BABEȘ-BOLYAI UNIVERSITY, CLUJ NAPOCA
FACULTY OF PSYCHOLOGY AND EDUCATIONAL SCIENCES
DEPARTMENT OF PSYCHOLOGY

EMERGENT STATES, TEAM DYNAMICS AND TEAM EFFECTIVENESS IN MEDICAL TEAMS WITH FLUID MEMBERSHIP

PhD Candidate: CIUCE (OȚOIU) CĂTĂLINA
SCIENTIFIC SUPERVISOR: PROF. ADRIANA BĂBAN, PhD

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INTRODUCTION

The present thesis analyses the dynamics of medical teams with fluid membership. While we will discuss phenomena that are integral characteristics of teams in general, the focus of this research is on uncovering specificities of this particular type of medical team. We believe that such a research endeavor is relevant, timely and also necessary.

Medical teams with fluid membership are those teams that are formed for a short period of time, with the specific purpose to address an immediate or urgent medical situation. This could be an emergency intervention team that functions as a first responder to accidents, home medical emergencies or larger scale crisis situations. These types of first responders usually function on a shift-to-shift bases which means that teams usually change composition every 12 to 24 hours. Another example is that of a trauma team where - especially in larger medical wards - a multidisciplinary team of health care professionals is instantly formed once a trauma case is brought into the emergency room. Depending on the criticality of the trauma case this team could have 5 members or many more, and the individuals that work on that case could rotate at any time. Once the emergency situation is completed the team is dismantled and those individuals may not work within the exact same structure for a long time, if ever. Similarly, a difficult surgery situation with complications could call for making changes to the surgical team during operating time. Once the surgery is over so is the team in that particular composition.

In all these examples, healthcare professionals of various specialties and with different degrees of expertise have to deal with issues that put a serious strain on collaborative work: there may be instances where they are forced to work with somebody they do not know, or have seldom worked with; they may have to start working with a certain person only to have their colleague leave the team and be promptly replaced by somebody else; they may enjoy at some point working with a certain team only to have to leave it and join a completely different team due to the nature of the medical emergency. Trauma cases and emergency situations in general add an extra stress on the teams that first respond to them because of the criticality of a rapid and effective response since correct and

fast response is essential for diminishing or eliminating the risk of death or permanent injury (Martin & Meredith, 2008). Hence, despite all the difficulties previously mentioned healthcare professionals have to work well together within these teams, to become quickly and properly coordinated and to communicate with ease. All of these group interaction processes are relatively easily implemented when the team members have a long history of working together. But medical teams with fluid membership lack this common history that offers the relevant knowledge on the expertise of other team members, on their individual work related preferences or even on their moods (Bedwell, Ramsay, & Salas, 2012). It is all of this information that helps guide ones behavior within the team and enhances coordination, communication and similar group processes and ultimately team effectiveness (Huber & Lewis, 2011b).

Medical research on emergency intervention has long been focused on identifying response protocols and procedures that enhance the effectiveness of the medical act. Most emergency wards on a global level use specific guidelines and indicators that are consistently used to evaluate each case and to speed up the medical decision process in emergency situations (Martin & Meredith, 2008). Performance in such cases is a result of the interaction of team members and the way that the team uses these guidelines. Recent studies (Bleakley, 2013; Flowerdew, Brown, Russ, Vincent, & Woloshynowych, 2012; Mazzocato, Forsberg, & Schwarz, 2011; Westli, Johnsen, Eid, Rasten, & Brattebo, 2010) within the field of medicine recognize the need to also focus on the effect that human factors have on the overall performance and effectiveness of emergency response in general, and of trauma teams in particular. Moreover, there is increasing evidence that links effective teamwork in health care with improvements in quality of care and reduction of medical errors (Chakraborti, Boonyasai, Wright, & Kern, 2008). There is a need to identify those specific team level components that differentiate between high performing and low performing teams within the general context of changes in team structure and composition. Following these arguments, we consider the focus on fluid medical team effectiveness and dynamics to be highly *relevant*.

Second, we believe a thorough investigation of team composition in general, and of medical teams with fluid membership in particular, is also *timely*. On the one hand, dynamic team composition is no longer restricted to a few very narrow practice domains and settings like, for example, emergency medicine, flight crews or disaster management teams. They may still be emblematic to these situations but they are no longer restricted to them. Temporary organizational systems have been extended to a variety of work contexts – like film crews, IT development teams or project management teams, just to name a few (Bakker, 2010). This extension of the usage of temporary and fluid teams and systems makes it imperative to gain a better understanding of the particularities of their functioning.

As far as the particular case of medical teams with fluid membership, in spite of their longer history, implementation issues still arise within healthcare organizations. There is an emergent trend in team research dedicated to the analysis of the viability of systems like rapid response teams (Leach & Mayo, 2013; Neale, Thompson, & Wheatley, 2013; Smith et

al., 2013; Vagts & Mutz, 2013) due to the fact that more and more medical centers have acknowledged the need to implement such teams or to evaluate already existing emergency response programs (Ritter et al., 2013; Sen, Morgan, & Morris, 2013). But in order to better prepare their implementation and to test their efficiency in practice, there is a need to better understand the processes that result in high team effectiveness.

Thirdly, the lack of understanding of the dynamics specific to medical teams with fluid membership and specific to changes in team composition is what makes this research *necessary*.

Due to the nature of their work, fluid teams are much more difficult to research than teams with a fixed composition that work together over longer periods of time. Therefore there is a small literature base that does focus on such teams and for the most part it employs indirect research methods that only offer a segmented and static view of team functioning (Bedwell et al., 2012; Tannenbaum, Mathieu, Salas, & Cohen, 2012). Team scientists recommend to look at teams in a dynamic fashion and to take on a temporal approach to their study in order to facilitate a proper understanding of the relevant team processes and emergent states (Cronin, Weingart, & Todorova, 2011; Steve W. J Kozlowski, in press; Steve W. J Kozlowski, Chao, Chang, & Fernandez, in press; S. W. J Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013; S. W. J. Kozlowski & K. J. Klein, 2000; Marks, Mathieu, & Zaccaro, 2001; Salas & Wildman, 2009). Moreover, in order to understand specific team phenomena it is also relevant to investigate teams in their natural environment (Rosen, Wildman, Salas, & Rayne, 2012; Salas & Wildman, 2009).

The shift in the research focus towards understanding what the concept of *teamwork* entails in different medical contexts is quite obvious in medical research. However, even though it has been frequently referenced in studies of medical environments and associated with medical team performance (Cooper et al., 2010; Lerner, Magrane, & Friedman, 2009; Williams, Rose, & Simon, 1999; Wright et al., 2009), there is a general lack of clarity with regard to what teamwork actually entails (Salas & Wildman, 2009). Not only it is necessary to advance the clarification of such key concepts, but it also becomes aparent that research efforts should be tailored to specific types of organizational contexts and specific types of teams (Edmonson & McManus, 2007).

It is not within the scope of the present chapter to exhaustively describe and discuss our main theoretical concepts. The proper theoretical background will be provided, later on, in each of the individual studies of the thesis. The purpose of this introduction is merely to present the rationale of the present research and the thinking behind this entire research process. As such, this first chapter in our thesis is organized as follows: we will begin with a presentation of our paradigmatic commitment and describe our understanding of organizations and teams as complex adaptive systems (1); we will briefly discuss the concepts that are the most relevant for the entire thesis (2); we will then present our overall research approach and our methodological commitment (3); the introduction will then conclude with a presentation of the structure of the thesis in terms of the studies included,

their individual research questions and objectives and the way in which they build on each other (4).

1. Paradigmatic commitment - Teams as Complex Adaptive Systems[1]

The last two decades have seen an increase in organizational theories that view organizations through the lens of *complexity theory* (Anderson, 1999; Chirica et al., 2009; Hatch & Cunliffe, 2006). The principles of complexity science build on previous theoretical perspectives and allow for a deeper analysis and understanding of organizational processes. They can be translated into practical designs that initiate and support change and invigorate organizations (Pascale, Millemann, & Gioja, 2001).

