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Advancing Our Understanding of Team Process Dynamics

An Empirical Investigation

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THESIS STATEMENT

This thesis constitutes the final assignment of the five year integrated master in Industrial Economics and Technology Management at the Norwegian University of Science and Technology, and was written within the field of Strategy and International Business Development. The main body of work comprises two articles devoted to team process phenomena, which addresses one distinct research question each. These are as follows:

Article 1

What are the factors and characteristics that impinge upon the process of team development?

Article 2

How can assessment tools enable us to unpack a team's dynamics, and thereby provide a learning mechanism for both instructors and the teams under investigation?

PREFACE

The success of teams that perform their tasks in high-risk environments is tightly interlinked with the quality of their coordination and interaction patterns. Yet, even though the importance of these processes is readily acknowledged, we still know surprisingly little about how they could be measured and developed. We argue that this is a consequence of reductionist research strategies, which have failed to incorporate the dynamics inherent in team processes during empirical investigations.

We owe our discovery of this apparent dearth in the team literature, to the Research Group “Operativ Ledelse” [operative leadership] under the supervision of Professor Endre Sjøvold. The group remains dedicated to pursue research directly applicable to teams that operate in contexts characterized by high levels of uncertainty, unpredictability and potential hazards. Examples such as the In Amenas hostage crisis, the Deepwater Horizon oil spill, and “the 22nd of July” terror attack, have made it agonizingly clear that we need to enhance competence levels of teamwork in such settings. The practical relevance of the issue, in turn, highlights the importance of conducting research on real-life teams, and the Research Group has been able to establish collaborative agreements with both Statoil ASA and the Royal Norwegian Naval Academy following such an understanding. We found this extremely intriguing, and it essentially became the reason why we chose to write our Master’s Thesis whilst being part of the Research Group.

The support and guidance we have been receiving has been indispensable. We would therefore like to take this opportunity to extend our sincere gratitude to our supervisors, Professor Endre Sjøvold and Ph. D. candidate Kenneth Stålsett. Your mentoring capabilities, encouragement, feedback and genuine interest in the subject of our thesis, have facilitated us greatly in arriving at what we hope will be a valuable contribution to the research community. Lastly, we would like to thank the Royal Norwegian Naval Academy for providing us access to investigate their teams.

Trondheim, June 11th 2015,



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ABSTRACT

This study comprises two independent articles, which are tightly interlinked in their overarching focus on team process dynamics. In the first article, we design a longitudinal study where we use a combination of retrospective self-reports and in-depth interviews to uncover the changes in internal dynamics of teams that participate in an 11-week exercise. Subsequently, we attribute these changes to a range of external and internal factors. The findings suggest that most of the investigated teams faced unquestionable positive developments following their participation in the exercise. These include an increased group cohesiveness, greater flexibility in the social role structure, higher similarity across team members' understanding of the task and team interactions, and a more equal distribution of the leadership influence. The outcomes are seen as clear indicators of the importance of providing feedback to learners, and of providing teams with tailor-made team building modules to facilitate their development.

In the second article, we engage in a more methodologically-driven approach, as we combine the use of retrospective self-reports and technological devices capable of direct "big data"-capturing of team interaction contents. The investigations are undertaken during two high-fidelity simulation exercises, which allow us to map the participating teams' dynamics. Our findings suggest that big data may well revolutionize the way we investigate human interaction in time, however, as it stands, the lack of a sufficiently large empirical research pool means that it still represents a qualitatively poor source of data. Thus, we argue that analyses of big data could be even more fruitful as a supplement to more traditional approaches.

SUMMARY IN NORWEGIAN

Denne masteroppgaven består av to artikler som empirisk utforsker dynamiske teamprosesser i en operativ setting. Dette er noe som har vært lite utforsket i litteraturen tidligere, da de fleste empiriske undersøkelser har behandlet dynamiske prosesser som statiske. Den første artikkelen tar for seg utviklingen i dynamikken til team som deltar i en elleve uker lang teambyggingsøvelse. Videre pekes det på hvilke interne og eksterne faktorer som bidrar til slike endringer. Funnene våre illustrerer at teamene som opplevde størst positiv utvikling innså viktigheten av å bygge gode relasjoner innad i gruppen, utvikle fleksible sosiale rollemønstre, diskutere tilbakemeldinger åpent i gruppen, dele på lederansvaret, og av å utvikle en felles forståelse i teamet av oppgavene som skulle løses og av teamprosessene som krevdes. Vi mener at dette kan anses som bevis for at skreddersydd teambygging kan bidra til at team utvikler en bedre og mer tilpasset dynamikk til den konteksten de arbeider i.

I den andre artikkelen illustrerer vi bruken av to ulike målingsverktøy som gir et overordnet bilde av et teams dynamikk. Vi kombinerer bruk av tradisjonell spørreskjemateknikk med elektroniske sensorer som kan fange opp kroppslige signaler under interaksjonsepisoder i gruppen. Det sistnevnte omtales gjerne som "Big Data"-teknologi, og det har blitt hevdet at denne kan bidra til å revolusjonere måten vi analyserer menneskelig interaksjon. I studien vår finner vi imidlertid ut at teknologien fortsatt er på et prematurt stadium med tanke på måling av teamdynamikk. Likevel ser vi klare sammenhenger med funnene fra spørreskjemaene, og konkluderer således med at Big Data kan være et viktig supplement til mer tradisjonelle målingsverktøy.

TABLE OF CONTENTS

Theoretical Foundation and Structure of Research	IX
Article One: A Look Inside the Black Box of Team Dynamics: An Analysis of Development in Team Processes	1
Introduction.....	1
Basic Group Functions and the Concept of Balance.....	2
Shared Mental Models.....	4
Team Development.....	5
Team Leadership.....	8
Method	9
Results.....	11
Discussion.....	15
Limitations of Study and Future Directions.....	17
Managerial Implications and Conclusive Remarks	17
References	19
Article Two: An Exhibition of the Dynamics in Team Processes: Using Retrospective Self-Reports and Big Data	23
Introduction.....	23
Conceptual Background.....	24
Team Leadership.....	25
Structures of Social Interaction and Collective Perceptions	26
Method	29
Results.....	32
Discussion.....	37
Implications and Conclusive Remarks	39
Limitations of Study	39
Directions for Future Research	40
References	41
Conclusive Remarks	XVII
Complete List of References	XVIII

THEORETICAL FOUNDATION AND STRUCTURE OF RESEARCH

Teamwork has been in the forefront of the transformation in the organizational landscape over the last century, and is today tightly intertwined in every aspect of how we conduct our business. It is a widely acknowledged fact that if the knowledge-based, twenty-first-century firm is to succeed, it has to rely on inter-disciplinary collaboration, flattened hierarchies, as well as continuous learning and innovation (Edmondson, 2012a). This recognition has fuelled research on team effectiveness and its underpinnings, and thereby pushed the migration from their long time domain in social psychology to a range of other disciplines (Kozlowski, Chao, Chang, & Fernandez, in press) - causing a flood of team-related literature. In fact, Morrison (2010) reported that the terms *team* or *group* were actually the most common keywords in submissions to the Academy of Management Journal from 2007-2009.

Scholars have reached a unified understanding that successful teamwork is not simply a result of individual talent and resource availability, but is also supported by the contextually shaped team processes that enable team member interaction and collaboration (Marks, Mathieu, & Zaccaro, 2001). As these involve the underlying mechanisms by which teams flexibly act and react to changing circumstances, they are inherently dynamic in nature (Sjøvold, 1995, 2006, 2007; 2014b). Yet, this theoretical realization has not transcended to empirical investigations (McGrath, Arrow, & Berdahl, 2000). Indeed, in most studies on team processes, researchers have been inclined to treat teams as simple, static and isolated entities (e.g. Cronin, Weingart, & Todorova, 2011; Kozlowski, in press; Kozlowski & Bell, 2003; McGrath et al., 2000) - and team process dynamics are therefore essentially understudied.

Several scholars hypothesize that this apparent inertia in team-related research could be attributed to researchers' preference for the intuitively appealing and easily explained tenets of McGrath's (1964) Input - Process - Output (IPO) heuristic (Cronin et al., 2011; Kozlowski, in press; Kozlowski & Bell, 2003; Kozlowski et al., in press). Following such an approach, team processes have usually been represented as a mediating "box" in a unidirectional causal relationship model (Kozlowski, in press). The bitter irony is that McGrath never intended for his IPO model to evolve into a conceptual framework where dynamic processes are frozen into static constructs. In fact, he has devoted considerable effort to advance and invigorate research that attempts to conceptualize team processes dynamically (e.g. McGrath, 1964, 1991; McGrath et al., 2000). However, it was the straightforward IPO model that seized the most attention, and became a leading tradition for studying team effectiveness for the decades to come.

A new logic is evolving, however, and researchers are increasingly asking for a more theoretically-driven approach to investigate team process phenomena (Kim, McFee, Olguin, Waber, & Pentland, 2012; Kozlowski, in press; Kozlowski et al., in press; Sjøvold, 2006; 2014b). This has led Kozlowski (in press, p. 34) to assert that: "At all systems level - micro, meso, and macro - dynamics is the next [research] frontier." The key concern is to advance our understanding of the dynamic interplay between content, context and process of team interactions (Kim et al., 2012; Sjøvold, 2006; 2014b). In line with this, Cartwright and Zander (1968) argue that group study output should follow from the evaluation of the dynamics causing group development, while at the same time treating these as multilevel dimensions (i.e. they involve both the individual team members and the team as a whole). This is not to say, however, that the emergence of dynamics necessarily follow a bottom-up process where individual characteristics are antecedents to a group's dynamics (Morgeson & Hofmann, 1999). Rather, the individual and group level properties influence each other in a recursive manner. This implies that in order to achieve conceptual clarity, one should both address the group level phenomena to derive what is changing, and the trajectories of these in time to assess how change happens (Cronin et al., 2011).

