kozlowski & Chao, 2012), and longitudinal research exploring the temporal dynamics of team coordination and adaptation is limited (Maynard et al., 2015). As a response to this void, in this study we set out to explore the temporal dynamics that drive team adaptation over time. This study uses a mediation parallel latent growth modelling (LGM) approach to examine whether initial cohesion (i.e. cohesion at the beginning of the team performance cycle) predicts team adaptation trajectories through team coordination. We based our theory on recent conceptual work on team adaptation, and existing models of team adaptation in complex work environments (McGrath, Arrow & Berdalh, 2000; Baard, Rench & Kozlowski, 2013; Burke et al., 2006; Maynard et al., 2015). Our rationale was further justified by Hackman's (2012) conceptualizations of team processes and effectiveness as temporal phenomena that are sensitive to initial enabling conditions (i.e. characteristics, properties, or configurations of the system that might lead to paths and states that are unique and desirable). Paying close attention to such initial enabling conditions is important for building effective human resource management practices, and to improving our understanding of how team conditions in the early stages of the team performance cycle shape team trajectories (McGrath et al., 2000).

This study contributes to the current literature by exploring the longitudinal dynamics that characterize episodic team processes, and by exploring how initial team conditions shape team adaptation over time.

Theoretical background and hypotheses

As with other living and non-living systems (e.g. flocks of birds or the weather), the way the constituents of systems co-evolve and interact over time is sensitive to the systems' initial enabling conditions (McGrath 2000; Hackman, 2012). Rather than examining the causes of behavior (e.g. why X causes Y), team research should examine the enabling conditions that shape team behavior (e.g. how Y changes over time, regarding X).

Considering initial enabling conditions in team research also improves our understanding of how complexity (i.e. a system's sensitiveness to its initial conditions) influences team phenomena. One example of a system's sensitiveness to initial conditions in team research can be found in the Mathieu and Rapp (2009) study. The authors show that defining adequate team charters and team task-work before the beginning of a performance episode (i.e. distinguishable periods of time over which performance accrues and feedback is available), leads to higher-quality performance trajectories over time. In this study, team charters and team task-work contributed as initial enabling conditions that promoted effective team performance over time. Another example is Zijlstra, Waller and Phillips (2012), who examined how the early interactions of swift-start teams (i.e. aviation teams) predict team performance trajectories over time. Zijlstra and colleagues (2012) found that the early emergence of stable interaction patterns, right at the very start of the team performance cycle, led to superior team performance over time. More specifically, the authors found that teams who developed more stable and organized communication patterns, and reciprocate more in terms of the information they share, outperform those who do not develop such effective patterns in the early stages of the team performance cycle. Extant literature on the predictors and drivers of team effectiveness in the workplace agrees that team cohesion can be an initial enabling condition for effective group processes. Team cohesion emerges in the early stages of the team life cycle, stabilises quickly, and is expected to become a *sine qua non* condition to the integrity of small groups (Festinger, 1950; Kozloswki & Chao, 2012; Marks, Mathieu & Zaccaro, 2001). Cohesion is considered of greatest importance when creating the conditions in which teams perform their tasks, secure group stability, facilitate functional group processes, and deliver high performance over time (Ensley, Pearson & Amason, 2002; Levine & Moreland, 1990).

Cohesion and team coordination

Team coordination happens when team members collaborate interdependently over time. Team coordination concerns the intentional use of task programming mechanisms and communication strategies in order to meet performance standards. Team coordination implies behaviors such as team members openly providing each other with feedback about the task environments and performance achievements, or communicating performance goal adjustment to meet unexpected situations (Rico et al., 2008). As Ensley and colleagues (2002) noted, cohesion might be a catalyst of team coordination. By increasing the connectedness between team members, cohesion is expected to facilitate smooth group interaction and open communication, both of which are needed for coordination. High cohesive teams are also more prone to cognitive conflict (as opposed to affective conflict), which promotes effective group processes and decision making over time (Ensley et al., 2002). By openly communicating, and debating ideas about the best strategy, team members can achieve far better coordination trajectories. In the study by Zaccaro and colleagues (1995), the authors also found that high task-cohesive teams invest more time in planning and information exchange during the planning period, and communicate task-relevant information more frequently during the performance period, than low task-cohesive teams do.

Over time, teams experience challenges that cause tension and harm team performance. Although these factors might hinder team coordination, it can be maintained in cohesive teams because these have stronger social ties and experience less affective conflict (Festinger, 1950). The connectedness between team members facilitates team planning and information elaboration over time, while improving team resilience to disturbances in team dynamics (Thompson, 1967). Cohesion creates a sense of coherence within teams that triggers enabling group processes and results (Greer, 2012). A meta-analysis by LePine and colleagues (2008) suggests the existence of a positive relationship between cohesion and team action processes, which included team coordination. Michalisin and colleagues (2004) found further evidence supporting a positive relationship between cohesion and team coordination by revealing that initial cohesion positively predicts superior management team responses, and management team industry returns over time. For management teams performing in the industrial sector (as well as in many others), being cohesive is important because cohesion helps maintain effective group functioning under the stressful conditions that so often occur in industry. Cohesion also builds stable and solid foundations for interpersonal relationships in teams (Carless & DePaola, 2000). This creates an enabling environment where teams can coordinate their work better over time. Considering the former rationales, we hypothesize that:

Hypothesis 1: Initial team cohesion positively predicts team coordination trajectories over time. We expect that teams with higher initial cohesion show more positive team coordination trajectories over time, than teams with lower initial cohesion.

Cohesion and team adaptation

In this study we regard team cohesion as an initial enabling condition to team adaptation over time, and that team coordination mediates this relationship (Kozlowski &

Bell, 2003). Thanks to cohesion, team members will openly express their thoughts, share relevant information, and adjust the team's strategy and goals when required (Zaccaro et al., 1995). The high cohesiveness of the team will give team members a sense of belonging that promotes speaking up for the team, and enables team coordination during adaptation episodes. During goal striving, it is likely that unexpected events will occur and adaptation will be required. Teams coordinate to achieve goals and they adapt to maintain or restore balance in their level of performance. When an unexpected event takes place, team performance decreases and team members increase their task coordination behaviours in order to restore equilibrium (Marques-Quinteiro et al., 2013; Maynard et al., 2015; Rico et al., 2008). One cross-sectional study by Marques-Quinteiro and colleagues (2013) found evidence of a positive relationship between team coordination and adaptive behaviour in police Special Forces. Marques-Quinteiro and colleagues (2013) also found that team coordination predicts team adaptive behaviours, and that these lead to more positive team performance outcomes. Another study with anaesthesia teams by Riethmüller and colleagues (2011) found that the more effective teams (e.g. the ones making fewer mistakes during patient anaesthesia, and responding more promptly to change) were the ones that coordinated better over time by adapting their coordination strategies to situational requirements.

Higher cohesion will be beneficial to the coevolution of team coordination and team adaptation because the stronger connectedness between team members will keep team members together, and will facilitate the flow of valuable information. More cohesive teams will communicate more swiftly, hence leading to better coordination. When teams need to adapt, cohesion gives the team the stability it needs to work through the situation without member loss or process failure, and it will facilitate coordination as a step towards team adaptation (Kozlowski et al., 1999). Hence, we expect that team coordination will positively mediate the relationship between initial cohesion and team adaptation trajectories. Accordingly, we hypothesize that:

Hypothesis 2: Team coordination trajectories over time positively mediate the relationship between team initial cohesion and team adaptation trajectories over time. We expect that more positive team adaptation trajectories over time will be found in teams that have higher initial cohesion and display more positive team coordination trajectories over time, than teams with lower initial cohesion.