The study of linear relations and of a modular analysis of organizational processes (like i.e. leadership, assessment, decision making etc.) can only offer a fragmented view of an organizational reality that is continuously subjected to change. Hence, integrated perspectives that focus on non-linear relations and on interdependencies among individual processes are becoming more and more popular.

Organizational theory, courtesy of the Open Systems Theory (Katz & Kahn, 1978; von Bertalanffy, 1950), has been acknowledging for a long time the necessity for a system to relate to the environment it functions in and to adapt to the dynamic of that particular environment while, at the same time, being highly aware of its own internal processes (Cohen, 1999; Harrison & Shirom, 1999). The basic concepts brought on by the Open Systems Theory are *input*, *output* and the *feedback loop* between the organization and its environment. According to this theoretical perspective organizations take resources from their environment (input), transform them through organizational processes and *feed them back* to the environment in the shape of producs or services that constitute the output (Harrison & Shirom, 1999). Complexity science offers more insight into these interactional processes between the organization and its environment. Relationships between system elements are considered to be primarely non-linear, feedback loops are much more complex and they function differently from the one advanced by the open systems theory. The basic concepts within this framework are *variety* (within and outside of the organization), *self-organization* (order emerges as a result of the nonlinear interractions and the multilevel closing of feedback loops) and *coevolution* of the system's elements *towards the edge of chaos*, a state of optimum functioning where the organization (the system) balances its stability with flexibility. Complexity science does not *replace* open systems theory, but rather it *complements* it by introducing new perspectives into the field of organizational theory and by reconceptualizing organizations as *complex adaptive systems*.

Characteristics of complex adaptive systems

[1] An initial version of this section on complex adaptive systems was previously published in (Chirica, Andrei, & Ciuce, 2009, pp. 153-159)

Complex adaptive systems reach and preserve this equilibrium between their internal variety and the diversity of external environmental conditions through four functional elements: (I) agents with schemata; (II) self-organizing networks sustained by importing energy; (III) coevolution to the edge of chaos and (IV) recombination for system evolution (Anderson, 1999).

I. Agents with schemata

The functioning of complex adaptive systems is based on a different pattern than clasic causal models. Changes in one of the systems' elements are not neccesarily determined by causes at the same level of the system. They are driven by the actions of *agents* that act according to a set of decision rules, and changes to these rules or to the interconnections between the systems' agents could produce different results at different system levels. Because of this, „order" within the system is emergent and not status-qvo, and it is dependent on the agregation patterns of the individual agents' behaviours (Anderson, 1999).

II. Self-organizing networks sustained by importing energy

Order within a complex adaptive system emerges from the ways in which agents repeatingly use a set of rules. This self-organization, that Fontana and Ballati (1999) name „system autogenesis", is a direct result of nonlinear interactions between agents that allow for certain behaviors to be amplified within the system by positive feedback loops. When some behaviors are amplified they automatically exclude from the system other behaviors (through the formation of negative feedback loops), and therefore „order" is generated.

III. Coevolution towards the edge of chaos

For a system to be adaptive it is necessary that its agents also function adaptively, and this means that each agent (individual) should act in such a way that their contribution is valuable, or rather that they are fit for the system (Holland & Miller, 1991). To that end, each agent is permanantely trying to increase their own fitness. But, due to the interdependence of agents in the system, their performance ultimately dependes on the actions of other system agents. Functioning on „the edge of chaos" refers to an organizations ability to balance that which is predictable with the unpredictable, in order for it to develop and change. A too rigid structure doesn't offer the tools an organization needs in order to adapt to its environment, and therefore, it doesn't allow for change to occur. At the same time, structure is essential in order to manage and organize a change process. Without it, it is also difficult to coordinate change as there is no coherence in the organizational actions which become chaotic (Brown & Eisenhardt, 1998).

IV. Recombination and system evolution

A fourth and final characteristic of complex adaptive systems refers to the changes that help the system evolve. Sometimes evolution is triggered when new agents are introduced to the system. They each bring their own set of schemata and produce new decision rules and these new conditions modify preexisting interractions and behaviors, and spur change. While that may be quite often the case, change doesn't always have to come

from external stimuli. Complex systems use their own existing components to produce innovation. This process is referred to as *recombination*.

2. Conceptual delimitations

Complex adaptive systems theory offers the lens through which we conduct the research within this thesis and, at the same time, it provides a coherent integration of the various theoretical concepts we will use. The three main concepts that we will work with throughout the thesis are *fluid membership teams, emergent states* and *team effectiveness*. The intention in this section is not to give an extensive presentation of these concepts, but to differentiate them within the larger team literature.

2.1. Fluid membership teams

Among the most well known conceptualizations of teams we find some common characteristics that have come to be associated with them: they are generally viewed as "collectives who exist to perform organizationally relevant tasks, share one or more common goals, interact socially, exhibit task interdependencies, maintain and manage boundaries, and are embedded in an organizational context that sets boundaries, constrains the team, and influences exchanges with other units in the broader entity'' (S. W. J Kozlowski & Bell, 2003, p. 334).

Analyzing this definition, as well as other similar ones - Devine (2002) offers an integration of team definitions and typologies -, we can easily identify some clear boundaries within which team characteristics are contained. These limitations, however, seem to have been set in place by some reasoning derived from past experiences with teams and not by a thorough analysis of current practice in the "real world". And here is why. Common understanding of team characteristics includes: a mostly fixed team membership (or mostly stable over time), clearly defined roles, relatively consistent tasks and a high degree of dependence on the larger social system within which the team is embedded. The larger system is the one that imposes these limitations and the teams' responsibility is to keep them in place.

The latest studies in team research bring forth the fact that one of the defining characteristics of teams – the boundaries that define them as a stable and independent entity with generally fixed membership structures – is no longer a given in the present dynamic and complex environment (Bedwell et al., 2012; Devine, 2002; Levine & Moreland, 1990; Mathieu, Tannenbaum, Donsbach, & Alliger, 2014; Summers, Humphrey, & Ferris, 2012; Tannenbaum et al., 2012).

For example, consider an emergency ward dealing with a sudden and large number of casualties. In situations like these, every available surgeon, resident, scrub nurse and anesthesiologist is called in to deal with the crisis. Depending on specific medical

intervention needs at that time, the personnel on call *can* and *will* team up with anyone among their colleagues. It might be someone they already know well and have previously worked with, but just as well it might be someone they have never even seen before. However, no matter what the team looks like in the end, they need to be almost instantly efficient, coordinated and make no mistakes. At some point during the medical intervention one member of the team might finish his/ her job and join a different ad hoc team that needs the particular expertise they have to offer. If that is the case and, for example the chief surgeon leaves for another intervention, residents or other surgeons need to pick up where he left off and finish the job. And still they need to be efficient, coordinated and make no mistakes.

There are a few things that become clear when using this example (Otoiu, 2014). First, team membership is not always fixed or stable in time. Team composition in this case may be an outcome of multiple variables like human resources availability, or difficulty of the medical procedure needed to be done. Second, once they are part of a team that deals with an emergency, everybody does what needs to be done even when actions sometimes go beyond official tasks or roles. Therefore, the needs of the team overcome personal preferences or habitual actions - but of course still within personal expertise limits. Third, at the time of such an event there is no "higher power" that organizes the activity. While there is an official emergency hospital team structure and composition, people on call self-organize based on input from triage. Asking for help, determining whose expertise is needed where, it all happens on site, not in an office far away. This means leadership is not an attribute of one particular person but it is distributed based on situation specific needs.

There is a rather small literature base that researches membership fluidity (Summers et al., 2012) and the existing studies generally draw on the findings on team adaptation. Team adaptation refers to "a change in team performance, in response to a salient cue or cue stream [in our case changes in team membership], that leads to a functional outcome for the entire team" (Burke, Stagl, Salas, Pierce, & Kendall, 2006, p. 1190).