As such, it becomes a vital task of the researcher to identify appropriate methodological approaches and assessment tools that enable direct capture of team process dynamics. This line of reasoning and guidance ensued in the following research questions (RQ1 and RQ2):

RQ1: *What are the factors and characteristics that impinge upon the process of team development?*

RQ2: *How can assessment tools enable us to unpack a team's dynamics, and thereby provide a learning mechanism for both instructors and the teams under investigation?*

The comprehensiveness of the RQs required a calculated line of attack. Our solution was to address them one by one in two separate articles. Nevertheless these represent two independent studies, written for publishing purposes, they are tightly interlinked in their focus on the dynamics inherent in team processes. Whereas the first article aims to uncover the changes in groups' dynamics over time, and simultaneously why change happens, the second article illustrates the use of different methodological approaches which purportedly could illuminate detailed team interaction contents. It follows, that the merits of breaking out of the IPO-based tradition for studying group effectiveness - which we see as filled with feedback loops that make it work like an "echo chamber" (Pentland, 2014) - could lead to new and improved findings about what constitute beneficial teamwork for particular work environments. In sum, we hope that the articles can help advance our understanding of team process phenomena, and, specifically, how teams interact, learn and innovate.

Research Design

As the topic of teams is inherently practical in nature, we identified an explanatory *case-study* (Yin, 2014), as the most applicable research design. We proceeded by engaging in a search to find organizations where teamwork was considered absolutely essential to accomplish organizational goals. As we followed this path, we quickly realized that it would be fruitful to look for teams that operate at the sharp end of an organization, and thereby in direct contact with its value creation and exposed to the dynamism of the external environment; examples would include military teams, offshore teams, crisis action teams, emergency units, fire brigades and many more. Our choice fell on the Royal Norwegian Naval Academy (RNoNA).

RNoNA teams need to be able to operate efficiently in complex contexts, characterized by high levels of mental stress and uncertainties, where execution of actions can be triggered by unforeseen events, and rapidly changing circumstances. Thus the teams are oftentimes faced with situations where unconventional and innovative responses represent the only possible options. Success is therefore contingent on the ability to envision novel opportunities as well as mastering new skills, which requires that teams must learn to be capable of both absorbing as well as creating knowledge while executing their tasks. In consequence, the RNoNA sees leadership as too complex for one person to handle. Moreover, they base their education on the premises that individual team members must be able to develop viable working relations with their teammates, and create a shared understanding of the task and team interactions. At the core, team process dynamics are therefore not only seen as means to an end, but also as the most important predictor of whether a given team will be able to navigate in the uncertain terrains of modern warfare. Our decision to investigate RNoNA's teams is a deliberate one; the Royal Norwegian Naval Academy is in the forefront of evidence-based team development in Norway (Sjøvold, 2014a).

Both articles involve empirical examinations of teams that participated in exercises which are part of the educational program at the RNoNA. The first article is based on investigations related to the *Magellan* exercise, an 11-week transatlantic crossing that plays out on the three-masted barque *Statsraad Lehmkuhl*. In the second article we undertake examinations during two different high-fidelity simulation exercises, namely *Aden* and *Carey*. The exercises are vastly different in their missions and constraints, yet they are similar in their strong focus on process outcomes and in the extensive leeway team members are provided to execute their tasks. This directly implies that a detailed blueprint for what represents a success or failure is non-existent.

Research Methods

To add robustness to our study, we chose to utilize a combination of quantitative and qualitative methods - what Yin (2014) denotes as a *mixed-method approach*. These were selected based on an evaluation of their appropriateness. For the purpose of the first article, we used the quantitative method Systematizing the Person-Group Relationship (SPGR), which constitutes a standardized instrument and validated method to measure group dynamics and intergroup relations (Sjøvold, 1995, 2002, 2006, 2007; 2014b). The retrospective self-report data from the SPGR were, subsequently, analyzed in light of the material collected from in-depth interviews with cadets and instructors at the RNoNA. Besides being a way to place the quantitative data in its social and cultural context (see McCracken, 1988), these interviews were also seen as a valuable approach by which we could get access to the team members and instructors' personal perceptions.

As we commenced with the second article, we took the opportunity to explore new and innovative approaches to capture group dynamics. The result was that the more traditional self-report method of SPGR was combined with sociometric badges (technological devices capable of "big data" capturing of interaction contents – see Kim et al., 2012; Olguin et al., 2009; Pentland, 2008, 2012; Waber et al., 2007). The latter technology was considered especially intriguing as it has been attributed the promise of being able to free researchers from the limitations inherent in the use of self-reports and observations (Kozlowski et al., in press; Waber et al., 2007). Parts of Article 2 are therefore devoted to reach a verdict to whether this could be the case.

article | ONE

A LOOK INSIDE THE BLACK BOX OF TEAM DYNAMICS: An analysis of development in team processes

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Abstract

This empirical study on team development challenges the traditional modelling of team processes as static constructs by explicitly shedding light on the changes that occur in a team's internal dynamics. The research is structured as a longitudinal design where we analyse and compare the development of cadet teams over the course of an 11-week live team building exercise. Using a combination of retrospective self-reports and in-depth interviews, we attribute the different degrees of development experienced by the investigated teams to a number of internal and external structural contingencies. These include the importance of building and maintaining healthy relations within a team, team members' genuine interest in understanding the predispositions of teammates, the willingness and desire to create a work environment in which the social role structure is flexible, and the continuous discussion of the feedback received from instructors. As there are apparent changes in the teams' dynamics following the exercise, we therefore support the contention that teamwork can be enhanced by the use of tailor-made team building interventions.

Keywords: team development, team building, team dynamics, Spin theory, SPGR, complex environments

INTRODUCTION

The increased application of team-based work structures has fuelled the quest to derive conclusions on how successful teams can be built (e.g. Pentland, 2012; Sjøvold, 2006, 2014b). Team building is an instructional strategy to enhance team performance, yet its design seldom reflects the outcome of empirically proven facts. Despite scholars' increasing attention to this matter, they have only to a limited extent been able to report a positive relationship between team building and team performance (e.g. Klein et al., 2009; Salas, Rozell, Mullen, & Driskell, 1999). However, the literature on team building tends to apply an inconsistent definition of the term, thereby leading to great differences in what is being evaluated. We define team building as "long-term, systematic and goal-oriented tasks, performed in a relevant context, in which the purpose is to improve a team's performance so that it can meet the demands of its surroundings" (Sjøvold, 2014b, p. 71). Sjøvold divides team building in *team training* and *team development*; where team training can be exemplified as drill of familiar tasks, and team

development as becoming better able to display a wider register of behavioural patterns, thus making teams more adaptable to dynamic environments and capable of handling uncertainty. It follows that team building intervention designs must be tailor-made and realistic - and in order to target distinctive team processes, one needs to acknowledge the dynamic nature of team phenomena.

Surprisingly, though, this has only been done to a limited extent in previous research. In fact, most empirical studies seem to follow the unidirectional cause-effect relationship of the Input – Process – Output (IPO) heuristic (McGrath, 1964), thereby treating team processes as static constructs – and often modelling them as a "box" (Kozlowski & Bell, 2003). A new logic is evolving, however, and researchers increasingly ask the research community to apply a more theory-driven approach to address the "P" of the framework, and thereby open the box of team dynamics (e.g. Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski, in press; Kozlowski, Chao,

Chang, & Fernandez, in press; Salas, Goodwin, & Burke, 2008). Contrary to the IPO tradition, the current study is positioned outside this stream of research – which we consider as filled with feedback loops that make them operate as an “echo chamber” (Pentland, 2014) – as we align with McGrath, Arrow, and Berdahl (2000), who describe teams as complex, adaptive systems. The research question (RQ) was founded on this premise:

What are the factors and characteristics that impinge upon the process of team development?

To address this RQ, we apply an assessment tool to evaluate team development over an 11-week live exercise involving cadet teams at the Royal Norwegian Naval Academy (RNoNA). RNoNA teams normally perform their operations in environments characterized by high levels of stress, complexity and uncertainty, which impose stringent needs on the teams’ ability to adapt to changing circumstances. The article should therefore be relevant for teams that perform their operations under similar conditions; examples could include military teams, offshore teams, crisis action teams, as well as other teams that work in the sharp end of an organization. As the assessment tool measures process outcomes rather than performance outcomes, the article could also be considered a response to Foster & Fletcher’s (2013, p. 315) request for studies focusing on measurement and development of abstract cognitive competencies, which enable teams to deal with unexpected events.

Our research is anchored in the Spin theory of groups (Sjøvold, 1995), which comprises a framework that focuses on relationship transactions measured at a team-level. It was considered highly applicable as a guide to our study as it incorporates the dimension of development team process dynamics.

BASIC GROUP FUNCTIONS AND THE CONCEPT OF BALANCE

The Spin theory of groups is an extension of Bales’ SYMLOG theory (Bales, Cohen, &

Williamson, 1979), and finds its theoretical roots in Bales’ (1985, 1999) theory of social interaction systems, Parsons’ (1953) functional model of group development and Bion’s (1961) theory of emotionality. It defines a group or a team - the terms are used synonymously - as “three or more people who share a common goal and interact to achieve this goal” (Sjøvold, 2006, p. 17). Unlike a number of other researchers (e.g. Eckes, 2002; Salas, Sims, & Burke, 2005) Sjøvold distinguishes between a dyad and a team, thereby drawing on the works of Simmel (1955) who argues that the complexity of the interaction pattern increases dramatically when a group is expanded from two to three people.