Method

Research environment

The research environment was identical to the one described in study 3 of chapter 5. For that reason, please consider the aforementioned description.

Participants

Research with longitudinal data is challenged with missing data (Graham, 2009).

512 teams were invited to participate in this study. Response rate throughout the study varied between 67.8% (week 1) and 87.1% (week 5). The overall number of incomplete cases was 92.42%, and the overall number of incomplete values was 78.93%. Scholars have not yet reached a consensus regarding the percentage of missing data that becomes problematic for research, with acceptable cut off points ranging between 5% and 20% (Schlomer et al., 2010). In our study we set the cut-off point at 20%, as suggested by Peng, Harwell, Liou and Ehman (2006). Using the cut-off point lowered the attrition level to between 2% (week 1) and 11% (week 5). The overall number of incomplete cases was 29.05%, and the overall number of incomplete values was 4.26%.

Graham (2009), and Schlomer and colleagues (2010) suggest that decisions regarding how to handle missing data should be established by examining the pattern of missing data: missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR). To determine the pattern of missing data, we performed Little’s (1988) MCAR test using the Missing Values Analysis command option in SPSS 22. We obtained a non-significant chi-square value ($\chi^2 = 53.81$, $d.f = 54$, $p = .81$), indicating that the pattern of missing data is MCAR (Little, 1988). MCAR is easily managed by using sophisticated stochastic imputation methods such as full information maximum likelihood (FIML; Schlomer et al., 2010).

The participants were 179 ad-hoc teams enrolled in the first stage of the GMC. The participants joined the competition as top management teams. Most teams were formed by

5 team members (64.8%; *M* = 4.67, *S.D* = 0.63). 31.8% of the participants were women and the average age was 39.40 (*S.D* = 9.28). 29% of the participants had at least a degree in management, and 17.7% of the participants had been enrolled in a previous edition of GMC at least once. Finally, 46.9% of the teams comprised professional workers, 45.3% were undergraduate students, and 7.8% were mixed (i.e. professional workers and undergraduate students)

Procedure

Data collection took place across five consecutive weeks (GMC's 1st round). Teams were self-selected and applied together to the GMC. Before the start of the competition two emails were sent to participants by the GMC organizing committee and the research team together. Emails were sent one week before, and on the eve of the start of the competition. In both emails, participants were invited to enrol in the study. Each week, participating teams received the link to the online questionnaire.

Measures

In this study, data was collected using obtrusive (i.e. self-reports via questionnaires) and non-obtrusive (i.e. share price) methods. Team members were asked to share their level of agreement regarding initial cohesion and team coordination using a Likert type scale ranging from *totally disagree* (1) to *totally agree* (7). Team adaptation was estimated by calculating a share price difference ratio in each week. More detail is provided below.

Cohesion was measured at week 1 using an adapted version of the group environment questionnaire (Carless & DePaola, 2000). Participating teams started preparing one month before submitting their first decision, which gave time for teams to establish cohesion (Festinger, 1950; Kozlowski & Chao, 2012). Due to data collection constraints, we measured cohesion using 5 items from the original 11-item scale, based on the saturation level of the items shown in Carless and DePaola (2000). Two items measured *task cohesion* ("Our team is united in trying to reach its goals for performance in the GMC", and "I'm unhappy with my team's level of commitment to the GMC"), 2 items measured *social cohesion* ("Our team would like to spend time together outside of work hours", and

“Members of our team do not stick together outside of work time”), and 1 item measured *individual attraction to the group* (“For me this team is one of the most important social groups I belong to”) (Cronbach’s alpha = .60.4; χ^2 (4) = 16.35, p< .01, RMSEA = .07, CFI = .98, TLI = .94, SRMR = .04). Although the literature suggests that alphas < .70 are questionable, it also suggests that values > .60 can be accepted (Gliem & Gliem, 2003).

Team coordination was measured over 5 weeks. We used an adapted version of West, Markiewitz and Dawson (2004) team coordination items from the team processes questionnaire. To measure team coordination, 4 items were used (“We are aware of what we want to accomplish, “We debate the best ways to get things done”, “We meet several times to guarantee effective cooperation and communication” and “We share task related information with each other”). The reliability and goodness of fit for task coordination at week 1 was as follows: Cronbach’s alpha = .82; χ^2 (2) = 17.04, p< .001, RMSEA = .104, CFI = .98, TLI = .93, SRMR = .03).

Team adaptation was measured across 5 weeks. To measure team adaptation we followed previous procedures adopted by authors such as LePine (2003, 2005), in which team adaptation was estimated based on a difference performance score between two time moments (Baard et al., 2014; Maynard et al., 2015). In the 1st round of GMC, every week is different as market conditions change. As a consequence, teams have to adapt weekly otherwise they will not succeed in the competition. As described in the procedure section, each team runs a company that has a share price value. This share price changes weekly and is estimated with an algorithm that equates the decisions that teams make, and the changes that have been happening in the business environment (e.g. other teams’ decisions; strikes; terrorism; floods). The difference ratio in the share price value between weeks offers a good measure of how well teams are adapting. If the ratio evolves positively, it means that a team’s company share price value is improving and the team is winning despite weekly change. Conversely, if the ratio is nil or negative, it means that the team’s company share price value has either stagnated or is decreasing and the team is losing. In week one, all teams start with a company share price value of 1. Team adaptation in week one was calculated by estimating the difference between the initial share price value of 1 and the share price value after the first decision was made (1 – Share price value $_{\text{time 1}}$). We then repeated this procedure to estimate team adaptation in each of the following weeks (e.g. Share price value $_{\text{time 1}}$ – Share price value $_{\text{time 2}}$; Share price value $_{\text{time 2}}$ – Share price value $_{\text{time 3}}$; and so on).

Control measures were team type, and team member familiarity. Team type was controlled by creating an index variable regarding the proportion of professional workers in the team. The index variable ranged between 0 (only students) and 1 (only professional workers). Controlling for whether teams comprise professional workers, undergraduate students or both is important because professional task/work experience and expertise have been shown to influence team processes and decision making in a multitude of studies (Salas, Rosen & DiazGranados, 2009). Team member familiarity was measured by asking each team member to estimate the percentage of team members they already knew before engaging in the GMC. Team member familiarity has been shown to have a positive relationship regarding relational aspects among team members and team performance over time (Harrison, Mohammed, McGrath, Florey & Vanderstoep, 2003).

Aggregation procedures

In this study we used a composition model to aggregate our variables to the team level. We followed Chan's (1998) recommendations regarding model specifications to assess higher level constructs using composition models. We tested within group reliability using the R_{wg} aggregation index (James, Demaree & Wolf, 1984). The average R_{wg} for initial cohesion was .79. The R_{wg} for team coordination ranged between .86 (week 1) and .81 (week 5). Estimating interrater reliability was achieved by using the intraclass correlation indexes 1 and 2 (Bliese, 2000). The ICC 1 and ICC 2 for initial cohesion were .20 and .54. The ICC 1for team coordination ranged between .16 (week 1) and .15 (week 5). The ICC 2 for team coordination ranged between .48 (week 1) and .54 (week 5).

Analysis

In this study we use a latent growth mediation modelling (LGMM) as it allows examination of the direct and indirect causal dynamics between constructs over time (Selig & Preacher, 2009). These are particularly useful to test for mediations where individual trajectories (i.e. trajectories between teams) of change over time are described, and where intra-individual change (i.e. trajectories within teams) is expected (von Soest & Hagtvet, 2012).

As in simpler mediation models, mediation in LGMM is supported when the variable *X* changes the level of the mediator *M*, and the change in the mediator influences the level of the outcome variable *Y* over time. The mediation process can be modelled as the effect of *X* influencing the growth of *Y*, indirectly though the growth of *M* (Cheong, MacKinnon & Khoo, 2003; Selig & Preacher, 2009).