Membership fluidity is a particular type of team adaptation as well as a very specific case of team composition. It represents a "dynamic flow of members in and out of teams, resulting in a change to the team composition" (Bedwell et al., 2012, p. 505). Bushe and Chu (2011) stress that only a few people research what they believe to be fluid teams. According to them it is important to differentiate between "project based teams" (where the team could work together on one single project but over long periods of time) and "fluid teams" which they define as "groups with unstable membership that organizations create and hold responsible for one or more outcomes" (Bushe & Chu, 2011, p. 181).

As such, in the present research we consider *fluid membership teams* to be those social entities which, while maintaining all relevant team characteristics (i.e. shared goal, interdependent actions) have flexible boundaries and a constant change in team membership within short periods of time.

Throughout the present thesis we will refer to the intended pool of participants as *medical team members*, *medical teams or medical units.* However, we really only take into

account those medical teams that have fluid membership like, for example, emergency intervention teams or ad hoc surgery and anesthesia teams. Medical teams with a fixed membership structure, where team members work together over long periods of time are not within the scope of the present research and will not be included in any of the analyses. Decisions to include/ exclude a certain medical team (or research paper on a specific medical team) in any one of the studies will be made on a case by case basis, depending on the characteristics of that specific team.

2.2. Emergence and emergent states

The conceptualization of teams as complex adaptive systems also implies the recognition of different types of dynamics that coexist within a team – local dynamics, global dynamics and contextual dynamics (Arrow, McGrath, & Berdahl, 2000). These are consistent with the mechanisms behind the multilevel perspective in the study of organizations (S. W. J. Kozlowski & K. J. Klein, 2000). As shown below in Figure 1., we can identify phenomena at three different levels – organizational level, team level and individual level – and they are linked with two different types of processes – top down processes and emergent or bottom-up processes. Time is the last element that grounds all these dynamics.

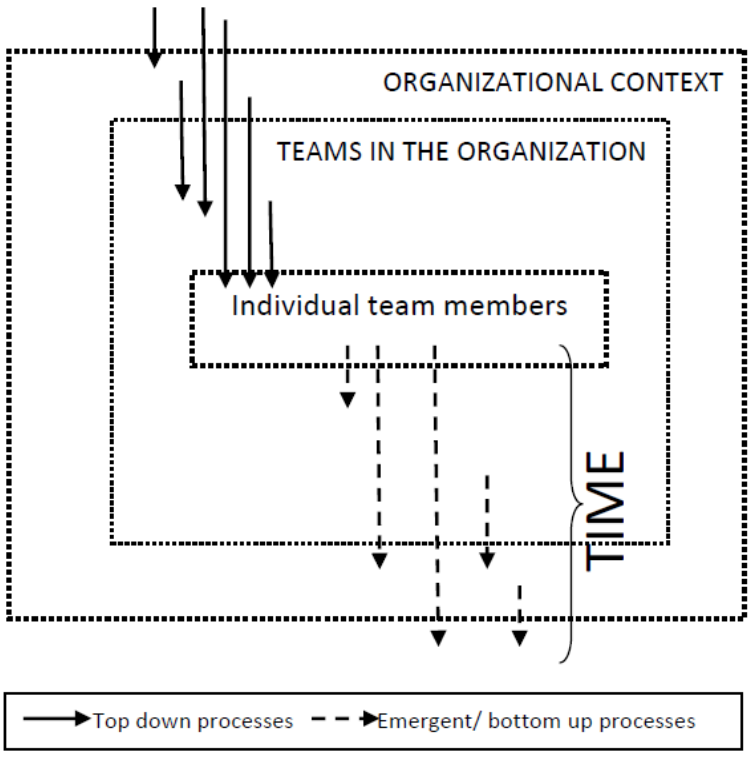

Figure 1. Multilevel perspective of organizations

Emergence is a dynamic, interactive process with three conceptual foci to capture its essential nature**:** it is multilevel, process oriented, and temporal (S. W. J Kozlowski et al., 2013). Team research - or the meso level in organizational research – is the ideal focal point

for the study of emergence and emergent phenomena. Another key aspect of emergence is its dual nature: it is at the same time a process – because it is embedded in time – and a structure when it crystallizes into emergent states.

Emergent states are "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). They are proprieties of the team as a whole and they refer to cognitive, affective and motivational states of the team rather than to interaction processes. This distinction is important because emergent states are not team processes in and of themselves (Marks et al., 2001).

Although they do not reflect team member's interaction they are a result of it and, at the same time, they can be an input for the development of new team interaction patterns and new team processes. As such, they are a higher-level phenomenon that can be at times both input and product of lower-level elements' interactional processes (Cronin et al., 2011; S. W. J. Kozlowski & K. J. Klein, 2000; Marks et al., 2001). As most group-level phenomena, emergent states are not static, they take time to occur and they change over time. "Understanding how a group-level construct can change is the first step to understanding group dynamics" (Cronin et al., 2011, p. 574) and it becomes therefore instrumental in our investigation of team effectiveness.

Some of the most researched emergent states are trust (De Jong & Elfring, 2010), psychological safety (Edmonson, 1999) or shared mental models (Klimoski & Mohammed, 1994) and they have all been associated with increased team performance and effectiveness, though through different specific mechanisms.

One of the more exciting and new emergent states is *cross-understanding*. It was first introduced to the literature of group emergent states by Kyle Lewis and George Huber in 2005. It is conceptualized as the extent to which members of a team have an accurate understanding of one another's mental models (Huber & Lewis, 2010b, 2011b; Lewis & Huber, 2005, 2008). The authors position cross-understanding somewhere between the better established concepts of *transactive memory systems* and *perspective taking*. It implies knowing more about your team colleagues than just their expertise, and unlike with transactive memory, it does not always lead to a division of the cognitive labor; it means being aware of their mental models, their personal preferences, beliefs and expectations, and all of this without necessarily sharing them (i.e. like with shared mental models) and without actively adopting their point of view (i.e. like in perspective taking). It is broader in scope than transactive memory systems and narrower than perspective taking (Huber & Lewis, 2010b).

Cross-understanding is relevant for our research because of one benefit that Huber and Lewis (2010, 2011) underline: the fact that it could provide means to explain high performance in instances where shared mental models are absent. This could prove to become one of the essential mechanisms behind the effectiveness of fluid medical teams.

2.3. Team effectiveness

Throughout the present thesis we will reference both *team effectiveness* and *team performance*. While for the overall research our interest is in *team effectiveness*, some of the studies included focus on *performance* related data. We take this opportunity to differentiate between the two concepts and briefly explain our intended use of them within this research.

Team performance has been conceptualized as both a process and an outcome of team members' interaction (Beal, Cohen, Burke, & McLendon, 2003; Hackman, 1987; Mathieu, Maynard, Rapp, & Gilson, 2008; Rosen et al., 2012). In terms of process, team performance is viewed as the sum of individual and team level actions and behaviors that are relevant to achieving some shared goal (Mathieu et al., 2008; Rosen et al., 2012). As an outcome variable, team performance is regarded as a "consequence of performance behaviors" (Mathieu et al., 2008, p. 416), the "productivity output of the workgroup" (Hackman, 1987, p. 323). In this conceptualization, performance appraisals should include criteria related to the quantity and quality of work, as well as multiple evaluation sources. However, because such objective measures differ depending on the type of teams and the type of tasks, they are not sufficient for the assessment of groups in organizations (Hackman, 1987; Mathieu et al., 2008; Rosen et al., 2012).