At its theoretical core the Spin theory describes team dynamics as the balancing of four basic group functions: *control* (C), *nurture* (N), *opposition* (O), and *dependence* (D) (Sjøvold, 1995, 2007). The *control* function is supported by structured, analytical and task-oriented behaviour, whereas the *nurture* function is supported by caring, socially oriented and empathic behaviour. Furthermore, the *opposition* function is supported by behaviour that is critical and assertive, and finally, the *dependence* function is supported by conformance, loyalty and submission. Essentially, the idea is that the group activates the function best suited to deal with the task at hand, which builds on Western traditions that stress the importance of both effective production and social relations to achieve successful performance (e.g. Blake & Mouton, 1964); that is, the C-N dimension must be balanced over time. By the same token, the O-D dimension must be balanced, as a group could neither endure constant criticism, nor blind obedience (Sjøvold, 2007). Indeed, both opposition and dependence are sometimes important to ensure optimal teamwork. The C-N and O-D dimensions make up the two first dimensions in the Spin theory:

1. Control versus nurture (C-N)
2. Opposition versus dependence (O-D)

Herein, it should be underscored that balance is not to be confused with the principle of equilibrium (Sjøvold, 2007). Whereas equilibrium would indicate that all functions are present in equal strength at all times, balance implies that the group functions exist in a dynamic interplay, where balance can be distorted if the situation entails it. As such, balance is a state in which the system is both balanced and unbalanced simultaneously; a paradoxical condition, which in natural sciences, is often referred to as “the edge of chaos” (Langton, 1989).

Balance could be achieved if each team member takes on roles to fill the different functions, yet this represents a rather static and inflexible solution. A more robust model is when every member is capable of performing all functional roles interchangeably in a dynamic manner (Sjøvold, 2006). Interchange highlights an important aspect in the Spin theory; balance is not simply a product of equally sized subgroups that adhere to opposing dimensional poles. Rather, the intensity of behaviour determines the effect of the group function it is associated with. Sjøvold (2007) exemplifies this with a conflict scenario in which the emotional power oscillates between the dimensional poles as team members fight to gain influence. According to the Spin theory, this element of team dynamics is encompassed in the third dimension:

3. Influence versus passivity (I-P)

Interestingly, this third dimension illustrates that balance can be skewed towards a dimensional pole if individual team members exert considerable influence in the group. Sjøvold (2007) explains that although this preponderance of influence may be beneficial for a group in some instances, empirical evidence suggests that the I-P dimension should also be balanced over time - the reasoning being that extremely dominant team members in a group tend to freeze the functional role patterns. Arguably, the balancing of the I-P dimension correlates with the idea of shared leadership, described as an emergent team property that emanates from

the distribution of leadership influence across team members (Carson, Tesluk, & Marrone, 2007). Consequently, one would expect members in a shared leadership team to exert rather similar degrees of influence over time.

What is Beneficial Team Dynamics?

Bales (1999) defines team dynamics as the perpetual shift between polarization and unification in a group. According to the Spin theory, polarization is a result of team members' occupation of roles associated with the basic dimensional poles (Sjøvold, 2014b). For example, a conflict might result from differences in opinion on whether an action should be executed immediately based on one team member's proposed solutions (control function), or await for a continued discussion until all team members have been allowed to have their say on the matter (nurture function). If this polarization is brief in nature, it represents advanced team dynamics. However, if it is lengthy in nature it may indicate that a permanent conflict exists in the group. The lifetime of a polarization is therefore highly descriptive of what constitutes beneficial team dynamics. Relatedly, one should be aware that some of these functions are more open to changes than others (Sjøvold, 2007), and the order of accessibility is nurture, dependence, control, and opposition.

Advanced team dynamics result from the high speed of dynamic interchanges of the functional roles team members take in the group, which implies that the polarizations are brief and follow no specific pattern. Conversely, if the speed is low, polarizations tend to persist between the same dimensional poles with subgroups tending to coalesce around the same individuals. The speed of this interchange is dependent on individual team members' ability to detect when to fill and change between social role functions. However, this also concerns whether the individuals in a team have a shared understanding of the team interactions so that they can coordinate this process. In the traditional team literature, this is the concept of shared mental models.

SHARED MENTAL MODELS

A growing body of research has advanced the concept of shared mental models (SMMs) as an underlying mechanism of effective team processes and team performance (e.g. Bolstad & Endsley, 1999; Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000). This concept has emerged from studies on individual mental models, which Johnson-Laird (1986, p. 10) explains as how “human beings understand the world by constructing working models of it in their mind”. In this article, we are most concerned with the team-interaction knowledge possessed by team members, which helps explain how team members work together within a given task domain. Adaptable teams are therefore those that are capable of understanding and predicting the nature of team interactions. The basic idea is that SMMs help team members predict their teammates’ future needs and actions, and thereby facilitate the team’s coordinating mechanisms (Jonker, van Riemsdijk, & Vermeulen, 2011). Extending on this view, team members’ mental models have been found to be important for learning, communication, safety and efficient performance (Eid, Helge Johnsen, Bartone, & Nissestad, 2008; Espevik, 2011; Espevik, Johnsen, Eid, & Thayer, 2006). Conversely, mental models that diverge widely may affect the team’s performance in a negative way (Espevik, 2011; Sjøvold, 2014b), albeit it must be emphasized that this is dependent on the context and nature of the task.

Indeed, Marks, Zaccaro, and Mathieu (2000) proved that SMMs are stronger predictors of performance in novel than in routine environments. Specifically, that they may enhance team members’ coordination when performing complex, unpredictable, urgent, and/or novel tasks. Espevik et al. (2006) showed in their research on submarine attack crews how teams in which team members possessed knowledge about their teammates outperformed those where this was not the case. They attributed the findings to the effect of SMMs, and argued that it represented a clear indication of the benefits of keeping teams

intact under training and operations. Moreover, their findings supported previous research on the influence of SMMs on team communication and coordination processes in stressful conditions. As teams encounter stress, the amount of communication tend to decrease, forcing team members to rely more on implicit coordination than on explicit communication (Espevik et al., 2006; Kleinman & Serfaty, 1989; Orasanu & Salas, 1993). In fact, during stressful periods teams benefit from SMMs by allowing team members to more readily anticipate the accurate needs of teammates (Salas, Cannon-bowers, & Johnston, 1997), thereby making team members capable of engaging in more effective and implicitly coordinated execution of actions. Danielsen (in press) exemplifies how this may play out in practice. During an interview with a Special Operation Forces (SOF) team member, the interviewee told Danielsen that he knows his teammates better than his wife, and that he knows how they think and will act prior to the actual execution of the action. In that manner, the SOF-team represents a unit operating with an intricate, collective interplay that enables them to adapt to the most complex environments.

However, this is not to say that a complete overlap in mental models is superior. In fact, exact replications of mental models across all members would even reduce the team’s availability of alternative solutions and strategies, thus resulting in decreased adaptability (Kozlowski, Gully, Nason, & Smith, 1999). Furthermore, the enactments of accurate mental models may lead to the emergence of groupthink, as team members that are similar in background are more prone to this phenomenon (Janis, 1972). Sachdev and Bourhis (1991) further argue that groupthink usually occurs in high-status groups, where certain individuals are viewed upon as extremely credible and the desire to be accepted is stratospheric. Salas et al. (2005) assert that the optimal solution would be for team members to hold sufficiently similar and compatible mental models to direct the members toward the same team goals. From this it is inferred that team members display

reciprocal respect, understanding, and simultaneously show that they are inquisitive about the different perceptions and proclivities of their teammates. In turn, this could spark fruitful discussions that could generate new knowledge.

According to the Spin theory, team members' shared understanding of the team processes is a distinctive characteristic of a team operating with advanced team dynamics. Thus, in order to enable a team's development it is vital to make "tacit knowledge" (Polanyi, 1966) explicit both about the task and the team itself. This may well be an imperative function for a team leader that intends to facilitate his/her team's development to bring into the team. With proper management, team members can challenge each other on the knowledge possessed within the group and consequently enable a higher level of SMMs. On the contrary, the inability to challenge each other's mental models characterizes a team operating with unsophisticated team dynamics (Sjøvold, 2014b), and will inhibit the team's collective learning and innovative abilities. Team development would therefore also imply a higher level of SMMs.

TEAM DEVELOPMENT

McGrath (1991) rejects the notion that groups need to pass through a fixed set of stages. Rather, he proposes that group development is a contextually contingent phenomenon in which time is an important parameter. It follows that real teams both have a history and a future. Mills (1984) seems to agree with this thinking, as he highlights that groups alter their role structures over the course of their development. Newly formed groups tend to perform more specific functional roles than teams with a history of solving complex tasks. Following a group's development, one would therefore expect to see members being willing to step out of their comfort zones and take on new functional roles, thereby increasing the complexity and effectiveness of the team's social role structure. In essence, this will make the team more flexible and adaptable to changing circumstances. However, it should be

noted that team development is not necessarily beneficial for all teams. In fact, it entails a considerable cost; both due to its resource-demanding nature and due to the large demands put on team members' mental capacities (Sjøvold, 2014b). Hence, team development should always be scrutinized in terms of its potential to enhance a team's performance for a given work context both in relation to the complexity of the tasks and of the perceived abilities of the team members; and thereafter conclusions can be drawn to whether it is likely to be fruitful or not.

In the Spin theory, group development corresponds to a team's increase in their level of purpose (LoP) (Sjøvold, 2006, 2007, 2014b), and it is encompassed in the fourth dimension:

4. Withdrawal versus synergy (W-S)

In teams operating at a low LoP, team members tend to fill functions that fit their comfort zones. For example, a person of an empathetic nature will typically fill a nurture role in the team, a structured and task-oriented person will fill a control role and so on. This represents a group operating close to the withdrawal pole. However, if team members are willing to learn and push the boundaries of what they are comfortable with, it allows for dynamic interchanges between team members' functional roles. In consequence, the pace of the interchange between the basic group functions increases, and team members become more adaptable and better able to master an increasing spectrum of behaviour - the team increases its LoP; but does not lose its ability to perform on lower levels (Sjøvold, 2014b). It follows that the team enhances its capability to handle uncertainty, to learn and innovate.