According to Selig and Preacher (2009), the testing of mediation in growth models requires first that the growth model for the mediator and dependent variables be modelled separately.

As a first step in hypothesis testing, we began by modelling the growth trajectories for team coordination (*M*) and team adaptation (*Y*) separately, using initial cohesion as a predictor, and team type and team familiarity as covariates. Secondly, we tested the mediation hypothesis by examining whether team coordination over time (i.e. the slope of task coordination) mediates the relationship between initial cohesion and team adaptation over time (i.e. the slope of team adaptation; Cheong et al., 2003; Hayes 2009; Selig & Preacher, 2009; von Soest & Hagtvet; 2012).

Growth curves (i.e. slopes/trajectories), and the LGMM were built based on standardised mean scores from initial cohesion (*X*), team coordination (*M*) and team adaptation (*Y*). A full information maximum likelihood estimator was used in all analyses to deal with missing data (Muthén, 1994). As recommended by Hayes (2009), and von Soest and Hagtvet (2012) bootstrapping was used to estimate all bias-corrected CIs based on 5000 bootstrap samples. Likewise, bias-corrected bootstrap CIs were computed for mediation effects. For this purpose, the “model indirect” in combination with the “cinterval” command was used in Mplus (von Soest & Hagtvet, 2012). For a more in-depth, step-by-step description of how to test LGMM, please see von Soest and Hagtvet (2012).

Results

Before testing the research hypotheses put forward in this study, we first examined the correlations between constructs, as well as the baseline growth models for team coordination and team adaptation. The results in the correlation table (see Table 20) suggest that initial cohesion is positively correlated with team coordination in each of the five weeks. The results also show that initial cohesion does not correlate with any measure of team adaptation in each of the five weeks. The correlation between measures of team coordination and team adaptation was only positive and significant for team adaptation between the third and fifth weeks. Additionally, team type significantly correlated with all measures of team coordination and team adaptation.

Table 20 - Unstandardized inter-correlations and descriptive statistics.

	1	2	3	4	5	6	7	8	9	10	11	*12*	*M*	*S.D*
1 Team type week 1.	-	-	-	-	-	-	-	-	-	-	-	-	.49	.49
2 Team familiarity week 1.	-.02	-	-	-	-	-	-	-	-	-	-	-	74	27.69
3 Initial cohesion week 1.	-.22	.19*	-	-	-	-	-	-	-	-	-	-	5.23	.83
4 Team coordination week 1.	.12	-.09	.47**	-	-	-	-	-	-	-	-	-	5.73	.69
5 Team coordination week 2.	.17*	-.10	.23**	.50**	-	-	-	-	-	-	-	-	5.74	.80
6 Team coordination week 3.	.14	-.17*	.23**	.49**	.50**	-	-	-	-	-	-	-	5.54	.89
7 Team coordination week 4.	.26*	-.13	.26*	.47**	.58**	.72**	-	-	-	-	-	-	5.68	.86
8 Team coordination week 5.	.26*	.03	.17*	.41**	.46**	.58**	.63**	-	-	-	-	-	5.64	.91
9 Team adaptation week 1.	.11	.15	-.04	-.04	-.03	-.06	.01	-.04	-	-	-	-	-.51	.06
10 Team adaptation week 2.	.07	.03	-.18*	-.02	-.03	.03	.02	.05	-.10	-	-	-	-.04	.06
11 Team adaptation week 3.	.15	.17*	-.10	.02	-.05	.06	.13	.15	.17*	.28*	-	-	.00	.06
12 Team adaptation week 4.	.15	.15*	-.10	.02	.08	.05	.07	.14	.09	.32**	.48**	-	.01	.07
13 Team adaptation week 3.	.20**	.13	-.14	.01	-.01	.08	.06	.06	.17*	.33**	.47**	.59**	.06	.08

Note. Team familiarity is estimated as percentage. ** $p < .01$, * $p < .05$.

Secondly, we also examined the latent growth model parameter estimates (i.e. factor means, variance, and covariance) for team coordination and team adaptation alone. The model fit for the team coordination latent growth model was poor: χ^2 (10) = 15.22, p = .12, RMSEA = .05, CFI = .99, TLI = .99, SRMR = .05). The results in Table 21 also show significant variation in both intercept (δ = .52, p < .001) and slope (δ = .02, p < .05), and that the intercept and slope bear no relation with each other.

The fit for the team adaptation latent growth model was: χ^2 (10) = 12.24, p > .05, RMSEA = .04, CFI = .99, TLI = .99, SRMR = .05). The variance for team adaptation intercept was negative (δ = -.01, p > .05) and, for that reason, we fixed team adaptation intercept to 0. This modification in the growth model retrieved a new growth model for team adaptation: χ^2 (12) = 28.97, p < .01, RMSEA = .09, CFI = .90, TLI = .92, SRMR = .10). The results in Table 2 show that the overall average starting value and change were null (μ = .00, p = 1.00), and also show significant variation in slope (δ = .05, p < .001).

Table 21 - Standardized simple growth parameter estimates.

	Initial status (intercept)		Change (slope)		Covariance (intercept – slope)
	Mean	Variance	Mean	Variance	
Team coordination.	.01	.52**	-.01	.02*	-.01
Team adaptation.	.00	.00	.00	.05**	

Note. The intercept for team adaptation was fixed to zero. ** p < .01, * p < .05.

After establishing the baseline growth model for team coordination and team adaptation, we proceeded to hypotheses testing. Following the von Soest and Hagtvet (2012) procedure by using LGMM, the first step towards testing our research hypotheses was to regress the task coordination slope on initial cohesion. The negative coefficient (β = -.06, *S.E* = .02, p < .001 95% CI LL = -.09, UL = -.02; χ^2 (67) = 92.23, p < .05, RMSEA = .05, CFI = .96, TLI = .95, SRMR = .06) suggested that team coordination over time decreases for teams whose level of initial cohesion is higher (see Table 22; see Figure 4). In this first step we also controlled for the effects of team familiarity, and team type on team coordination slope. We found that neither of these control variables accounted for team coordination variation over time. Hypothesis 1 proposed that team initial cohesion positively predicts team coordination over time. Our findings reject Hypothesis 1.

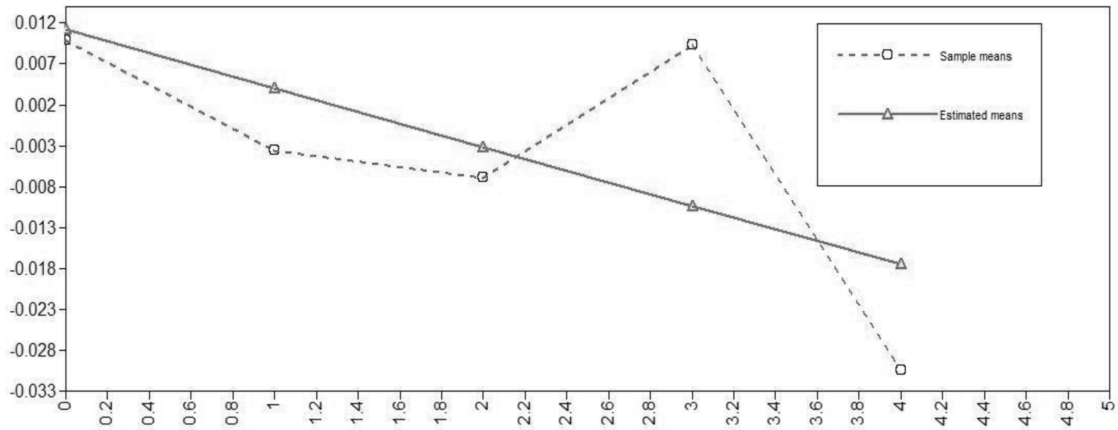

Figure 4 - Observed and estimated values for team coordination (standardized values).