Recent literature recognizes team effectiveness as a multidimensional and complex concept. It is "an evaluation of the outcomes of team performance processes relative to some set of criteria. It is a judgment on how well the results of performance meet some set of relatively objective or subjective standards" (Salas, Rosen, Burke, & Goodwin, 2009, p. 41). These criteria refer to performance outcomes, team members' affective reactions and team viability outcomes (Hackman, 1987; Mathieu et al., 2008). As we have previously mentioned, performance outcomes differ according to organizational and team context, hence, for the present work, we expect to identify a set of criteria that are specific to the functioning of fluid medical teams. The study of affective reactions as an element of team effectiveness usually centered on the concept of team satisfaction and team or organizational commitment (Mathieu et al., 2008). The third criterion for team effectiveness, team viability, is a more elusive concept. It has been defined as a "team-level team-level criterion whereby members have a collective sense of belonging (similar to the notion of social cohesion). Elsewhere, viability is likened to team membership stability over time. Yet further, viability is often considered in terms of the extent to which individuals wish to remain as members of the team. Thus, team viability has become a generic term for a variety of different constructs.(Mathieu et al., 2008, p. 418)". The present research focuses on teams where membership is not stable over time, therefore we understand team viability as the extent to which team members wish to maintain team structure or believe they could function effectively within the same team composition in the future.

Considering these broad conceptual delimitations, the present thesis is interested in understanding *team effectiveness* in fluid membership teams. But, since it is a

multidimensional construct, we will look at different elements of effectiveness at different times in our research depending on the specific objectives of the individual studies.

3. Research approach of the present thesis

Our conceptualization of teams as complex adaptive systems led us to take on a *pragmatic* view of the research process (Morgan, 2007). At the same time, this understanding of teams and the nature of our focal concepts and their dynamic nature systems has also influenced our decision to use *multilevel modeling and analysis* (S. W. J. Kozlowski & K. J. Klein, 2000) and *process research* (Langley, 2009*)* throughout the individual studies. Finally, all of these choices and a revision of the general research purposes and questions led to the use of an *integrated mixed model approach* (Maxwell & Loomis, 2003; Tashakkori & Teddlie, 2003)to the general research design. In the following section we discuss these choices and the way they have influenced the investigation.

3.1. Research questions and rationales

Considering team literature and the gaps with regard to understanding team dynamics – especially within the frame of complexity and team adaptation – we are now going to explain how these have shaped the research questions that the thesis is based on.

We have numerous examples of studies that found significant positive effects of group processes and emergent states on group performance (Curseu, 2006; De Jong & Elfring, 2010; Edmonson, 1999; Klimoski & Mohammed, 1994; S. W. J. Kozlowski & K. J. Klein, 2000; Marks et al., 2001). Because of their emergent nature trust, cross-understanding, shared mental models, implicit coordination, transactive memory systems and other similar group level phenomena usually take time to develop. They are born from the interactions of group or team members and are based on a shared history and experience within that team (Curseu, 2006, 2007; S. W. J. Kozlowski & K. J. Klein, 2000). Real work settings however do not always afford such contexts for lengthy interaction. As we have shown in the previous section, the boundaries and structure of some medical teams are fuzzy in nature, and they tend to have a dynamic of their own. A constant change in team membership brings a new strain to task accomplishment and to overall team performance and effectiveness. On a basic, intuitive, level we have to acknowledge the fact that medical teams with fluid membership (i.e. medical emergency intervention teams) still need - and usually have - group level phenomena like trust and coordination and even transactive memory, in spite of their lack of a fixed membership structure or prolonged interaction and past experience.

Hence, the present research starts with the following research questions in mind: *What happens to team processes and emergent states in medical teams with fluid membership? How do membership changes impact their development and their dynamic and how do they, in turn, impact team performance and effectiveness?*

A secondary focus is to study in more detail the concept of cross-understanding. Kyle Lewis and George Huber (2005, 2008, 2010, 2011) make an interesting argument and have developed a well rounded theory of cross-understanding and its possible impact on team performance, especially in the instances where mental models are not shared within the team. But cross-understanding is still a new theoretical concept and there is hardly any empirical evidence to support it and/ or its presumed benefits.

An extra set of research questions, in line with our initial ones, was tailored to focus specifically on cross-understanding: *Can we identify cross-understanding components within teams with fluid membership? If yes, how does cross-understanding emerge in these teams, what is its dynamic over the team's lifecycle and how does it impact fluid membership team performance and effectiveness?*

Newman, Ridenour, Newman, and DeMarco Jr. (2003) advocate moving beyond the articulated questions in search of the deeper purpose of the research - what they call the rationale, or the reason for doing the research in the first place. We have used the typology they propose in our investigation and have uncovered two main rationales and two secondary ones, all of them directly shaped by our research questions.

The *main rationale of this thesis is to understand the complex functioning of medical teams with fluid membership*. This means understanding complex group phenomena, the relationship between them, and their dynamics. We aim for this understanding because it can become a solid basis for making informed decisions with regard to practice in the settings where such groups operate. Hence, *a second primary but more distant purpose is to improve practice and have an impact on fluid medical team functioning in real work contexts*.

Going through the typology advanced by Newman et al. (2003) we have further identified two subordinate rationales of this research. First, we hope to *strengthen the knowledge base on fluid medical team effectiveness* by integrating existing research, developing and verifying a multilevel theory of team effectiveness for fluid medical teams. Secondly, through our exploration of cross-understanding, we mean to *test new theories and generate new knowledge* with regard to a still fairly unknown concept.

3.2. Methodological commitment

Pragmatism, as a research paradigm, stems from the need to reconcile the divide between qualitative and quantitative research approaches in instances where neither one is sufficient or completely appropriate. It rejects the incompatibility thesis initiated by the single paradigm/methodology link (Postpositivism – quantitative methods versus constructivism - qualitative methods) of Lincoln and Guba (1985), and the forced choice between postpositivism and constructivism in terms of logic and epistemology. In doing this, the focus shifts towards a very practical and applied research philosophy (Teddlie & Tashakkori, 2003). From a *pragmatic* standpoint, the rationale of a research (its purpose) is what should lead the researcher to identify appropriate investigation methods (Bergman, 2008; Bryman, 2008, 2009; Morgan, 2007; Newman et al., 2003).

Traditionally, some of the rationales behind our research are associated with usage of qualitative research methods (understand complex phenomena, generate new ideas and have an organizational impact). Others have been investigated using quantitative methods (add to the knowledge base, test new ideas) (Newman et al., 2003). The authors argue that, aside from generating new ideas (that will always be qualitative in nature), all other purposes could benefit from enriching the traditional approach with a mixed methods one. For the present thesis we decided to take on their advice and adopt a mixed methods approach to our research, as we believe in the richness such an approach can bring to the findings.

We followed the recommendations of mixed methods researchers (Bergman, 2008; Bryman, 2009; Morgan, 2007; Morse, 2003; Newman et al., 2003), and built on our rationale as a starting point for the investigation, while, at the same time, keeping in mind some of the following questions, which have eventually shaped our research: What is the main theoretical drive of the project? How will data or findings be integrated? How will the sampling be done for the different quantitative and qualitative parts of the study? How will the dominance of a certain method change throughout the study? How will we preserve the methodological integrity of the research? (Creswell, Plano Clark, & Garret, 2008; Morse, 2003). Our main purpose has a clearly stated discovery agenda. Hence, we position this research under an *inductive theoretical drive*. Because we also wish to, at least partly, verify a theory of team effectiveness, at some point in the research we will also need to shift dominance towards a deductive approach. The results from the initial qualitative phase will be built on in subsequent studies. This does not change, however, the overall exploratory nature of our thesis, nor does it position our work within the classical sequential mixed design typologies (Creswell et al., 2008; Maxwell & Loomis, 2003; Morse, 2003; Tashakkori & Teddlie, 2003)

Considering the emergent and dynamic nature of our conceptual framework, our purposes and research questions, as well as mixed methods design typologies (Creswell et al., 2008; Morse, 2003) we decided to employ a ***fully integrated mixed model design*** (Tashakkori & Teddlie, 2003). Integrated mixed model designs incorporate concurrent, sequential and conversion designs and are much more flexible with regard to the combined use of quantitative and qualitative approaches to research (Maxwell & Loomis, 2003; Tashakkori & Teddlie, 2003). “Rather than seeing <design> as a choice from a fixed set of possible arrangements or sequences, such approaches […] treat the design of a study as consisting of the actual components of a study [n.a. Maxwell and Loomis here refer to purposes, conceptual framework, methods etc.] and the ways in which these components connect with and influence one another” (Maxwell & Loomis, 2003, p. 245). In this type of design not all the pieces of the puzzle are known from the start of the investigation, and additional pieces or studies may emerge as the analysis evolves. This is also in line with the emergent nature of our main concepts and with process research in general.