Moreover, an increase in LoP entails that team members become more aware of and better able to understand teammates' social cues. Pentland (2008, p. xxi) describes these as "behaviours that are so expensive or so directly connected to the underlying biology that they become reliable indicators that others use to guide their own behaviour". Underscoring this description, social cues may well be regarded an

important component of communication and display. In fact, they have been proven to work effectively in chaotic contexts; and can even be effective in the dark (Pentland, 2008). These physical movements facilitate the effectiveness and understanding of the vocal communication within teams. As such, it adds another layer to the communication process – which is commonly left out in most communication studies.

K2 - constructive confrontation

Sjøvold (2014b) asserts that the quality of communication is tightly interlinked with a team's LoP, and proposes the implementation of K2 - also known as *constructive confrontation* (Burgess & Burgess, 1996) - as a purposeful strategy to improve the communication patterns in a group. K2 can be described as the constant thirst for new information and the will to question each other's statements. Yet, although it could be intriguing to challenge teammates' perceptions of the task and the work environment, it is emphasized that the method is founded on the exhibition of genuine interest towards the predispositions of others and mutual respect. Thus, in order to keep discussions and arguments constructive, it is important that clear guidelines are set prior to the use of K2 (Sjøvold, 2014b). Hence, teams operating at a low LoP are advised to engage an external instructor to facilitate this effort. By the use of K2, one would expect that latent disagreements and barriers that hinder development will be uncovered, and implicit values brought to light (Sjøvold, 2014b). It follows that all team members will remain updated about the intention of a message put forth by a team member, thereby reducing the prevalence of detrimental misunderstandings. Teams operating at a high LoP will therefore have incorporated the ideas of K2 in their routine work environment, which makes it a distinguishing characteristic of such teams.

Four levels of purpose

Sjøvold (2007) defines four specific dynamics of interaction patterns that corresponds to movement from the withdrawal to the synergy poles: *reservation*, *team spirit*, *production*, and

innovation. It should be noted that teams do not necessarily move from reservation to innovation in a fixed order, nor is this always the best case. The LoP most appropriate for a team depends on the external environment, the task at hand, and the team itself (Sjøvold, 2006). Generally, one would expect that the more complex a team's daily work environment, the more it would benefit from operating at a high LoP. Such a synergistic, or innovative team, herein defined as "teams that are capable to interact in a way that enable them to use technology in new ways; even during complex situations enhanced by mental pressure and uncertainty" (Stålsett, Olsen, & Sjøvold, in press), would have internalized the notion of continuous learning by chasing new ideas, criticizing the status quo, and monitoring the external environment (Sjøvold, 2007). Danielsen (in press) exemplifies this with SOF-teams that work like organic units, based on efficient communication, the ability to read the body signals of teammates, adaptability and innovative adeptness when facing complex tasks. Moreover, Danielsen explains that these teams, at the same time, are able to adapt to simple, routine tasks if this is required. In contrast, one would expect that a team operating at a low LoP will struggle to adapt when the complexity is increased and/or circumstances changed. An illustration of the group development dimension and its related four LoP are provided in Figure 1.

Reservation. Typical in newly formed groups where team members do not know each other. The group might well be characterized by harmonious interaction, however, there is little room for criticism, and the need for a strong leader is considerable. Tasks are usually divided in smaller activities that are performed by individuals, who are coordinated by their team leader. Moreover, the individual focus that persists in the group makes team members less aware of and interested in the propagation of social cues during interaction sequences within the team. It follows that these teams have low levels of SMMs.

Team Spirit. The group is now a collective where members have a shared identity. A set of norms is established and a strong “We”-feeling makes the team distance itself from outsiders. Members are both willing to fill the nurture function by supporting each other, but at the same time defer to the norms (dependence). Given that the boundaries of the team are clearly set, the task is simple, and the leader can fulfil the opposition and control functions, Team Spirit teams could be highly effective. Notwithstanding the complexity of social cues that may exist in the group, the dependence on an authoritative leader figure is significant. The strong team focus would, however, entail

its external environment, and a higher level of SMMs enable a more shared understanding of the team processes needed to deal with changing circumstances. A Production team is therefore more willing and eager to collaborate with other groups. One would expect a higher performance, and self-management is an option, albeit only under relatively stable circumstances. The ability to initiate small, incremental innovations is profound, which may have a considerable impact over time. As such, production teams are eager to learn and disseminate knowledge.

Innovation. The members display a high

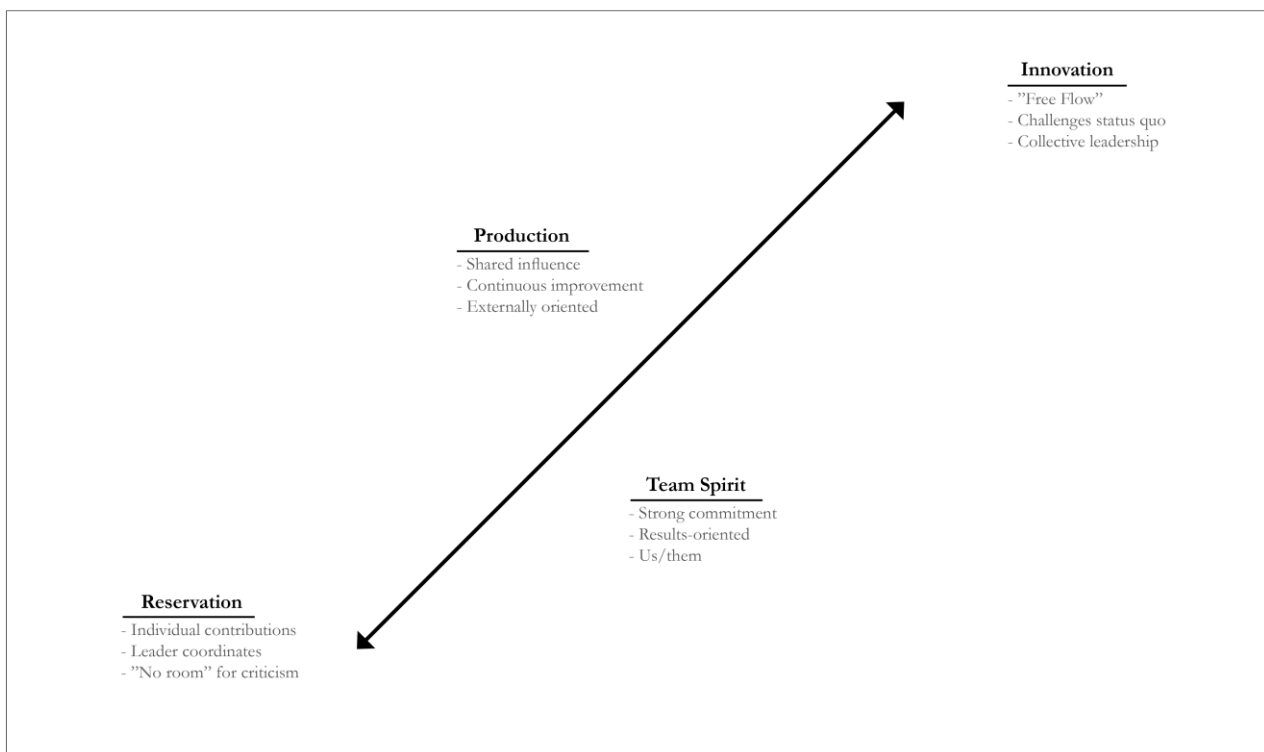


Figure 1: Reservation and innovation correspond with the poles withdrawal and synergy, respectively, in the group development dimension in the Spin theory. As a team changes its group dynamics from a lower to a higher LoP, its external focus and the quality of team members' interactions increase.

higher levels of SMMs. Typically, Team Spirit teams are highly devoted to drill and training of specific tasks.

Production. Members are willing to contribute to achieve the team's goals, both by showing initiative and partake in collaborative problem solving. Thus, there is a lesser need for a prominent leader figure in the team. As teams increase their LoP, they become more aware of communication in the group is intense. Moreover, team members' understanding of

degree of reciprocal trust and accept criticism of the “way things are done”. The group benefits from its creative force and will proactively try to manage its external environment. The spread of ideas and impressions that emanate from this process, lead to new and unique knowledge. It can be compared with Csikzenmihalyi's (1975) idea of “free flow” that characterizes highly creative teams. It follows that the the close connection between personal and team growth, implies that the classical conflict

between loss of individual freedom and team identity is non-existent. Remarkably, team members' SMMs and understanding of their teammates' body signals – and other social cues – enables fast and complex coordination, which allow innovation teams to excel in uncertain and dynamic contexts. The ability to rapidly adapt during changing circumstances is further invigorated by a collective leadership style that enables rapid decision-making.

TEAM LEADERSHIP

Building on a tradition initiated by Gibb in 1954, we define team leadership as “the management of interpersonal processes during actions” (Morgeson, DeRue, and Karam (2010, p. 8). The field of leadership research is vast – yet most of it actually describes how leaders are conceived – and not how to effectively lead teams (Hogan, 2007; Kaiser, Hogan, & Craig, 2008). Nevertheless, it has consistently been identified as a key determinant of the successful functioning of work teams (Hogan, 2007; Kozlowski, Watola, Jensen, Kim, & Botero, 2009). Several researchers have underscored the importance of the team leader's capability to set proficient standards and ensure a good and functional climate in their team (e.g. Edmondson, 2012b; Salas et al., 2005). Team leaders drive effective performance not by handing down solutions, but by facilitating collaborative problem solving through cognitive processes, coordination processes, and the team's motivation and behaviours (Salas et al., 2005). Hence, team leadership is not performed in a vacuum, but rather as part of a larger interactive network. In spite of this observation, scholars have found abundant leadership literature that follow a more reductionist strategy: “leadership studies have traditionally focused too narrowly on a limited set of elements, primarily highlighting the leader yet overlooking many other potentially relevant elements of leadership such as the follower [team member] and the context” (Avolio, 2007, p. 25). It echoes the need for leadership studies to take a more holistic approach by attending to considerations of structural contingencies that affect and moderate a leader's conduct.