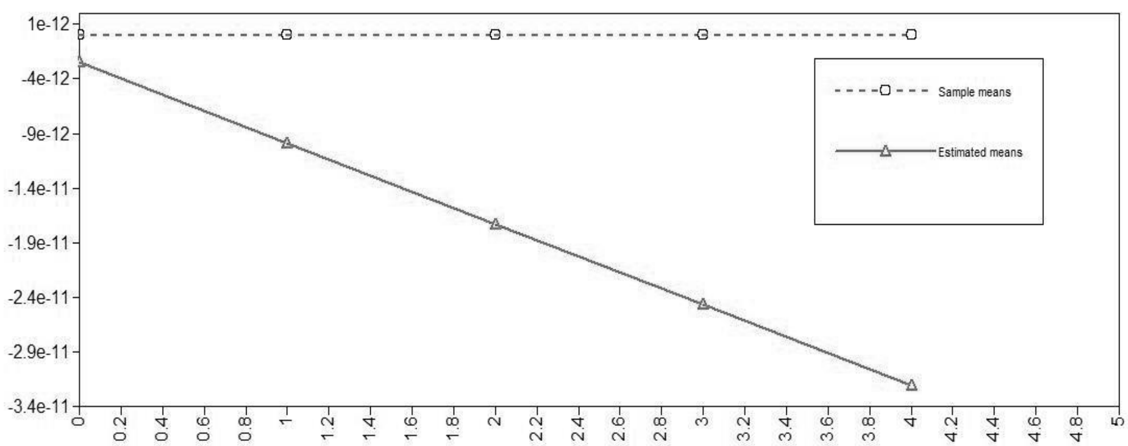

Figure 5 - Observed and estimated values for team adaptation (standardized values).

The second step towards testing our research hypotheses was to regress the team adaptation slope on initial cohesion. The negative coefficient (β = -.04, *S.E* = .02, p < .001 95% CI LL = -.07, UL = -.004; χ^2 (68) = 94.96, p < .05, RMSEA = .05, CFI = .96, TLI = .95, SRMR = .07) suggested that team adaptation over time decreases for teams whose level of initial cohesion is higher (see Table 17; see Figure 5). In this second step we also controlled for the effects of team familiarity and team type on the team adaptation slope. We found that both control variables positively and significantly accounted for team adaptation variation over time ($\beta = -.05$, *S.E* = .02, $p < .01$; 95% CI LL = .02, UL = .08; $\beta = -.04$, *S.E* = .02, $p < .05$ 95% CI LL = .01, UL =.08).

Hypothesis 2 was tested through the examination of a slope-only mediation model in which mediation is expected to occur through the slope of team coordination. The results show that team coordination over time does not mediate the relationship between initial team cohesion and team adaptation over time ($\beta = -.004$, *S.E* = .01, $p > .05$; 95% CI LL = -.01, UL =.01; χ^2 (63) = 92.14, $p < .001$, RMSEA = .05, CFI = .95, TLI = .94, SRMR = .06). Hypothesis 2 proposed that team coordination trajectories over time positively mediate the positive relation between team initial cohesion and team adaptation trajectories over time. Our findings reject hypothesis 2.

To summarise, our research findings suggest that: *a)* higher initial cohesion is negatively associated with team coordination and team adaptation trajectories over time, and *b)* team coordination trajectories over time do not mediate the relationship between initial team cohesion and team adaptation trajectories over time. Additionally, our findings (Table 22) show that team member familiarity and team member task experience both positively predict team adaptation trajectories over time.

Discussion

The study of the temporal dynamics of team processes is essential to fully understand how teams adapt (Cronin, Weingarten & Todorova, 2011). The aim of this study was to examine how initial team cohesion, team coordination, and team adaptation relate over time. More specifically, this study set out to test whether team coordination over time mediates the relationship between initial cohesion and team adaptation. Overall, this study suggests that initial team cohesion negatively predicts team coordination and team adaptation over time, and that high levels of initial team cohesion might work as a disabling condition to team coordination and team adaptation. Although our research findings go against most of the empirical evidence available in the teamwork literature, there is also empirical evidence that helps us to explain why we might have found such puzzling results.

One possible explanation is that the high levels of initial team cohesion (i.e. M = 5.23; d.p. = .83) reported by participating teams in this study (Table 1) might have functioned as a heuristic for team members to determine to what extent the team is working efficiently,

Table 22 - Standardized growth parameter estimates for hypothesis 1 to 2.

	β	*S.E*	95% CI (lower limit – higher limit)
Hypothesis 1 - Main variables.			
Initial cohesion → Team coordination (slope).	-.06**	.02	-.09, -.02
Hypothesis 1 - Control variables.			
Team type → Team coordination (slope).	.02	.02	-.01, .06
Team familiarity → Team coordination (slope).	.02	.02	-.02, .02
Hypothesis 2 - Main variables.			
Initial cohesion → Team adaptation (slope).	-.04†	.02	-.07, -.004
Initial cohesion → Team adaptation (slope) when team coordination is included in the model.	-.03†	.02	-.06, .00
Team coordination (slope) → Team adaptation (slope).	.07	.11	-.16, .18
Initial cohesion → Team coordination (slope) → Team adaptation (slope).	-.004	.01	-.01, .01
Hypothesis 2 - Control variables.			
Team type → Team adaptation (slope).	.04*	.02	.02, .08
Team familiarity → Team adaptation (slope).	.05**	.02	.01, .08
Team type → Team coordination as mediator (slope).	.02*	.02	.004, .06
Team familiarity → Team coordination as mediator (slope).	.02	.01	-.01, .04
Team type → Team adaptation (slope) when team coordination is included in the model.	.02	.01	-.001, .03
Team familiarity → Team adaptation (slope) when team coordination is included in the model.	.02	.001	-.003, .03

** $p < .01$, * $p < .05$, † $p \leq .06$The second step towards testing our research hypotheses was regressing the team adaptation slope on initial cohesion. The negative coefficient (β = -.04, *S.E* = .02, $p < .001$ 95% CI LL = -.07, UL = -.004; χ^2 (68) = 94.96, $p < .05$, RMSEA = .05, CFI = .96, TLI = .95, SRMR = .07) suggested that team adaptation over time decreases for teams whose level of initial cohesion is higher. In this second step we also controlled for the effects of team familiarity and team type on team adaptation slope. We found that both control variables positively and significantly accounted for team adaptation variation over time (β = -.05, *S.E* = .02, $p < .01$; 95% CI LL = -.02, UL = .08; β = -.04, *S.E* = .02, $p < .05$ 95% CI LL = .01, UL =.08).

and whether there is a need to change the *way things are usually done.* Artinger, Petersen, Gigerenzer and Weibler (2014) suggest that heuristics play a fundamental role as drivers of adaptive decision making in managerial work environments. The authors advocate that heuristics provide a simple, less cognitively loaded, source of information from which fast decisions can be reached. However, such decisions can result in a positive, or a negative outcome. This argument finds support in research by Callaway and Esser (1984), and Mullen, Anthony, Salas and Driskell (1994) who found that more cohesive groups often render poorer decision making outcomes.

As previously stated, team coordination is dependent on team members' ability to communicate openly and share relevant information (Ensley et al., 2002; Rico et al., 2008). However, the inefficiencies of high cohesion that cause a decrease in coordination capacity can harm team adaptation because the decision to engage in adaptive action might be delayed when team members fear sharing their thoughts, or when need-for-adaptation flags are visible but ignored (e.g. the Pearl Harbour attack; Esser, 1998).