Process research is well suited for questions that address dynamic and temporally evolving phenomena. It is interested in understanding *how* and *why* processes evolve over

time (Langley, 1999, 2009). Mohr (1982) was the first to differentiate between *variance* and *process* theories. The distinction lies with the type of explanations they provide. While *variance* theories discuss relationships between dependent and independent variables, process theories discuss patterns in events and activities over time and focus on their sequence and ordering (Langley, 1999, 2009; Maxwell & Loomis, 2003). In this, process research is more descriptive in nature and aims to provide more depth and detail to the studied phenomenon, rather than uncover causal relationships. Steve Kozlowski states that "the only way the field is going to make progress incorporating temporal sensitivity and process dynamics in theory and research, is for us to begin compiling knowledge - a research foundation – that provides essential descriptive information. We need to know the time scales over which different phenomena emerge, change, and vary" (Steve W. J Kozlowski, in press, p. 35). Process research provides us with the opportunity to do just that with the present thesis and the Complex Adaptive Systems framework offers the generative mechanisms that ground such process conceptualizations. Hence, this is the overall research strategy we intend to use throughout the entire research project, although we are aware that there may at times be a need to use a hybrid approach and incorporate variance theory and data analysis. The decision to do this will be made on a case by case basis so that it does not affect the overall conceptual and methodological integrity of the thesis.

4. Structure of the thesis and objectives of individual studies

The previous section presented the overall research questions and rationale. This following section will show how these translate into more specific research questions and objectives for each individual study and how they build on each other within the larger research design of the thesis. Group processes, emergent states and cross-level dynamics are too numerous and complex to study and fully comprehend within a single research project. Therefore, aside from cross-understanding, which is consistently studied throughout this entire thesis, we intend to have an emergent approach to our studies, not only in terms of content, but also in terms of research process. This is also in line with the inductive thrust of the present research (Morse, 2003). Consequently, the thesis is structured in three distinct parts with the following objectives:

Part 1

The objective of the first part is to ***provide the context-specific theoretical background for the study of the dynamics of fluid medical teams.*** This will happen in two steps.

First, we intend ***to develop a theoretical framework of fluid medical team effectiveness based on current research***. In doing so, we intend to identify same-level and cross-level influences, as well as the main group processes and emergent states that have been associated with fluid medical team performance or effectiveness. This first objective

will be addressed in **Study 1 – *The Road so Far: a Systematic Review of Fluid Medical Team Effectiveness***.

We will use the framework proposed by S. W. J. Kozlowski and K. J. Klein (2000) for building multi-level theory as a starting point for the analysis and coding of the studies included in the systematic review. In line with the conceptualization of teams as complex adaptive systems, the studies included in the review will then be integrated using the local, contextual and global dynamics framework proposed by Arrow et al. (2000).

A second step is ***to refine the resulting theory by contrasting it with an alternative, inductive theory of medical team effectiveness using data from real work contexts*.** This objective will be addressed in **Study 2 - *Development of Emergent States in Constantly Changing Teams***.

In doing so, we expect to identify parts of the theory that we can verify within the ensuing studies of the present thesis, as well as parts of the theory that would be better suited for future research efforts. We believe that in dividing the initial theory - that could prove to be quite complex – we ensure a more thorough investigation and testing of each specific same-level and cross-level relationship, and thus reduce the risk for theoretical misspecifications and hasty conclusions. As we are still within a discovery framework, since we aim to understand complex phenomena and to generate new ideas with regard to cross-understanding, we approach this study from an inductive standpoint.

The second study starts from the **following research questions**: *Which team processes/ emergent states are considered by team members to be particularly relevant for their teams' effectiveness in teams with fluid membership? Does cross-understanding develop within teams that constantly change membership, and, if yes, what are the processes that facilitate its development?*

Building from these questions we have formulated a series of more **specific objectives** that will help shape and refine the theory of team effectiveness:

- To investigate the participants' perspectives on the team processes and emergent states that they view as relevant to their teams' effectiveness.
- To identify what cross-understanding components are present within medical intervention teams.
- To identify how the different types of information and knowledge associated with cross-understanding emerge and how they are used within these teams.

The intended result for this second study is to formulate a clear and more parcimonious theory of team effectiveness specific for medical teams with fluid membership, which will then be verified in the following part of this thesis.

Part 2

The second part of this thesis has as a general ***aim to verify the theory on team effectivenes in medical teams with fluid membership***. This is the part of the project that takes on a deductive approach to the investigation. Because it has two underlying purposes

– to test the dynamic of model components in time and to verify the relationship between membership fluidity, the identified emergent states and team performance, this objective is addressed in two stages.

A first stage looks into how emergent states have different functions within a team at different points in the timeline of that teams' functioning - **Study 3 – *What* is relevant *when*? An Investigation of the dynamics of emergent states in fluid membership teams**. In order to be able to observe the different functions, and how emergent states modify in time depending on where the team is with respect to its task, we draw on the reccuring phases of transiton and action proposed by Marks et al. (2001), and we will investigate the evolution of the relevant emergent states accross these stages in the team's temporal cycles of goal-directed activity.

This study starts from the following **research question:** *What are the dynamics of group processes and emergent states throughout the lifespan of a fluid medical team?* It focuses on the functioning of one medical team throughout its lifespan - from its formation at the beggining of a shift to the end of its activity twelve hours later.

The objective of the next study is ***to analyze patterns in the relationships between model components across different teams and in different performance and clinical case complexity situations*** (**Study 4** - ***Team dynamics patterns across different team performance and case complexity levels***). Because of the particular tasks of the intended sample, team performance and clinical case complexity will be evaluated using Subject Matter Experts, which in this case are doctors with experience in emergency intervention, trauma treatment and anesthesia.

Part 3

Finally, the last part of the thesis is meant to use the knowledge obtained so far ***to develop a prototype of a research and intervention tool customized for fluid medical teams.***

Our rationale for including this final part in the thesis is twofold. First and foremost, we consider this thesis as a starting point for future personal research that will further verify our theory of fluid medical team effectiveness. Current research recognizes that traditional methods are no longer well suited for the analysis of such integrated and complex models of team effectiveness and team dynamics. Simulations and computational modeling seem to be preferred as more appropriate research methods (Coultas, Driskell, Burke, & Salas, 2014; S. W. J Kozlowski et al., 2013; Mathieu et al., 2014; Otoiu, 2014; Tannenbaum et al., 2012). Hence, this is the first step in the long and complicated process of the development and validation of a new research tool. Second, simulations are one of the more efficient training and intervention tools within medical contexts. Among other researchers, Bedwell et al. (2012) argue that a possible solution to improve team performance in medical teams with fluid membership is a well thought-out teamwork training program that targets generalizable skills, information sharing, shared leadership, and implicit coordination.

At this point in the research we go back to a quallitative approach which is more appropriate for the present context-bound research purpose (research and intervention tool development, and having an organizational impact). Once again we are at a stage where we need to integrate literature from different research domains: psychology, medicine and the already interdisciplinary field of simulation research. Therefore, first we conduct a theoretical overview of the literature on simulations in order to see how the simulation theory and methodology has integrated the major developments of team theory. By doing this we intend to make sure that there is no misfit between our theoretical (complex adaptive systems theory) and methodological (simulation methodology) standpoints.