The presence of uncertainty and stress are two examples. Hannah, Uhl-Bien, Avolio, and Cavarretta (2009) found conflicting evidence for what that is perceived as effective leadership in extreme contexts. Some research suggest that in uncertain situations, team members appreciate their team leader to take an authoritative and instructive style of leadership (Krabberød, 2014). Hannah et al. (2009) describes this as a situation in which a culture for participative leadership is not established. In the terms of the Spin theory, this may well represent a group on a low LoP, where team members are inclined to display behaviour that supports the dependence function - like soldiers in a trench awaiting orders (Sjøvold, 2007). However, there is also evidence of effective team leaders who are receptive to inputs from team members and willing to integrate their efforts into the team's operation (Hannah et al., 2009). The latter illustrates a group on a higher LoP, in which all team members are proactive in trying to influence processes and decisions in the team (Sjøvold, 2006). A team operating on a high LoP is therefore expected to display a leadership style that builds on the premises of collective leadership.

Following this rationale, team leadership is considered a contextually contingent entity, which finds support in Heldal and Antonsen's (2014) findings which illustrate that team leaders' responses to interacting contextual factors are tightly intertwined with their interpretation of the situation, and therefore also to whether team members find the leadership purposeful or not. Moreover, it induces that instead of taking a normative approach, which tries to define a universal solution (e.g. Katzenbach & Smith, 1993), leadership is regarded with a more dynamic perspective. The implications in practice are that there are no correct answers or standard approaches, and that the team itself must be able to adapt their leadership-perspectives to the changing circumstances.

Regarding the tasks of the leader, he/she needs to evaluate what behaviour or action is appropriate in given situations and in the long

term, and thereby make a deliberate choice (Sjøvold, 2007). In other words, effective leaders are those who provide whatever functions are most needed in a team (Marks, Mathieu, & Zaccaro, 2001), which entails the ability to enable the team to accomplish its task while simultaneously show support for team members (McGrath, 1991). While it is seldom possible to both optimize productivity and care for employees at the same time - referred to as the leadership dilemma (Stogdill & Bass, 1981) - a team leader will have to balance control and nurture functions over time (Parsons et al., 1953). Successful team leadership is therefore conditioned on the leader's ability to score high on the synergy dimension.

METHOD

The authors applied an *embedded, single-case design* (Yin, 2014) involving the Royal Norwegian Naval Academy (RNoNA), which were investigated using both quantitative and qualitative methods.

Participants

This study involved a total of 4 teams with 8 members within each team (age range = 20 - 27). Participants included both female (F=6) and male (M=26) cadets with a military service background that ranged from 1 to 8 years with ranks ranging from Sub-Lieutenant to Lieutenant. The 4 teams were analysed in fine-grained detail based on interviews and surveys that achieved a response rate of 100%. Prior to the study, they had been training as intact teams for 2 months.

RNoNA staff functioned as facilitators, Subject Matter Experts (SMEs), educators and instructors throughout the entire exercise. The SMEs were all Officers in the Norwegian Navy, with military ranks ranging from Sub Lieutenant to Commander.

Case Description

The empirical foundation in this paper stems from an investigation of teams that participated in the exercise, *Magellan*, in 2014. *Magellan* is a transatlantic crossing exercise, which plays out over 11 weeks on the three-masted barque

Statsraad Lehmkuhl, with the objective of educating cadets in the topics of team development, seamanship and leadership under demanding maritime conditions. The ship is basically stripped from high-technology equipment, which makes cooperation and shared responsibility imperative to ensure a successful crossing. The cadets are left with extensive leeway to execute their tasks based on their self-interpretation of their current circumstances, which directly implies that a detailed blueprint for what represents a success or failure is non-existent.

Sjøvold (2006) argues that demanding exercises often lead to changes in team dynamics. Moreover, the RNoNA bases its educational program on the premises of the Spin theory, with K2 extensively applied to facilitate team development. Following this, the choice to investigate RNoNA cadet teams participating in *Magellan* was considered as purposeful for the present study.

Data Collection

Interviews. We conducted 6 in-depth interviews that involved 2 instructors, and 1 cadet from each of the 4 teams. These will be referred to as I_i ($i = 1,2$) and C_j ($j = 1, \dots, 4$) in the *Results* section, respectively. The interviews had a semi-structured format, and were conducted by phone with a duration ranging from 0.25 to 0.5 hrs. The purpose of the interviews was twofold. First, we wanted to obtain what Smith, Flowers, and Larkin (2009) describe as a phenomenological understanding of the interviewees' subjective perceptions of the topic, thereby drawing on the interpretive traditions within qualitative research (Broom, 2005). Second, the interviews were considered an essential step to place the obtained quantitative result in its social and cultural, as well as theoretical context (see McCracken, 1988). Interviewees were asked general questions about their thoughts on aspects such as team leadership, team development and advanced team dynamics, as well as team-specific questions such as why they thought their teams developed as they did over the course of the exercise. The interviews were

recorded, transcribed and categorized to theory, and all informants were anonymized.

SPGR. The quantitative data were gathered using the Systematizing the Person-Group Relationship (SPGR) instrument, which is an operationalization of Sjøvold's Spin theory. It is a validated method for analysing team dynamics (Sjøvold, 2002). The present study is based on self and peer ratings using the standard SPGR 24-item behaviour scale, in which each item asks the respondent to provide ratings according to whether a specific behaviour *never or seldom occurred* (1), *sometimes* (2), or *often or always* (3). The scale has a well-documented construct and predictive validity (Sjøvold, 2002). Participants were asked to respond three times during the exercise; once at the beginning, once approximately halfway and once upon completion.

The method is founded on a factor analytical space comprising three SPGR dimensions: Control-Nurture (C-N), Opposition-Dependence (O-D), and Withdrawal-Synergy (W-S). Whereas the pairs of the first two dimensions represent the basic group functions, the pairs of the third dimension serve as an indicator of the team's LoP. As the basic group functions are supported by a distinct set of behaviours, respondents' ratings, on average, yield a snapshot of a group's most predominant behaviours. Moreover, the members' ratings of themselves and their peers illustrate how they view each other's mental models by displaying how often they notice a certain behaviour (Sjøvold, 1995).

SPGR-analysis. The SPGR instrument constitutes a set of analyses that are extracted from more fine-grained analyses of the social fields, patterns of polarization and group typology (Sjøvold & Park, 2007). In this study the discussion revolves around the application of the Average Field analysis, which is an efficient feedback measure when investigating group dynamics (Sjøvold & Park, 2007). It was chosen due to its applicability as an illustrative tool to highlight team development over time (Sjøvold, 2006). The SPGR field analyses are presented on a template composed of three

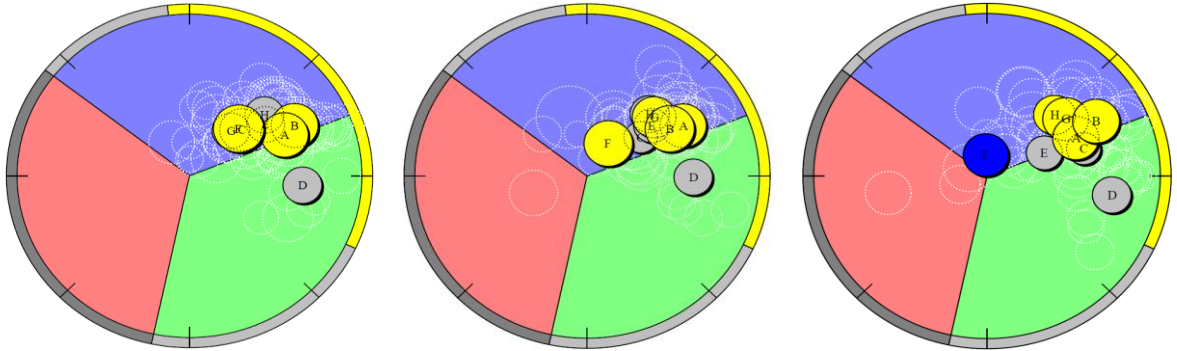
sectors. Behaviours that support the "Control" group function are plotted in the upper sector, behaviours supporting "Nurture" in the bottom right, and finally, behaviours supporting "Opposition" are plotted in the bottom left sector. Individual members are presented as circles of different sizes and colours. The size of the circle illustrates a team member's influence in the group, and the colour indicates a person's predominant display of behaviours that support the different group functions. A yellow circle indicates that the team member displays a balanced spectrum of behaviours; a blue circle indicates task-oriented and analytical behaviour; a green circle indicates friendly, informal, open, and democratic behaviour; red indicates an intolerance for control and authorities; a light grey circle indicates cautious and obedient behaviour; and finally, dark grey, small circles in the red sector indicates a person that is perceived as resigned and uninterested in the team as a whole.

The Euclidian distance between the circles displays the relational closeness between different team members. As such, the field analysis displays the presence of subgroups, and thus polarizations in the team. It should further be noted that the Average Field analysis displays the differences in team members' mental models as each individual respondent's rating is represented as dotted circles. Thus, the wider the clustering of dotted circles, the more different is the team members' mental models. Finally, the colours in the periphery delimit sectors of behaviour that hold vital importance for a team's interplay. First, the yellow border encapsulates an area that supports constructive and goal-oriented teamwork; second, the light grey border indicates behaviour that is sometimes necessary, but in excessive amounts is damaging for the team; and finally, the dark grey border indicates behaviour that restricts constructive teamwork.