For teams whose initial level of cohesion is higher, it might well be that biasing group phenomenon such as groupthink and polarisation interfere with the quality of decision-making that requires team adaptation. Indeed, highly cohesive teams might avoid task/cognitive conflict because they believe that conflict will hamper team processes and outcomes. Rather than openly communicating, constructively confronting and exchanging ideas during adaptive episodes, team members will stick to the plan and avoid any kind of confrontation that threatens the team. Such passivity could be another good candidate in explaining why high initial high levels of cohesion cause a reduction in team coordination and team adaptation over time. In one study by Hardy and colleagues (2005) examining the relationship between cohesion, processes and performance in sports teams, the authors found that fifty-six percent of the participants explicitly reported that cohesion was detrimental for individual and collective dynamics. Participants reported that too much social cohesion caused time wasting during training, goal-related problems, and team member social isolation (e.g. ugly duckling effect; scapegoat effect). In Hardy and colleagues (2005), participants also reported that high task cohesion often causes decreased member contribution to the team or task, reduced social relations and communication inefficiencies.

Communication inefficiencies have been shown to be detrimental to team coordination over time, and to team adaptation as well (e.g. Burtcher et al., 2010; Grote et al., 2010). When team members fail to assess relevant information it is likely that errors will happen during the communication and coordination processes. Such errors also result in a collective inability to build accurate team situational models, which results in poor performance (Rico et al., 2008; Stout, Cannon-Bowers, Salas & Milanovich, 1999). The reduction of team social relations also brings several problems to team coordination because the decrease in team members' collective awareness reduces the likelihood that team members will attend task inputs and fellow team members' needs in a timely manner (Driskell & Salas, 1992).

In conclusion, finding that team familiarity and team task experience positively contributed to predicting team adaptation trajectories over time was an interesting result. Team familiarity concerns how well team members know each other, and is a good indicator of team member proximity. This resembles social cohesion. However, the fact that team cohesion and team familiarity led to different team adaptation trajectories might suggest that they play different roles in shaping the interpersonal processes that influence team adaptation. Regarding team member task experience, it could be that it is closely related to team cognition in the sense that the more task experience team members have, the bigger and more accurate the mental model they will share.

Theoretical implications

Most studies on team cohesion and team cohesion sub-dimensions as well, have found empirical support for the benefits of highly cohesive teams. These results have been received without much questioning, probably because the idea of cohesion as a good thing is intuitively appealing and apparently logical. Although our findings suggest that too much cohesion is bad for team functioning, we cannot say that cohesion is not functional for coordination and adaptation. Cohesion is certainly important to a certain extent.

Our findings echo previous research showing evidence of team cohesion as having a negative effect on teamwork dynamics. In our study, while a cross-sectional examination of the relationship between initial team cohesion and team coordination showed a positive relationship between both constructs, using a longitudinal approach allowed us to identify a negative relationship. The evolution of team coordination and team adaptation over time got worse for teams whose levels of initial cohesion were higher. These findings raise an interesting point; they suggest that the way theory on the relationship between cohesion and teamwork dynamics is built should be firmly rooted in longitudinal data (Cronin et al., 2011; Roe, 2008). Furthermore, these findings suggest that the way relationships between constructs are theorised, and examined, is heavily dependent on how levels of analysis and time are considered (Kozlowski & Klein, 2000; Roe, 2008).

The evolution of team coordination and team adaptation over time could show different trajectories regarding which sub-dimension of cohesion are being considered. For instance, given that social cohesion is the sub-dimension that most relates to the quality of the relationships within the team (Greer, 2012), it is likely that initial social cohesion will have a stronger detrimental effect on task coordination and team adaptation over time, than task cohesion will. Plus, which dimension of team cohesion contributes the most to team coordination and team adaptation trajectories over time might be dependent on the team development stage (Kozlowski et al., 1999). For less experienced teams with little familiarity amongst team members, social cohesion and interpersonal attraction to the group might be the most important types of cohesion that need to be leveraged. The sooner team members establish stronger social ties; the better team members will be able to engage in collaborative learning and performance. Engaging in such behaviours will then facilitate the development of team mental models that are needed for coordination and adaptation. Over time, as teams gain experience and forge clearer interpersonal connections, task cohesion might emerge as a more relevant dimension of team cohesion. This is because it will give team members a sense of agreement and stability that will reduce stress and cognitive load and afford team members the opportunity to focus on task or goal directed behaviors. Nevertheless, how different facets of team cohesion gain preponderance across the team development cycle, and hence influence teamwork, might be contingent on potential moderators such as task interdependence (Gully, Devine and Whitney, 1995), and task complexity (Man & Lam, 2003).

Research by Barrick and colleagues (2007) revealed that top management teams with high interdependence achieved better team and company performance when the team was more cohesive and communicated more. Conversely, for teams with low interdependence, performance was only higher when communication and cohesion were lower. Research by Rico, Cohen and Rodriguéz (2006) has also shown that superior virtual team performance is contingent on the match between the nature of the task (low task interdependence versus high task interdependence) and team communication modality (synchrony of communication versus asynchrony of communication). These findings tap into research carried out by Wise (2014). Using a Social Network Analysis approach to study cohesion and performance in business teams, Wise (2014) found that group cohesion and team performance share an inverse ‘U’ shaped relationship. In our study, participating teams all reported high levels of cohesion, which suggests that our analyses valued the difference between high team cohesion and very high team cohesion. This result is very interesting if we consider that most theories on team emergent states "propose" a positive relationship (linear) between constructs. This result supports the idea of a curvilinear relationship between cohesion and team dynamics, and challenges the linear rationality. Additionally, in the Wise (2014) study, team cohesion was regarded as a measure of network density (i.e.

the number of connections between nodes). In complex systems, network density is also an expression of the interdependence of a system's constituents. Contingent on how much interdependence the system (e.g. task) requires from team members, the more efficient networks will display a higher or lower density structure. Density is an expression of adaptation to interdependence, and moderates the flow of communication that is needed during team coordination and team adaptation.

Additionally, task complexity could also work as a moderator. In high complexity tasks, team members are exposed to contextual (e.g. deadlines) and interpersonal stressors (e.g. conflict) that often have a detrimental effect on teamwork dynamics (Kozlowski, Chao, Chang & Fernandez, in press). Research by Man and Lam (2003) found that the relationship between team cohesiveness and team performance is positively higher when task complexity and team cohesiveness are higher, rather than when task complexity is lower. Under conditions of high task complexity, high cohesion teams might display more positive coordination and adaptation trajectories than teams with low cohesion (Kozlowski et al., in press).

Considering the arguments presented in the two previous paragraphs, it would be reasonable to say that the participating teams in our study performed in an environment where task interdependency and task complexity were low. We anticipate that more cohesive teams would suffer from low task interdependence and task complexity

Practical implications

Overall, this study significantly contributes to organizational behavior and human resources management practice because it sheds new light on the relationship between team level constructs that are often regarded by most organizations as being of the most importance. Being aware that using cross-sectional versus longitudinal lenses to examine cohesion might result in conflicting information is an important message to *take home*. Indeed, I/O Psychologists and Managers can learn that managing performance over time requires the use of longitudinal data analysis in order to gain a more reliable perception of what is going on. Our findings also suggest that measuring cohesion at the beginning of a project might help towards designing better training and coaching support programs. These results suggest that investing in training in team coordination skills is a valuable and important human resources management practice. Not least because being able to effectively coordinate over time is a baseline condition to achieve adaptation in the work place (Burke et al., 2006; Grote et al., 2010; Rico, de la Hera & Tabernero, 2010). Finally, the debate that was raised in the previous section regarding the role of potential moderators should also be regarded as a valuable information in case practitioners wish to compare teams that have different roles (e.g. top management teams and project teams), and where differences in terms of task interdependence and task complexity are likely to exist.