The objectives of our final study are ***to build the simulation design specifications and to test the simulation prototype*** (**Study 5 – *The Other Side of Medical Compentece: The Development of a Simulation Game for Increasing Effectiveness in Medical Teams with Fluid Membership***). We draw on the empirical evidence provided so far by the present thesis with regard to the antecedents of team effectiveness in teams with fluid membership to form the theoretical framework for the prototype, and on the work of Duke (1974) and Klabbers (2009) for guidelines to the design and implementation process. Finally, in view of the scientific scope of this thesis, that takes precedence over the more pragmatic and practical aim of this last study, we have chosen a theory-oriented approach to the evaluation of the simulation prototype (Hense, Kriz, & Wolfe, 2009; Kriz & Hense, 2006), thus ensuring appropriate scientific rigor in the development of the research and learning tool.

For an overall view of the present research and an easier understanding of the general and more specific objectives behind it, the figure below presents a schema of the entire thesis. This shows more specifically what was intended with each study and how the different parts of the thesis draw on each other in order to gain an understanding and clarification of our research questions and, hopefully, meet the ultimate rationale of the present work.

Figure 2. Visual structure of the thesis and general objectives of individual studies

CONCLUSIONS

In the introductory chapter to the present thesis we argued that a focused research endeavor on the study of team effectiveness in medical teams with fluid membership is relevant, timely and also necessary. We considered it *relevant* because of the high stakes work that these teams perform. We claimed it is *timely* due to the fact that more and more healthcare facilities implement rapid response systems that take the shape of fluid membership teams. At the same time, fluid membership and dynamic team composition steadily become characteristics of teams in different environments and within a diversity of professional domains. Finally, we maintained it is *necessary* due to the lack of empirical evidence collected from these teams that also takes into account their dynamic nature. In order to be able to improve their performance we need a better understanding of their specific functioning and effectiveness. Therefore, the decision to study medical teams with fluid membership in their real work contexts was easy to make. The research process however, was not without challenges.

First, most of these challenges pertain to features of the environment within which these teams are embedded. It is characterized by ill structured problems, uncertainty and dynamism, all of which are coupled with extremely high stakes. This means that "good performance" may differ from instance to instance depending on unpredictable situational specificities. Consequently, when there is no clear single outcome, it becomes difficult to identify a clear work strategy and means to attain the desired results. Linking team processes to team performance becomes cumbersome. Moreover, because of the high stakes and risks associated with their daily activity, such teams are difficult to access and study at length (Rosen et al., 2012).

Second, changes in team composition pose a further challenge. On the one hand, they complicate the data collection and analysis process due to natural fluctuations in the data points. On the other hand, membership fluidity has both positive and negative impact on team interaction processes and emergent states (Tannenbaum et al., 2012). The research in the field is still relatively new (Bedwell et al., 2012) and because different team compositional structures have more or less salience in various periods of performance episodes and team development stages (Mathieu et al., 2014) we need more evidence with regard to the effects of membership dynamics on team effectiveness.

Third, the focus of the present thesis was on emergent states, their development and effect on team performance. Because of their dynamic nature they are rather elusive concepts, difficult to measure using classical research methods and data analysis procedures (Coultas et al., 2014; S. W. J Kozlowski et al., 2013). So far, retrospective self reports and cross-sectional studies dominate investigations in this area (Coultas et al., 2014; Steve W. J Kozlowski, 2012; Steve W. J Kozlowski, Chao, Chang, et al., in press; Steve W. J Kozlowski, Chao, Grand, Braun, & Kuljanin, in press) and therefore, the expected advances of the research on team dynamics and emergent processes did not yet occur (Cronin et al., 2011; Steve W. J Kozlowski, in press). In the case of our thesis, capturing dynamics of team emergent states is further complicated by the fluid character of team composition of our targeted teams. Emergent states develop as a result of team interaction over time; hence, they are dependent on a common history and experience of team members working together (Marks et al., 2001). Some researchers argue that fluid teams or ad hoc teams do not afford such conditions for emergent states development (Essens, 2014), while others argue that in these contexts a swift type of phenomenon does emerge, based on other mechanisms [see for example *swift trust* - Meyerson, Weick, and Kramer (1996)].

And finally, our forth major challenge was to integrate work done in two quite different professional and research fields - organizational studies and medicine. The issues we had to face here deal mainly with distinctions in conceptual delimitations and in the research methods employed. As expected, we found interesting and relevant contributions in both domains, but there was no integrated theoretical background that would allow them to build on each other. There are a few organizational psychologists that have taken specific interest in medical action teams [see for example Steve W. J Kozlowski (2012), Bedwell et al. (2012); Klein, Ziegert, Knight, and Xiao (2006); Kolbe et al. (2013); Kunzle, Zala-Mezo, Kolbe, Wacker, and Grote (2010); Rosen et al. (2012); Tschan et al. (2006)] and what we know so far about their functioning and specificities is rather limited to their work.

All of these challenges are inherent to the study of work teams in real work contexts. Salas and Wildman (2009) state that investigations "in the wild" are highly relevant for understanding the complexities of team effectiveness in different contexts. Rosen et al. (2012) suggest some means to overcome the issues related to research in real work settings and further encourage such endeavors. Finally, Steve W. J Kozlowski (2012) argues that multilevel influences should always be taken into consideration in such projects. For that to

happen properly, "an open mind, and spirit of conceptual adventure are essential" (Steve W. J Kozlowski, 2012, p. 280).

When we chose to study *Team effectiveness in medical teams with fluid membership* we decided to do just that - keep an open mind, be aware of these issues and be adventurous both with the concepts of interest and the methods we employ to analyze them. We hope to have been able to surmount at least some of the problems and obtain worthwhile results and contributions. Hence, this concluding chapter is structured as follows: we will begin with an overview of the main objectives of our thesis and will briefly review the main findings with regard to them and the degree to which we met our initial purpose (1); we will then discuss the main theoretical and methodological contributions as well as the practical implications of our studies (2); finally, we will present some of the limitations of this investigation (3) and we will conclude with a short overview of what we consider to be worthwhile future research directions (4).

1. Overview of the research objectives and the main findings of the thesis

The present thesis starts with the following research questions in mind: *What happens to team processes and emergent states in medical teams with fluid membership? How do membership changes impact their development and their dynamic and how do they, in turn, impact team performance and effectiveness?* One of the emergent states that we decided to focus on is cross-understanding (Huber & Lewis, 2010a, 2011a; Lewis & Huber, 2005, 2008), a fairly new concept and still understudied. Therefore we also have a secondary set of research questions, in line with the first ones: *Can we identify cross-understanding components within teams with fluid membership? If yes, how does cross-understanding emerge in these teams, what is its dynamic over the team's lifecycle and how does it impact fluid membership team performance and effectiveness?*

We used the typology proposed by Newman et al. (2003) to investigate the purposes behind these research questions and we have identified two main and two secondary rationales. We asked these questions because we wished mainly *to understand the complex functioning of medical teams with fluid membership* and to *improve practice in real work contexts*. Also, as a secondary focus, we hoped to *strengthen the existing knowledge base on fluid medical team effectiveness* and, through our exploration of cross-understanding, we

meant to *test new theories and generate new knowledge* with regard to a still mostly unknown concept.

Considering these purposes and the research questions that frame our thesis, the first step was to obtain an accurate understanding of what has already been studied related to team effectiveness in medical teams with fluid membership. In *Study 1* we performed a systematic review of the literature. We found that most of the research conducted on medical teams with changes in team composition has used qualitative designs with only a few attempts to employ quantitative or mixed methods. These were usually conducted in simulation conditions and not in real work settings. Also, most studies did not specifically focus on the effects of membership changes on team effectiveness and performance but rather just integrated it as a situational characteristic. Basically, they recognized it, but did not study its effects either on team outcomes or on team processes. Due to the fact that research in this field is also segmented by the different approaches organizational and medicine studies take on team effectiveness and team work in general, we found a plethora of concepts associated with both. Leadership, communication and coordination are among the team processes most commonly associated with team performance. There was however no common ground with regard to conceptual delimitations and that makes it is difficult to compare and integrate findings. Team effectiveness is mostly research in terms of objective data related to its performance component, or as team member satisfaction. The main result of this study was to integrate previous research into a contextualized theory of team effectiveness in medical teams with fluid membership.