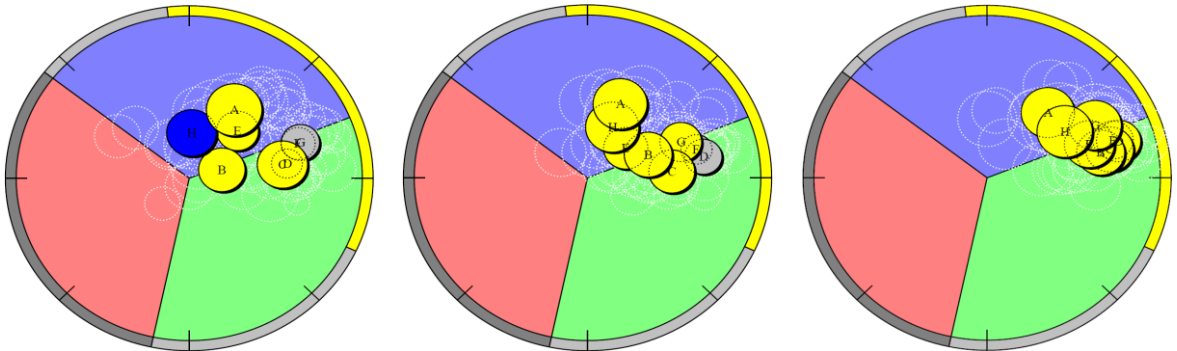
RESULTS

Figure 2 displays the SPGR Field Diagrams of the four different teams. The diagrams are presented chronologically from left to right.

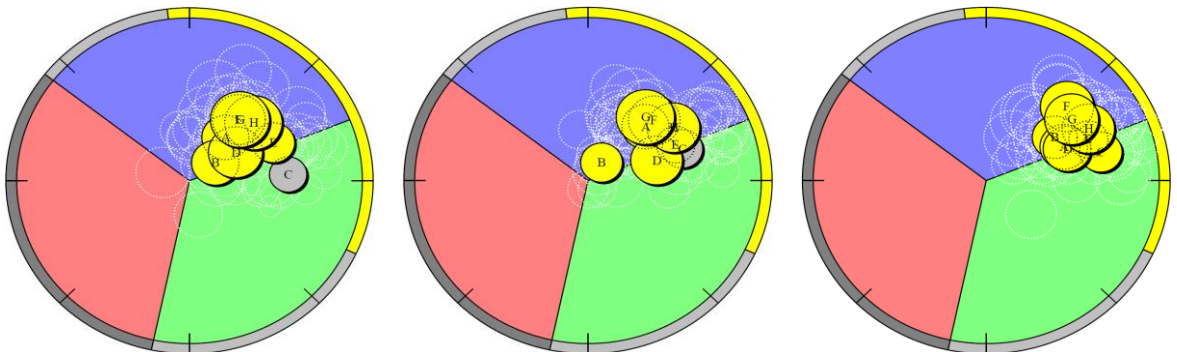
Team 1



Team 2



Team 3



Team 4

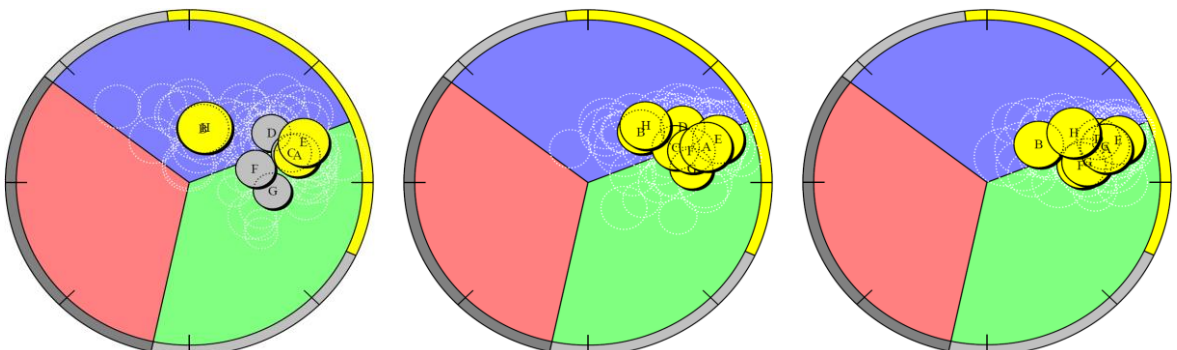


Figure 2: SPGR Field diagrams of Teams 1-4. Measurements taken from three different points in time. The diagrams are presented chronologically with the leftmost representing the first measurement.

Team 1. The diagrams suggest that the team has faced a negative development over the course of the exercise, in which the relational closeness between team members at the start was tighter than it was towards the end. Furthermore, it is apparent that the presence of subgroups and polarizations is more profound at the end than it was at the beginning of the exercise. Some team members even display a more restricted range of behaviours upon completion of the voyage than they did initially, as could be illustrated by team member F who starts off as synergistic and ends up being rated as highly task oriented. Relatedly, the social role structure seems to have frozen with several of the individuals occupying the same functions in the group across all three measurements. According to C₁, this is indeed the prevailing situation: “It is extremely contingent on personal preferences. Some usually lead the conversations, some bring out new ideas, some are more reserved, and some take on a nurture role. People usually have the same position in the group”.

Moreover, C₁ claimed that it is usually the same 2-3 individuals that take charge and initiative when the situation entails it. This corresponds with the SPGR diagrams, which enlist Person A, B and F as the most dominant members throughout all three measurements. It further echoes the voice of I₁, who posited that some teams struggle from the presence of an individualistic attitude, which stems from a too strong focus on the task and negligence of the team process.

In terms of mental models, the field diagrams illustrate that team members’ perceptions of the dynamics in the group are widely diverging in all three measurements. Questioned about how C₁’s team tackled unforeseen events, it was accentuated that the group has suffered from suboptimal communication: “The communication is poor, and we’re not on the same wavelength, we disagree on the purpose and we have a different situational understanding. As a consequence, we do not find common ground on what to do.” However, as is also seen in the diagrams, C₁ argued that the team manages to remain

dedicated to solving their tasks at hand, and also to providing alternative solutions to given problems. The latter was acclaimed to be an attribute that team member F brought into the group, and C₁ stated that this actually facilitated the team’s operations. C₁ continued by explaining that the missing focus on outcomes, such as building good relations, resulted from a lack of genuine interest towards one another, and the general perception that it was not worthwhile.

I₂ suggested that Team 1’s negative development could be due to several reasons, including poor chemistry between group members, past experiences of teamwork prior to the exercise, or simply that the group was what he referred to as late starters. In case of the latter, he claimed that some teams learn so much from their initial struggles, that when they finally “crack the code”, they jump on the development scale. However, he also stated that this is seldom the case, which indicates that it is unlikely for Team 1 to reach a high LoP unless significant changes are made or enforced. Indeed, the strong focus on the task, the lack of interest towards one another, the tendency of a fixed social role structure, the presence of a few dominant members, and the differences in mental models, indicate that Team 1 is mostly operating at the *Reservation level*.

Team 2. The diagrams suggest a positive development in which the team has become more cohesive over the course of the voyage. In fact, the team was initially divided into subgroups, whereas the final measurement illustrates a higher degree of relational closeness. According to C₂, there were several incidents that drove this evolution: “During the hurricane, two of the members became seasick. We just laughed about this, and I feel that episode tightened us as a unit. Moreover, towards the end of the exercise, we were handed extensive amounts of work, thereby having to choose among what courses of action to take. As we were dedicated to the team choices and decisions, it was an enabling factor to make us more cohesive.” The most evident sign for outsiders that the group acted more as

collective, he continued, was that they started to have their dinner together.

Notably, in the last measurement all members, except team member F, were rated to display synergistic behaviour. This represents an improvement from the first assessment where three team members were rated as cautious and obedient, and one team member as highly task oriented. However, it was suggested by C₂ that there was a tendency of team members to become locked in specific social roles. This could illustrate that the different team members displayed a preponderance of certain behaviours, but at the same time were willing to try out new social roles if this was required. Over the course of the exercise, team members' degree of influence has become more equally distributed. C₂ suggested that this was a result of guidance from instructors who advised the most dominant members to take a step back in order to let their teammates become more influential. Questioned about the latter, I₁ stated that this is a common advice given to teams in order to accommodate the problem of team members who act like "bulls in a china shop" when performing teamwork. C₂ further posited that the levelling of influence was also likely to be a consequence of development in how they communicated as a team: "(...) when someone raises a suggestion that I disagree with, I choose to highlight the elements of the suggestion that I think are feasible, rather than cutting the legs of the suggestion right away. Thus, everyone gets the feeling that they are contributing. I think everyone has become better at displaying such an attitude."

Asked about how the team tackles unforeseen events, C₂ argued the importance of staying proactive, which he stated, is contingent upon having the leeway to decentralize the leadership function. However, he acknowledged that misunderstandings tend to happen, which leads us to infer that team members have a different situational understanding. Drawing on the findings from the SPGR diagrams, we are offered a clearer picture of this circumstance; the team has benefited from developing more similar mental models, yet there is still room for further development.

Based on these findings, one might argue that the team operates on a high LoP, however reports of a fixed social role structure and differences in situational understanding will restrict the team from operating as an innovative team. Still, there is a clear indication that the team works as a collective whole with a genuine interest in ensuring further development. Arguably, these findings therefore illustrate a team that has developed so that it is capable of operating close to the *Production level*.

Team 3. The SPGR diagrams illustrate that the team has faced an overall positive development. Both at the start and at the end, however, seven out of eight team members were rated as synergistic, illustrating that this situation remained fixed. The positive changes relate to the team's increased cohesiveness, and the distribution of influence, which became more equal over the exercise. C₃ explained that among the reasons for these outcomes, were the team members' open and honest ways of communicating, as well as their genuine interest in each other's personal development. Moreover, C₃ stated that the team spent considerable time on building healthy relations: "We scheduled private conversations with teammates in order to get to know each other better. The meetings, which revolved around team members' private matters, would generally last for about half an hour, and involved a new team member every day. Socialization was really important for us." I₂ proposed that this genuine interest in each other was essential for the team's ability to perform well during the stormy conditions in the Atlantic Ocean.