Limitations and future research

The nature (simulation) and specificity (top management team) of the research context frame the generalizability of our research findings. Nevertheless, the adoption of management simulations such as the one used in this study is not new (e.g. Santos & Passos, 2013). Furthermore, there is considerable growth in the number of empirical studies showing that simulations are most beneficial for learning and training; particularly those that best recreate the real-life context in which trainees will have to perform. The closeness between simulation and reality increases the likelihood that participants will behave in a similar way to how they would behave when performing in real environments (Leemkuil & de Jong, 2012). This strengthens the reliability and generalizability of the research findings.

As described in the method section, the limited access given to the research team impeded our ability to model the need for adaptation, hence raising the question of what would have happened if such modelling had been possible (e.g. Baard et al., 2014; Maynard et al., 2015). Nevertheless, the nature of the simulation in which teams were engaged is dynamic in the sense that change happens every week, and teams are continuously forced to adjust to changing situational demands. This causes team adaptation trajectories over time to have a minimum degree of variability, and this creates the conditions for team adaptation to happen. This argument is supported by our findings showing that team adaptation significantly changed over time. Still, it would be interesting to reproduce the same study but with the introduction of a *dramatic change* in the team task environment (e.g. LePine, 2005; Resick, 2011). Such manipulation would result in a more visible drop in team processes and, subsequently, a better observable evolution of team processes over time depending on initial cohesion. In light of current research indicating the boundary conditions of team cohesion, it is feasible to expect that whereas in a management context, the findings from this study would be replicated, cohesion might be crucial to avoid team disruption and failure in a field context where team relationships are pushed to the limit (e.g. life and death situations), (Kozlowski & Chao, 2012; Kozlowski et al., in press).

The decision not to include any potential moderators in our study was linked to our primary interest in describing how team coordination trajectories over time mediate the relationship between initial team cohesion (regardless of whatever those moderators could be) and team adaptation trajectories over time. The unexpectedness of our research findings led us to ponder what other variables could be responsible for such results. Task interdependence and task complexity emerged as two potentially explanatory variables. Future studies could try to replicate our findings and include potential moderators such as the ones suggested. Researchers willing to do so could create a laboratorial task where task interdependence and task complexity are manipulated. Plus, should they decide to further extend our findings in the laboratory, team adaptation could also be experimentally manipulated by introducing a sudden shift in task conditions that could also be utilised to manipulate task complexity (LePine, 2005).

Finally, the communication and dissemination of unexpected or contradictory findings is important to improve social sciences (Ferguson & Heene, 2012). Having found no support to our research hypotheses might hinder perceptions of the potential contribution of this study. However, recent work by authors such as Franco, Malhorta and Simonovits (2014) have raised an alert regarding the potentially biasing effect of avoiding the publication of research findings that support the null hypothesis, especially in the social sciences. Franco and colleagues (2012) stress the negative biasing effects that such practice have in the development of knowledge because they limit our full understanding of living and social systems. Additionally, we decided not to engage in HARking (i.e. hypothesizing after results) because it poses a serious threat to science (Bosco et al., 2015).

Conclusion

Understanding the dynamics characterising teamwork and team members' interrelations requires incorporating the role of time and the consideration of initial conditions triggering the trajectories of positive or negative team processes (Chen et al., 2011; Hackman, 2012). This study contributes to the teamwork literature by showing that, over time, high cohesion teams tend to suffer a decrease both in coordination and adaptation trajectories. The more cohesive a team is, the greater the likelihood that the team will see its ability to coordinate and adapt weaken over time.

Part III

9. General Discussion

General Discussion

The first half of the twenty first century promises the beginning of a new age for mankind. Mars is becoming closer and closer, the cure for cancer is beginning to be no longer a utopia, and *going green* passed from being an eccentricity to become inculcated in our everyday life. Nevertheless, greater progress also brings greater turmoil and work environments are becoming less and less stable (Ceja & Navarro, 2011; Goodwin et al., 2009; Marion, 1999). Such instability puts co-workers under an adaptive tension because managers, who often care more about results than processes, are also aware of the importance of having a work force that is able to deliver efficient solutions to every day challenges (Kozlowski et al., 1999; Rico et al., 2011). Although we acknowledge the complexity and variety of phenomena requiring individual adaptive capacity in the workplace, we decided to focus on adaptation as a team level process. This decision was motivated by the centrality of teams in the majority of modern organizations, and by the need to further explore how a group of individuals is capable of behave adaptively in face of uncertainty.

Team work is the pillar of the twenty first century organization. The highly demanding business environment of today's organizations, and the complexity of natural and human-made incidents around the world, makes the study of adaptation in the work place a fundamental topic for the modern age scientific agenda (Baard et al., 2013; Goodwinn et al., 2009; Rosen et al., 2011). The relevance of understanding what is, and what drives team adaptation in the work place is visible in the growing number of theoretical and empirical contributions that have been published on the topic. The interest has risen to such a level that scholars have begun to organize conferences and journal editorials entirely dedicated to the topic, and large scale organizations have been sponsoring research on the subject for more than a decade.

In this discussion section, we will not repeat what has been already debated in the discussion sections of each of the studies that form this dissertation (see table 35). Instead, we will broadly integrate our research in the extant literature and debate several ideas that can be derived from what we have found.

With this dissertation, and the *reflexivity* we hope it triggers, we contribute to the science of teams by adding new knowledge on the multilevel and longitudinal drivers of team adaptation in complex work environments. Furthermore, we contribute to leveraging a *tipping point* towards which the field of teamwork is approaching.

Summary of main findings and implications

This dissertation contributes to the team adaptation literature in 2 major topics: Scale development and validation, and team process and emergent states theory. In the next paragraphs we will briefly outline the main findings of this dissertation and detail how these relate, and contribute to theory and practice in human resources management and organizational behaviour.

Scale development and validation

The development and validation of feasible and reliable questionnaires to assess individual and collective behaviour in the work place is very important to assure proper data collection. Furthermore, the use of psychological tools that have received adequate statistical treatment improves the quality of the data analysis process from which scientific, practical, and policy making conclusions are derived.

Developing the adaptive performance scale resulted from the need to have an instrument that would allow us to measure team adaptation at the individual and team level, in a way that was aligned with dominant theories of team adaptation in the work place. We acknowledge the existence of theory grounded alternative tools such as the team adaptive performance markers proposed by Rosen and colleagues (2010), or the adaptive coordination coding protocols used by authors such as Grote and colleagues (2010). Nonetheless, using questionnaires for data collection often is the only way through which scholars and practitioners have access to data. Up to now, literature on team adaptation offered a limited number of solutions to accurately measure adaptation trough questionnaire administration. The development and validation of the adaptive performance scale has filled in this gap.

Team processes and emergent states

Theories and path based models of team effectiveness in the work place often regard the role of team processes and emergent states as the driving forces trough which teams perform, and achieve their goals (Marks et al., 2001; Ilgen et al., 2005; Rico et al., 2011). Team processes have been identified has the self-regulatory mechanism that collectives adopt to manage their intra and inter-team relationship with other organizational agents, and the work environment. Team emergent states tap onto these mechanisms by providing teams with the cognitive and emotional cues (i.e. knowledge) that feed team processes and drive team behaviour.