The purpose of *Study 2* was to refine this theory by using input from a series of interviews we conducted with paramedics that work in such teams. The objectives here were to identify what are the *participants' perspectives on the team processes and emergent states that they view as relevant to their teams' effectiveness*; *identify what cross-understanding components are present within medical intervention teams; and identify how the different types of information and knowledge associated with cross-understanding emerge and how they are used within these teams*. We found that when working on a case paramedics mostly rely on effective coordination, both explicit and implicit, to align their actions and speed up the intervention. Team monitoring and systems monitoring are both essential to reduce human error, provide necessary back-up behaviors and integrate new members into the team. It also serves as a mechanism to counteract the potentially

negative impact of changes in team composition on team effectiveness. Team structure in this situation has a similar function. Team members contribute according to their role in the team and therefore, even when somebody new works on a case they can better coordinate with the rest of the team members by providing role based behaviors. Our main finding with regard to cross-understanding is that in spite of the frequent membership changes, paramedics are still able to access relevant information about their potential team members, through socialization. Most of the infomation they actually use during a case intervention is related to personal preferences of their team members with respect to their task accomplishment.

After we refined the theory to these main components extracted from the interview study, Study 3 and Study 4 looked at how these team processes and emergent states develop within fluid medical teams and at the influence they have on team effectiveness. We did this in two stages. At first we looked at one team for the entire duration it functioned - one 12 hours shift (*Study 3*). Our findings show that coordination is highly explicit when it comes to performing actions that are related to the next steps in the task. It only becomes implicit once the next step is clear. Also implicit coordination is associated with handling of equipment and most of the helping behaviors are, most of the time, implicit, that is, unsolicited. When changes to team membership occur, the influence on team processes (i.e. monitoring, coordination) is different depending on who the newcomer is. It may result in shift in leadership when a specialist is brought on and then leadership is shared among the two lead doctors. We also found that there is a clear difference in information sharing during and in between cases. During cases information sharing is strictly case related for the team working directly on the case. In between cases, when monitoring other patients or when activity levels are lower and there is no emergency there is an increase in personal information sharing.

Study 4 investigated the same concepts but across teams. We found that higher performing teams overall used more explicit coordination than lower performing team, but there were no significant differences in implicit coordination behaviors. When task complexity increases, there was an increase in both explicit and implicit coordination, an increase in team and systems monitoring as well as leadership hand-on treatment. Lower complexity task situation is where we found more leadership teaching behaviors. Most of the concepts we investigated were found to be more proeminent in situations when

membership changes occured. The team relied on their role structure to flexibly include the new members into the team, by passing on role related behaviors. Also, this was where we could identify dynamic leadership delegation since the hands-on leadership function in these situations was usually taken on by the new team member if that person was a specialist on the problem the team was facing at the time.

Finally, the last study of the thesis takes these findings and integrates them in the development of a simulation customized for medical teams with fluid membership. The simulation can be both used as a research method or as an intervention tool for team training.

2. Contributions of the present thesis

2.1. Theoretical and empirical contributions

Our first theoretical contribution is the development of a theory of team effectiveness customized for medical teams with fluid membership which takes into account all of their particularities. The theory is build after a systematic review effort that integrates literature from different research fields like medicine, social and organizational psychology. In order to ground the resulting theory within the real work environment of these teams, the theory was then empirically revisited and revised. To the best of our knowledge, this is the first research endeavor to focus so specifically on these teams and that also brings together empirical evidence from all relevant theoretical contexts. Previous integrations are usually situated within the boundaries of one research and practice domain (i.e. medicine). Since research focus, conceptualizations and methods vary widely from field to field, we consider this segmented integration to limit the building of solid theory. Our initiative is also in line with recommendations to strive to develop local theories and interventions embedded into the specificities of particular professions and their culture (Edmonson & McManus, 2007). Our findings show that, when it comes to emergency medicine in Romania, the professional culture is translated through a series of national and local context particularities that reshape organizational processes and phenomena. This further increases the need for tailored interventions. Previous research on Romanian hospitals and medical teams has reached similar conclusions (Spânu, 2012).

A second important theoretical contribution stems from the fact that our entire work is grounded into the Complex Adaptive Systems perspective on organizations and teams. This had direct implications on our theory building process, where we used the CAS framework proposed by Arrow et al. (2000) to differentiate between local, global and contextual dynamics. We then used the multilevel theory building guidelines provided by S. W. J. Kozlowski and K. J. Klein (2000) to integrate findings from existing literature into the three dynamics. By doing this, "*Time*" became an integral element of our team effectiveness theory. This is particularly relevant in the current team research context with increasing recommendations to include a temporal aspect to the research of team dynamics (Ancona, Goodman, Lawrence, & Tushman, 2001; Cronin et al., 2011; Steve W. J Kozlowski, 2012; Steve W. J Kozlowski, Chao, Grand, et al., in press; S. W. J. Kozlowski & K. J. Klein, 2000; Marks et al., 2001; Roe, Gockel, & Meyer, 2012; Rosen et al., 2012). The pressure is high because "cross-sectional designs in the field and laboratory still dominate groups and teams literature, but very few group phenomena are truly static" (Steve W. J Kozlowski, 2012, p. 279). It is difficult to study time effects on team processes when construct conceptualizations and theoretical perspectives do not include it. This leads to a problem-method misfit (Edmonson & McManus, 2007; Roe et al., 2012). Hence, by developing a multilevel theory of team effectiveness and integrating CAS dynamics we provided a context where we can actually examine what happens in these particular teams as time unfolds, and so provide some much coveted insight into team processes and emergent states.

While these first two contributions we mentioned are situated on a more general level, we also have a few theoretical contributions that discuss more specific concepts.

Membership fluidity is one of the key elements in our research. Interest in dynamic team composition is also on the rise (Steve W. J Kozlowski, Grand, Baard, & Pearce, in press; Mathieu et al., 2014; Tannenbaum et al., 2012). Most of the recent research however focuses on multiple team membership [like in Pluut, Flestea, and Curseu (2014)] or on the study of project based teams, that come together, work in that compositional format on a project and then disband [for further references see Bakker (2010); Tannenbaum et al. (2012)]. We conceptualize membership fluidity as a dynamic flow of members in and out of teams and we study it in the context where this happens to teams that work together for short periods of time and under extreme conditions. Previous research that employed

similar operationalization and explicitly focused on membership changes either used simulation scenarios (Summers et al., 2012) or was conceptual (Bedwell et al., 2012; Bushe & Chu, 2011). Most of the studies that analyze ad hoc medical teams recognize this characteristic but that is the extent to which they incorporate it into their design. To our knowledge this is the first contribution that examines membership fluidity in a dynamic manner as a process component in fluid medical teams.

Cross-understanding has been initially introduced a decade ago (Lewis & Huber, 2005) but the concept still lacks empirical evidence. There are barely any empirical investigations on the effects of cross-understanding on team processes and team effectiveness, in spite of the promising theoretical framework that George Huber and Kyle Lewis developed (Huber & Lewis, 2010a, 2011a). The few studies that do look into it fail to clearly distinguish it from similar and more established concepts, especially transactive memory and shared mental models. We do not presume to have clarified such issues or to have provided the ultimate evidence for the development of cross-understanding in teams with fluid membership. We did however show that team members do share the type of information and knowledge that are associated with cross-understanding components and that they use it as they work to facilitate both social interaction and task completion (Otoiu, Andrei, & Baban, 2011).