Speaking about the distribution of influence in the group, C₃ asserted that it was noted early on that three to four team members were more influential than the rest. In order to address this issue, the team initiated a process whereby each team member got assigned specific tasks according to their level of influence. For example, one team member, who usually had a lot of speaking time during team meetings, was tasked to be more hesitant to allow less influential team members to take more space.

According to C₃, this process advanced the team's development. However, when the team faced unforeseen events, C₃ claimed that the team members had a tendency to fall back into comfortable social roles, despite their effort and desire to have a flexible social role structure.

The SPGR diagrams also highlight a positive development in terms of team members' SMMs. Based on C₃'s reflection on the subject, the improvement was even considered as more significant than what the SPGR entails. Specifically, due to the increased ability to remain short and concise when communicating during stressful events: "The total number of words has decreased - we have become rather good at this." As such, it may indicate that the team was capable of operating at a high LoP, yet the reported tendency of a fixed social role structure during stressful events, illustrates that the team seldom manages to operate at the Innovation level. In conclusion, the relatively shared degree of influence, the indications of SMMs, team members' interest in their teammates, and the focus on team processes, may resemble a team that has developed so that it is able to operate at the *Production level*.

Team 4. The SPGR measurements point to the perception of a significant development in the team's functioning. First and foremost this relates to the group's evolution from comprising various sub groups at the start of the exercise, to become a more cohesive whole. Moreover, all team members have become capable of synergistic behaviour, whereas at the beginning, one half of the team was rated as cautious and obedient. According to C₄, team development was closely linked to personal development: "We were encouraged to try out new social roles, and those who dare to take this challenge are blessed with a greater development. Some are less willing to take part of this journey due to personal attributes such as shyness. Still, everyone is motivated to try anyhow, and my team managed to accomplish this." As such, it aligns with the voices of both I₁ and I₂ who argued that personal development and group development are mutually dependent, and that the willingness and interest

of team members to step out of their comfort zones to take on unfamiliar challenges, are requisites for such development. Furthermore, C₄ asserted that the team benefited from team members' genuine interest towards their teammates' self-development, from the high degree of openness in the team, as well as from the camaraderie that evolved in the team throughout the voyage. Notwithstanding this positive development, there is potential for further progress - in particular that the social role structure seems to have become locked in a pattern. Defending this issue, C₄ argued that it is difficult to generate mental changes in terms of what individuals are most comfortable with over a short time span, albeit it is a focus area.

Regarding the distribution of influence, the SPGR indicates a considerable positive change. Based on C₄'s interpretive understanding, this resulted from the team's desire to make everyone responsible for the leadership function. C₄ continued by exemplifying how this became evident in practice: "During a storm on the journey from Cape Verde to the USA, we faced several obstacles. No one had been appointed the formal leadership role, and everyone had to fill the social role functions that were needed. It was demanding and at one point one of the crewmembers almost fell overboard. But the team remained efficient and confident enough to display leadership without any second-guessing. At that point I felt like we had overcome a barrier - there were no longer any passive bystanders."

In terms of SMMs, the SPGR illustrates that team members have become more similar in their perception of team's dynamics. Questioned about the topic, C₄ drew an insightful conclusion: "We come from different places and have different experiences, but when we work as a team to solve the tasks at hand, a language that is specific for our team emerges. Everyone has internalized the deeper meaning of the expressions that are applied. When this happens, the processes become more efficient as the group works toward a common goal - team members agree what social role functions that need to be performed, what is required and what is prioritized."

Conclusively, based on the findings of a strong focus on team processes, the willingness to try out new social roles, the relatively equal degree of influence between team members and the similarities in mental models, there are indications of a group that is capable of working at a high LoP. Yet, further development is required to break out of the tendency of a fixed social role structure. In sum, this would indicate that the team has developed so that it is able to operate at the *Production level*.

DISCUSSION

Our findings suggest that the teams that were highly occupied with building healthy relations, benefited from greater team development. As emphasized by instructors at the RNoNA, a healthy relation does not necessarily imply friendship between A and B, but that everything is out in the open and that A knows about B's strengths and weaknesses and vice versa. Consequently, building such relations is a prime element of promoting trust in a team. The presence of reciprocal trust, in turn, allows for an open climate where team members are more willing to challenge established norms, and dare to perform functional roles that are outside of their comfort zones. In our findings, the teams that furnished these capabilities were also the teams that achieved the most significant degree of development.

Advanced team dynamics relates to a team in which its members know when to perform the needed functions, and this is of pivotal importance to enhancing the ability for rapid adaptation, as well as learning and innovation (Edmondson, 2012a; Sjøvold, 2014b). Herein, it is underscored that the findings further illustrate that the ability to perform the various functions is learned through consistent training in relevant contexts. The important skill to be learned is to identify and fill needed social functions. Moreover, the team must continuously be made aware of potential points of improvement in their functioning – thereby emphasizing the importance of assessment tools. Indeed, providing feedback to learners is

warranted great attention as a cornerstone of successful team building exercises (Brannick, Salas, & Prince, 1997; Danielsen, in press; Salas & Cannon-Bowers, 2001). Nevertheless, the feedback should not be seen as an end in itself, but as a means by which teams are made aware of their strengths and weaknesses to allow them to initiate appropriate actions. In our research, it became evident that the teams with the greatest development profited from an ongoing discussion in the group about the feedback they were receiving from assessments, both during and post exercises. In her research of SOF-teams, Danielsen (in press) reported similar findings, and attributed to this process the potential of conflict resolution, tension release, and of keeping personnel mentally balanced. For the groups studied in this paper, this entailed an honest way of communicating, which resembles the elements found in K2. Relatedly, we found that in these groups, team members expressed a genuine interest in the development of their peers, as they saw personal development and team development as mutually dependent.

It was also evident from the SPGR measurements that most of the teams developed a more equal distribution of influence. This may well follow from the RNoNA's understanding of leadership as being too complex for one person to handle, which is why their educational program focuses on equalizing the level of impact across team members. At the same time, the degree of unequal distribution of influence within the teams may indicate that some team members preferred an authoritative leadership style, as was posited by Hannah et al. (2009). According to several of the interviewees this was particularly true when the situation was complex and surprising, which, in turn, may demonstrate that the teams - in the terms of Sjøvold (2007) - were not operating at a sufficient LoP. One team, however, explained that they experienced a stressful situation in which all team members proactively filled the needed functions, without any predetermination of who had the formal leadership responsibility. Hence, there were also examples where teams operated at a higher

LoP, and when the teams failed to do so they attributed this to insufficient training in complex operations. Moreover, it was claimed that it is difficult to generate mental changes in what teammates are comfortable with over a short time span. In sum, these two arguments emphasize the importance of providing team training in uncertain and stressful situations, and acknowledge the need to set aside enough time to allow teams to develop.

RNoNA cadets are trained to collectively monitor and interpret external cues to solve their tasks at hand. This illustrates that the external environment plays an imposing role both on how the team functions and on how leadership is performed. Indeed, both the team and the team leader must continuously address their surrounding circumstances, thus illustrating that external elements impact continuously on internal team processes. It follows, that the IPO model, which tends to delineate contextual factors as inputs to team processes, is poorly suited to help explain how RNoNA teams dynamically interact with their circumstances.

In interviews with both instructors and cadets it was posited that advanced leadership follows a dynamic process in which leadership changes with both the complexity and the task environment, thereby reflecting Heldal and Antonsen's (2014) view of leadership as contextually dependent. Relatedly, it was emphasized that teams will not reap the full benefits of collective leadership unless teammates internalize the notion that they are responsible to facilitate the team leader's efforts. Such participative leadership furnishes the dual benefit of both ensuring full use of accumulated mental capacity of team members during critical decision-making, and safeguarding that viable choices are made even in situations where the formal leader is absent.

However, it will be difficult to reach a common understanding of what is the appropriate action if teammates diverge in their mental models. In this study it therefore seems reasonable to assume that the differences in mental models that were seen in the SPGR diagrams, are interlinked with the teams' expressed

misunderstandings during operations. The basic rationale is that when team members possess a more similar apprehension of the task and their colleagues, the occurrence of detrimental misunderstandings will decrease. This could be exemplified by the team which expressed that they, in spite of their differences in background, gradually managed to develop their own "language", which facilitated the team in their communication process, subsequently reducing coordination overhead. Our results further suggested that some of the teams had experienced an improvement in their way of handling stressful situations, as they had become better able to coordinate their actions with the use of less explicit communication. To some degree, we attribute this finding to what we propose is team members' increased capability to read each other's social cues, which interlinks with the presence of SMMs in the teams.

In order for team members to develop SMMs, the tacit knowledge possessed by team members must be made explicit so that teammates can challenge each other's mental models – which premises on the usage of K2. Indeed, one of our informants suggested that being able to constructively criticize and suggest alternative solutions to established preferences, are two critical abilities in order to ensure team development. However, RNoNA instructors posited that a preponderance of cadets find it difficult to state their opinions regarding certain matters. Arguably, this indicates the usefulness of external facilitators to help teams in implementing K2. At the RNoNA this is commonly strategized as engaging instructors to initiate team discussions on various important subjects. Yet, in order to create such an arena for constructive discussion and criticism, team members must exhibit high trust levels. Building mutual trust and developing SMMs, in turn, necessitate a timely effort. In fact, cohesion grows stronger when personnel get to know each other for a long time and form personal ties (Ben-Ari, 1998). Similarly, units that have been in combat together have been reported to form powerful bonds (Grossman, 1995). In sum, this points to

the advantage of keeping teams intact, both during practice and operation.