In the team adaptation literature, how teams perform adaptively and achieve adaptability is often very similar to the relational dynamics that are proposed in team effectiveness models. Most commonly, propositions of what drives adaptation highlight the roles of such processes as coordination, feedback and learning (e.g. Burke et al., 2006; Kozlowski et al., 1999). Such propositions also emphasise the positive contribution of emergent states such as shared mental models, situational awareness and trust (e.g. Burke et al., 2006; Zajac et al., 2013). Nonetheless, other team constructs have been left out of the team adaptation literature until recently. For instance, constructs such as transactive memory systems and cohesion haven't received proper examination as potential contributors to team adaptability. In this dissertation we have been able to shed new light on the *pros* and *cons* of having a well-developed transactive memory system, or a highly cohesive team. Trough cross-sectional and longitudinal data analyses, we have been able to find empirical evidence suggesting that while transactive memory systems can improve (e.g. adaptive performance; implicit coordination) and hinder (e.g. reflexivity) team processes, high cohesion can be detrimental for management teams' adaptive performance over time. Even though higher cohesion positively correlated with adaptive performance measured at different time points, how adaptive performance changed over time was negatively related with the level of cohesiveness that teams displayed. This finding is important not only because of the clarifications it brings to the relationship between cohesion, explicit coordination and adaptive performance, but mostly because it reiterates the scholarly claim of the urgency of including time in organizational science (e.g. Cronin et al., 2011). Under a temporal framework, it might be that constructs' causal dynamics that we assumed as given might display a rather unexpected complex behaviour.

The study of team processes and emergent states, and how these relate to explain adaptation and effectiveness in the workplace is a baseline condition to help HR professionals and IO Psychologists understating the drivers of team adaptability, and implementing HR management practices that promote the development of individual and team level adaptive competences.

The findings from this dissertation also point in a way suggesting that coordination and reflexivity are two team collaborative behaviours that should be developed and encouraged in the work place. Despite the fact that most training programs in coordination and reflexive behaviour are implemented in out-of-the-office work environments such as healthcare, piloting, firefighting and warfare, the communication and collaborative skills that emerge from such training programs could improve the quality of the team work that is performed in other organizational work environments (Salas & Cannon-Bowers, 2001). Trough pausing and reflecting, and by knowing what information should be shared or retrieved in an exact moment, teams can easily achieve their goals even under the most complicated situations (Marques-Quinteiro et al., 2013).

As an ending note to this chapter, we decided not to include other influential frameworks like Arrow and colleagues (2000) because they examine teamwork dynamics differently from the approach we have taken in this dissertation. Indeed, Arrow and colleagues' (2000) approach to work groups is built within a complex adaptive systems (CAS) framework. These include feedback loops, non-linearity and deterministic behaviour. While feedback loops and non-linearity are contemplated in both I-P-S-O and I-M-O-I models, and can be easily accommodated in most longitudinal research designs and by the majority of statistical software programs, deterministic behaviour is less so. Deterministic behaviour is better known in the social and life sciences as chaos[4] (Gleick, 1987). Evidence of its existence and adequacy to describe teamwork dynamics can be found in the work of Ramos-Villagrasa, Navarro and García-Izquierdo (2013), or Guastello

[4] The word "chaos" is often erroneously used as a synonymous of a system "disorder", "disorganization" or complete "randomness" (Gleick, 1987). However, chaos is deterministic in the sense that tiny changes in a system current state can deliver to global sized transformations in the system state later on. One often cited example is Lorenz's Butterfly Effect.

(2010). Although we are fond of this theory, and we acknowledge that Arrow and colleagues' (2000) approach offers a breaking through perspective on the true nature of teams, we are also aware that fitting a causal chain of events with fixed paths between variables is far discordant with what is deterministic behaviour (even though these include some kind of non-linearity).

Limitations

Beyond the limitations that have been addressed in each study, we believe that this dissertation has two main overarching shortcomings: *a)* the complete reliance on quantitative methods, and *b)* the dependency on self-report questionnaires.

The use of qualitative research offers scholars the possibility to have a more in-depth comprehension of the phenomena that drive team behaviour in the work place (Graça & Passos, 2012; Costa et al., 2014). Trough qualitative data collection and analysis, researchers are able to gain insight regarding the episodic and interpersonal processes that shape team adaptive performance trajectories over time. Indeed, qualitative methods create the possibility for detailed processes description (e.g. a team leader describing how the team re-organized itself to cope with the new task scenario), and a deeper understanding of how team members use shared knowledge to drive collective behaviour. The use of qualitative methods is also relevant for the study temporal team dynamics has they allow the direct registration and coding of behaviour. One particular example in which qualitative research has given a significant contribution to the study of team adaptability in the work place regards studies of team adaptive coordination, and situational awareness as well. In both cases data is collected through interview, coding, and observation protocols, which allow a more in-depth view of team adaptive dynamics (Zajac et al., 2013)

Although we acknowledge that using quantitative methods offers the possibility for more *sophisticated* data collection and analyses, the richness and variety of information that is obtained through quantitative approaches might be limited. The fact that the studies being presented in this dissertation mostly rely on self-reported measures of individual and team behaviour is builds on this limitation. Indeed, research has found support for the respondents' tendency to under-rate or over-rate behaviour depending on their role within the team, how cohesive they perceive their teams to be, and whether the respondent is evaluating his own team, or another (Costa & Passos, 2012; Hamilton & Rose, 1980). The conclusion derived from studies study 4 and study 5, for instance, are careful because data collection was done at a single moment in time, which according with some authors increases the likelihood of common method biasing (Mathieu & Taylor, 2006).

Future directions

Science is a never-ending story, and research always ends with *to be continued*. Science is a collective, temporal process of thinking, proposing, testing, and learning. As scientists, we are committed to this cycle and it is expected that we build on our work to point alternative paths ahead. It is expectable that we are the firsts to point the flaws and weakness of our own research, and to guide others in a direction that might help them improving what we have achieved.

Ironically, in this section our goal is not to further dwell on previously repeated considerations throughout this dissertation. We won't repeat the importance of longitudinal thinking-doing, nor shall we repeat how non-obtrusive data collection methods are a step that is worth taking into twenty first century's organizational science. Instead, our goal with this subsection is to launch a provocative idea regarding what is team adaptation, and whether we are using the appropriate frameworks to understand it. We encourage researchers and practitioners to scrutinize this idea and to examine under which conditions it can be useful to strengthen our knowledge of what is team adaptation.

The next section offers a reflection about what is adaptation and where we could go from here. We are aware that we might be adding noise to an already *cacophonic* debate, but we also believe that what we are proposing is already out there and that calling to its attention might help us getting somewhere clearer.

A nonlinear dynamic systems (NDS) approach to adaptation in the work place

Fast and uncontrollable change is what characterizes much of the work environments in which work teams have to perform. Teams are a group of interdependent, loosely coupled individuals who perform towards a common goal (Hackman, 1987; Arrow, McGrath & Berdhal, 2000). Teams are open systems that oscillate between adaptive and non-adaptive states. As other living systems, teams are constantly pulled towards non-adaptive states that often characterize by a dramatic decrease in performance, and that result from factors such as team member loss, poor goal clarity, and unexpected change (Arrow et al., 2000). Over time, teams can display smooth performance trajectories that suddenly jump towards a higher, or lower, level of adaptation (Guastello & Guastello, 1998; Guastello, 2013).

The challenge of studying team adaptation lies in the emergent nature of the behaviour. Team adaptation is a phenomenon of continuous discontinuities, with some degree of interdepend causality between team adaptation episodes. How teams adapt during different adaptation episodes has temporal dependency and sensitiveness to initial conditions. Moreover, teams are *open systems* in the sense that they exchange information and resources with other teams and organizational units at different levels within the organizational structure.