2.2. Methodological contributions and practical implications

Our most important methodological contribution is the process research approach to the study of team emergent states. By employing an intensive longitudinal design (study 3) and video recordings of behavioral manifestations (study 3 and 4) related to leadership functions, coordination and monitoring we adapted research methods to a context where they have been hardly used in spite of recommendations to do so (Kozlowski, in press). Team performance, especially in uncertain and dynamic environments is not stable in time. Even within the same team and with the same membership structure the team may perform at one point and underperform just minutes later. Process research and measuring team behavior in a time sequence offer a better understanding and a higher temporal resolution to team dynamics (Rosen et al., 2012). Therefore, our methodological choices are

in line with the recommendations to advance multilevel dynamics of emergence in teams (Kozlowski et al, 2013, Kozlowski et al, in press).

Another relevant contribution is the development of the simulation that is customized to serve as a future research tool for the investigation of emergent states in medical teams with fluid membership. Simulations have been increasingly used as research tools in such contexts and are still among the only means to capture team dynamics outside of real work settings that are so difficult to access. Moreover, this is at the same time an important practical implication of our research, since the simulation can easily be adapted as an intervention tool for the development of team effectiveness in such teams.

3. Limitations of the present research

Our work is not without limitations. While the nature of our data offered opportunities to study these teams in a dynamic way it also imposed some constraints on our research.

For both our qualitative analysis studies and the mixed methods studies the samples we used were rather small. Even though they were appropriate for the analyses we performed, we recommend increasing the samples, especially in the mixed methods condition.

Also, the video recordings we accessed limited our analysis to what was going on in the resuscitation room but we were not able to gather any information about team members' interactions once they left the room. This also meant that we were not able to collect additional data on each medical case specifically, so we had no information with regard to patient status at arrival, aside from what was discussed and presented inside of the Resuscitation Room.

Moreover, we are aware that when we wish to investigate a concept such as team effectiveness, the number of variables that could be involved is large and we are aware that we may have missed some relevant contextual characteristics or team processes along the way. However, the final choices about the concepts we did study were grounded in our research and so we believe this thesis does provide worthwhile data on team functioning in medical teams with fluid membership.

4. Future research directions

As with any research process, it was impossible to cover in this thesis all of the things we wished to study with regard to medical teams with fluid membership. The study of dynamic composition and membership fluidity is still in incipient stages and so there are limitless possibilities to expand the research and knowledge base.

In the design phase of the thesis we were careful to consider what some of the more prominent scholars in the field suggest to be necessary steps in advancing theory on team dynamics. Steve Kozlowski and his colleagues (Steve W. J Kozlowski, 2012, in press; Steve W. J Kozlowski, Chao, Chang, et al., in press; S. W. J Kozlowski et al., 2013) have a number of such recommendations: explicitly incorporate conceptual considerations of multiple levels and time in the study of team dynamics; explicitly specify process mechanisms; encourage, support and value good descriptive quantitative and qualitative research; appreciate the limits of cross-sectional designs and static assessment of process constructs; supplement traditional questionnaire-based measurement with alternative assessment tools; and adapt or create innovative research designs for the study of emergence and process dynamics. Mathieu et al. (2014) propose to integrate team compositional structures into the study of team effectiveness and highlight a few possible research directions: identifying critical times in the teams' lifecycle where membership dynamics have the highest impact on performance; identifying potential influences of the number of membership changes on performance or if there are differences with regard to what role the new or former team member occupies within the team; verify the effect of previous work experience with team members in member replacement on team effectiveness etc. Tannenbaum et al. (2012) recommend looking into the factors that affect team effectiveness in teams that need to form rapidly and to verify how team critical states (trust, shared cognition, identity) are influenced by dynamic membership. These are just some of the more prevalent arguments that we found in the literature and that have shaped the overall design and structure of the present thesis. By our choice of research topic and the decisions with regard to the conceptual framework and the methodology we employed, we did cover some of these recommendations.

This thesis is, however, still a starting point for the study of medical teams with fluid membership. Considering our findings, here are some of the more important future investigative endeavors we wish to undertake.

Because we tend to agree that simulations are still a good medium for the study of team dynamics, the further development of the simulation prototype we built would be one of our first steps. Before we can use it as a research method, the prototype needs to be further tested within a medical simulation center and with the intended audience as participants. Duke (1974) recommends performing up to ten individual test rounds of the simulation, before the final design specifications are established. Even fewer test rounds would offer important information about how the simulation actually plays out and we would be able to make the necessary adjustments that will increase the content validity of the instrument as well as collect data on its predictive validity. Once the simulation is sufficiently tested it would provide a valuable tool for both future research and for training and team development in trauma intervention and in medical emergency situations is general.

Second, the behavioral observations we gathered offer rich input into fluid medical team processes. But, our understanding of what is going on during an intervention would be greater if we would also have some insight into what people think and feel while working on a case. Bourbousson, Poizat, Saury, and Seve (2010) used such an approach to investigate coordinative efforts in basketball teams. They coded behavior on a ten minute sequence of a game and then interviewed players and asked them to describe what they were thinking while performing those actions, play by play. In future studies we intend to adopt a similar design and incorporate self report and interview data with behavioral observations. This would not only give extra meaning to behavioral patterns, but it would also highlight and hopefully clarify some of the contextual elements that stand behind these patterns, and that we may have not been aware of during the current analysis. At the same time, such data would allow us to collect evidence on the affective and viability team outcomes and hence evaluate team effectiveness as a multidimensional construct.

Third, while we did gather some empirical data with regard to cross-understanding, we cannot state that we have provided sufficient evidence to clearly differentiate it as a construct. For instance, it was not within the scope of the present thesis to measure team transactive memory and so it was impossible to establish whether there is conceptual

overlap or we have to distinct construct. A cluster analysis of coded interactions where both concepts are accounted for would offer much better data for the empirical and theoretical development of cross-understanding. Also, Kyle Lewis developed and tested a transactive memory measure that has been successfully used so far in multiple studies (Lewis, 2003). While there are no largely recognized instruments for the measurement of cross-understanding, we did test such a questionnaire in a study of emergent state dynamics in student teams (Otoiu, Ferent, Andrei, & Baban, May 15, 2015). Using the two instruments to complement observational data and a structural equation modeling analysis would be an important step for research on cross-understanding.

Fourth, there are a few concepts relevant for team effectiveness in situations with dynamic team composition which we did not include in the present analysis. Maybe the most noteworthy would be core team roles, team member familiarity and team identity. Our findings emphasize the fact that medical personnel working in emergency intervention situations, either on an ambulance or in the Emergency Room, cope to changes in team membership by relying on role structures that are closely linked to task accomplishment. Valentine and Edmonson (June 10, 2014) have similar findings and introduce the concept of team scaffolds as a meso-level structure that bounds together a set of roles rather than a set of individuals. In a simulation study of business teams, Summers et al. (2012) prove that there are differences in team performance when changes in membership occur in strategic team roles, versus changes to non-strategic team roles. In our work we were able to observe some influence of role structures on team behaviors and team performance, but they were not part of the research design per se. Moreover, the qualitative study on Emergency Intervention Crews (Study 2 in the thesis) showed that whenever possible, within these role structures, people tend to form teams based on personal preferences and familiarity with other team members. But, even in these situations we did not find team level identity. Identity seems to the larger system. Paramedics did not associate themselves with a particular team, but they were proud to be part of the Emergency Intervention Service. We believe this is also a result of membership fluidity and role structures. In a future research design we intend to focus on the relationship between these variables, membership fluidity and team performance, and to verify system dynamics in different familiarity conditions.

Finally, the focus of the present thesis was on medical teams with fluid membership. However, most of the processes that we have witnessed were in fact shared by a number of

fluid medical teams, part of a Multiteam system. By including another organizational level to our research we would be able in future studies to examine the same behavioral patterns and team interaction at Multiteam systems level.

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