Most studies on the drivers of team adaptation are undertaken under a rational of linear causality. However, reality as we know it is more about sudden *jumps* or *drops*, discontinuous behaviour and unpredictability. The goal of this final section is to present a provocative perspective on the conceptualization of what is and how to measure team adaptation. Throughout the following paragraphs we describe how a specific branch of NDS theory, cusp catastrophe theory, can be used to further extend what we know regarding team adaptation in the work place.

A catastrophe (Zeeman, 1976) is a mathematical model of nonlinear dynamics used to describe discontinuity in physical, biological and psychological systems (Guastello, 1991, 2001; Sheridan, 1985; Zeeman, 1979). Catastrophe theory is useful to describe and predict under which conditions abrupt change can happen, hence causing system's state bimodality (e.g. adapting versus not adapting). Catastrophe theory has been successfully used in other organizational science research such has individual job performance (Guastello, 1984), withdrawal behaviour (Sheridan, 1985), turnover (Wagner & Huber 2003), and accident processes in industry (Guastello, 2014).

According with the cusp catastrophe theory, the dynamics V of team adaptation z can be expressed mathematically by two predicting variables (control parameters) x and y (Zeeman, 1979):

$$V(z,x,y) = zx + (1/2)z^2\, y - (1/4)z^4 \qquad (1)$$

The first derivative of the cusp potential function *V* will be the *equilibrium plane* of the cusp catastrophe:

$$\frac{\partial V\ (z,x,y)}{\partial z} = z^3 - yz - x \qquad (2)$$

The equilibrium plane that is shown in Figure 1 characterizes the level of team adaptation *z* at several points, for all possible combinations of the two control parameters (*x* and *y*).

Under the assumption that team adaptation dynamics follow a cusp catastrophe distribution, *x* and *y* will form the *control plane* that determines change in team adaptation *z*. The segments O-D (ascending threshold) and O-Q (descending threshold), that go from the equilibrium surface to the x-y control plane describe the cusp region.

Following the cusp model, the dynamics of team adaptation *z* are characterized by two stable regions or fixed point attractors (i.e. the lower area in the front left and the upper area in the front right). In these two regions, team adaptation is characterized by smooth variation. Beyond the two stable regions, and when approaching the two threshold lines (O-D and O-Q), team adaptation becomes unstable and abrupt fluctuation happen (i.e. sudden drop or sudden increase in team performance). The paths A, B, and C in Figure D describe three typical, yet different, trajectories of change in team adaptation *z*. Path A shows that when y < O, there is a smooth and continuous relationship between the asymmetry variable *x* and team adaptation *z*; path B shows that when *y* > O, if the asymmetry variable x increases to reach and pass the ascending threshold line O-D, team adaptation *z* will show a sudden increase from the low stable region of the equilibrium plane; finally, path C shows a sudden drop in team adaptation *z* as *x* declines to reach and pass the descending threshold line O-Q.

From this description it might have become obvious that a cusp mathematical model is very different from a linear model in critical ways. Firstly, while a cusp model allows the simultaneous modulation of the team adaptation *z* forward and backward distributions, linear modelling requires that backward progression follows the same path as the forward progression does.

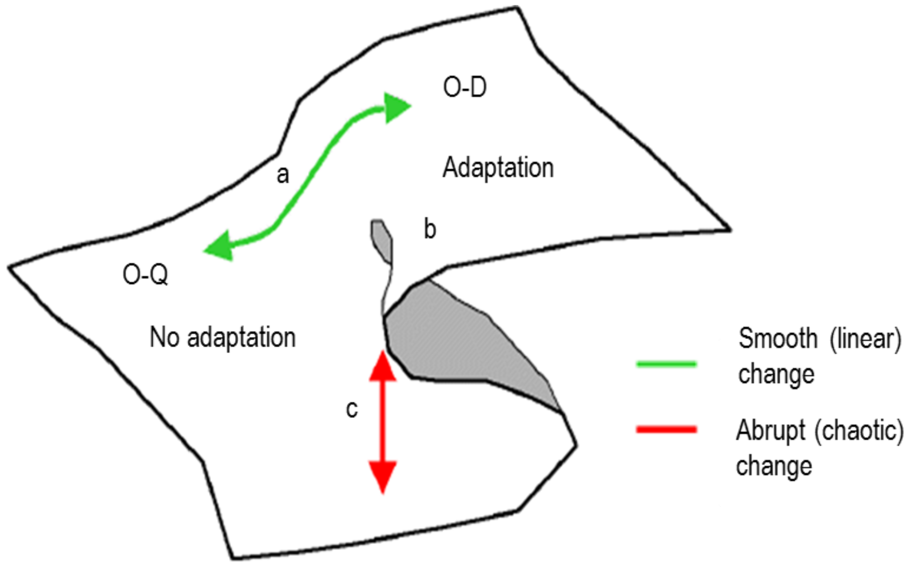

Figure 6 - The team adaptation cusp plane.

Secondly, cusp models cover both the continuous components and the discrete components of change. While continuity is visible through linear and smooth behaviour (path A), discrete change is made visible by sudden and nonlinear events (path B and C). Finally, a cusp model regards two stable regions and two thresholds for sudden changes to occur.

Besides describing the nonlinear dynamics of team adaptation *z*, the cusp model also allows the estimation of under which conditions of the control parameters *x* and *y* team performance *z* travels through the cusp control plane. The control parameters are estimated through an asymmetry (*a*), and a bifurcation (*b*) variable (factor). While the asymmetry factor *a* is responsible for smooth and continuous change in team adaptation *z* (path A), the bifurcation factor *b* is responsible for sudden change in team adaptation *z* (path B and C).

To summarize, it is expected that the dynamics of team adaptation *z* follow a cusp catastrophe in the sense that team adaptation oscillates between two stable states: successful adaptation (the upper area in the front right of the cusp plane, Figure D), and unsuccessful adaptation (the lower area in the front left of the cusp plane, Figure D). Our argument is that how team adaptation shifts from one stable state to another can be described as an abrupt episode. In the submarine example with which this dissertation was started, adaptation was bimodal in the sense that team adaptation oscillated between two alternative states: being adapted, and not being adapted. Moreover, cohesion might have contributed as a smooth attenuator of the grim atmosphere within the submarine hence maintaining adaptation. However, the squid incident triggered conflict, which in turn caused a sudden and major decrease in team adaptation. Finally, the fact that one specific team member recalled that there was a solution for their current problem, led the team back onto an adaptive state.

The cusp catastrophe model is only one example of how NDS theory can contribute to push the field forward and to help us disentangling the dynamics team adaptation (Ceja & Navarro, 2012; Guastello, 2010; Ramos-Villagrasa et al., 2011). Besides cusp catastrophe theory, there are other theories and methodologies within NDS theory that might help researchers and practitioners better understanding how behaviour, cognition, and affects emerge within, and between teams. However, that is a conversation for another time and we sincerely hope to meet you there.

Concluding remarks

This dissertation has contributed to theory and practice of team science by unveiling some of the enabling conditions and causal dynamics that drive team adaptation in the work place. Our findings come to extend previous knowledge on the topic, reinforce existing theory, and open new roads for research as well.

Finally, we conclude this dissertation by claiming that the designs and tools that right now we are using to measure team adaptation in the work place immensely condition the richness of the data we are collecting. The use of interviews, protocols and questionnaires, entangled with tree, four and sometimes 5 data collection points is offering scholars a limited and probably biased view of what really is going on. Although rationales abound (e.g. Arrow et al., 2000; Guastello, 2013), it is urgent to shift the way we do research in team science by adopting simpler, *lighter* ways of collecting data, and to bring nonlinearity to the game. Nonlinearity is neither the boogieman, nor the Ghost of Christmas Past. It is the next step in team adaptation and teamwork research (e.g. Ramos-Villagrasa et al., 2012).

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