LIMITATIONS OF STUDY AND FUTURE DIRECTIONS

We acknowledge that there are certain limitations to our research; and the implications that can be drawn from it. It was remarked at an early stage that the literature has tended to apply a rather broad definition of team building, which incorporates various interventions that are conceptually unlike. Indeed, Lipsey and Wilson (1993) report that there are gray areas of what represents a certain intervention. Our line of attack was therefore to cast a narrow net by utilizing a more precise definition of team building; specifically by dividing it into team training and team development. Scoping the literature, it was detected that this way of conceptualizing team building is not that prevalent, and that the research done on group development to some extent represents a gap in the literature. Consequently, we had to draw on the works of a small set of authors to challenge the established “echo chamber” within the field. This opponent strategy, in which we battle against “common sense”, has been proven to yield significantly better returns (Pentland, 2012, 2014).

There are also methodological limitations in this research. Some of these are related to the use of SPGR, which entails potential for bias, such as selective memory, social desirability bias, and the lack of in-depth information. To accommodate the latter, we also conducted interviews to achieve a more thorough and nuanced understanding of the topic. However, in-depth interviews are also sources to limitations. In our case these include that we did not conduct interviews face-to-face, which made us unable to observe social cues from the interviewees; the possibility for lack of memory; and finally, the personal nature of an interview could make findings harder to generalize. Other limitations involve our inability to personally observe the exercise and gather real-time data from it.

From our outlook, we argue that these limitations not only represent limitations of the present study, but also potential for future research. First, although the tide of research covering team training has been rising, the focus on team development has been less comprehensive. We therefore call for a continued attention towards team development, and thereby on the dynamics inherent in team processes. Second, we argue that more cross-fertilization between disciplines should be engaged in, in order to facilitate new and improved findings. Third, we support the call for a combined use of observation and surveys to evaluate team dynamics (Sjøvold, 2014a). Fourth, technological developments have enabled the use of devices that capture “big data” of real-time interaction patterns (Kozlowski et al., in press; Pentland, 2008). We propose that combining this with interviews and surveys will yield a more holistic and solid foundation to investigate teams.

MANAGERIAL IMPLICATIONS AND CONCLUSIVE REMARKS

Critics might argue that the usage of a military sample restricts the degree of generalization of the findings to a civilian context, and admittedly this is up for debate. Researchers seem to be divided in their view. For example, Delise, Gorman, Brooks, Rentsch, and Steele-Johnson (2010), using sample type (military or civilian) as a moderator in a meta-analysis, found no difference in the effect of team training. Still, they acknowledged that military participants are more likely to have extensive experience with structured and well-designed training programs. Essentially, this underlines the difficulty of building well-functioning teams, given that military personnel partake in training that is impossible to conduct in the civilian world (Delise et al., 2010). However, we argue that the core of group dynamics constitutes social psychological aspects, and that similarities between military and civilian settings, in that respect, are possible to uncover. Moreover, there exist more readily apparent proofs of how the civilian world can benefit from devoting more interest towards military practices. The most interesting example

is the Israeli venture community's adoption of the military concept of debriefing, including a tolerance for failure and after-action reviews, which has facilitated the country in becoming an entrepreneurial hotspot (Senor & Singer, 2009). In fact, debriefing in the Israeli military is so greatly valued that all personnel are rated on this particular skill, and also on how they are able to support a climate that accepts failures and see them as an opportunity for learning. As military service is mandatory for both men and women in Israel, it follows that the idea of debriefing has spread beyond the military.

We have also demonstrated how it is possible to design a study that assesses development in team dynamics over time. Such a longitudinal design has been proposed as an advantageous method to reveal the team phenomena under investigation (Kozlowski & Bell, 2003). Notably, we have also provided indications of a team building program that actually yields the desired results. Surprisingly, this is not always the case. Indeed, there are several strategic interventions that are reported as complete "mumbo-jumbo" (Wheen, 2005). Further, notwithstanding the vast amount of financial resources spent on these (e.g. leadership interventions), their effects remain relatively unstudied (Avolio, Reichard, Hannah, Walumbwa, & Chan, 2009; Collins & Holton, 2004). This highlights the importance of conducting research similar to that of the current paper, which aims to uncover whether team building programs have the desired effects on its participating units.

The work context of the teams investigated in this study was also devoted special attention, as it has a considerable impact on the team's processes. Edmondson (2012b) argues that teams that excel in complex and uncertain environments are capable of embracing uncertainty, and thereby also to learn and innovate as they execute their tasks. However, as it is human nature to seek predictability, developing such teams requires a strenuous effort. In the present article, the solution was described as increasing the flexibility of the social role structure in the team, thus making it more adaptable to changing circumstances, and making leadership a shared responsibility. Both

of these goals were evaluated as time and resource demanding, as well as mentally challenging for the teams in question. Managers should be made aware of these issues, and, in turn, assess in detail whether such team development will be worthwhile. Moreover, we underscored the significance of building healthy relations, both in order to develop high levels of mutual trust and in order to lay the foundation for an arena devoted to constructive discussion, challenging of each other's mental models, and criticism of established truths. Practitioners and managers should find this interesting as it points to the advantages of intact teams.

REFERENCES

- Avolio, B. J. (2007). Promoting more integrative strategies for leadership theory-building. *American Psychologist*, *62*(1), 25.
- Avolio, B. J., Reichard, R. J., Hannah, S. T., Walumbwa, F. O., & Chan, A. (2009). A meta-analytic review of leadership impact research: Experimental and quasi-experimental studies. *The Leadership Quarterly*, *20*(5), 764-784.
- Bales, R. F. (1985). The new field theory in social psychology. *International Journal of Small Group Research*, *1*(1), 1-18.
- Bales, R. F. (1999). *Social interaction systems : theory and measurement*. New Brunswick, N.J. ; London: Transaction Publishers.
- Bales, R. F., Cohen, S. P., & Williamson, S. A. (1979). *SYMLOG: A system for the multiple level observation of groups*. New York, NY: Free Press.
- Ben-Ari, E. (1998). *Mastering soldiers: Conflict, emotions, and the enemy in an Israeli military unit* (Vol. 10): Berghahn Books.
- Bion, W. R. (1961). *Experiences in groups: And other papers*. New York, NY: Basic Books.
- Blake, R., & Mouton, J. (1964). *The Managerial Grid*. Houston, TX: Gulf.
- Bolstad, C. A., & Endsley, M. R. (1999). *Shared mental models and shared displays: An empirical evaluation of team performance*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.
- Brannick, M. T., Salas, E., & Prince, C. W. (1997). *Team performance assessment and measurement: Theory, methods, and applications*. Psychology Press.
- Broom, A. (2005). Medical specialists' accounts of the impact of the Internet on the doctor/patient relationship. *Health*, *9*(3), 319-338.
- Burgess, H., & Burgess, G. (1996). Constructive confrontation: A transformative approach to intractable conflicts. *Mediation Quarterly*, *13*(4), 305-322. doi: 10.1002/crq.3900130407
- Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecedent conditions and performance. *Academy of Management Journal*, *50*(5), 1217-1234.
- Collins, D. B., & Holton, E. F. (2004). The effectiveness of managerial leadership development programs: A meta-analysis of studies from 1982 to 2001. *Human resource development quarterly*, *15*(2), 217-248.
- Csikszentmihalyi, M. (1975). Play and intrinsic rewards. *Journal of Humanistic Psychology*, *15*(3), 41-63.
- Danielsen, T. (in press). Making Warriors in the Global Era: An anthropological study of institutional apprenticeship: selection, training, education, and everyday life in the Norwegian Naval Special Operations Commando.
- Delise, L. A., Gorman, A. C., Brooks, A. M., Rentsch, J. R., & Steele-Johnson, D. (2010). The effects of team training on team outcomes: A meta-analysis. *Performance Improvement Quarterly*, *22*(4), 53-80. doi: 10.1002/piq.20068
- Eckes, G. (2002). *Six Sigma Team Dynamics: The Elusive Key to Project Success*: Wiley.
- Edmondson, A. C. (2012a). *Teaming: How Organizations Learn, Innovate, and Compete in the Knowledge Economy*. San Francisco: Jossey-Bass.
- Edmondson, A. C. (2012b). Teamwork On the Fly: How to master the new art of teaming. *Harvard Business Review*.
- Eid, J., Helge Johnsen, B., Bartone, P. T., & Nissestad, O. A. (2008). Growing transformational leaders: exploring the role of personality hardiness. *Leadership & Organization Development Journal*, *29*(1), 4-23.
- Espevik, R. (2011). "Expert teams: Do Shared mental Models make a difference?". (Doctoral thesis), Universitetet i Bergen.
- Espevik, R., Johnsen, B. H., Eid, J., & Thayer, J. F. (2006). Shared mental models and operational effectiveness: Effects on performance and team processes in

- submarine attack teams. *Military Psychology*, 18(Suppl), 23-36.
- Foster, R. E., & Fletcher, J. D. (2013). Toward training transformation. *Military Psychology*, 25(3), 308-317. doi: 10.1037/h0094971
- Gibb, C. A. (1954). Leadership. In G. Lindzey (Ed.), *Handbook of social psychology* (Vol. 2). Reading, MA: Addison-Wesley.
- Grossman, D. (1995). *On Killing: The Psychological Cost of Learning to Kill in War and Society*: Little, Brown.
- Hannah, S. T., Uhl-Bien, M., Avolio, B. J., & Cavarretta, F. L. (2009). A framework for examining leadership in extreme contexts. *The Leadership Quarterly*, 20(6), 897-919.
- Heldal, F., & Antonsen, S. (2014). Team Leadership in a High-Risk Organization: The Role of Contextual Factors. *Small Group Research*. doi: 10.1177/1046496414533617
- Hogan, R. (2007). *Personality and the fate of organizations*. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.
- Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annu. Rev. Psychol.*, 56, 517-543.
- Janis, I. L. (1972). *Victims of groupthink: A psychological study of foreign-policy decisions and fiascoes*. Oxford, England: Houghton Mifflin.
- Johnson-Laird, P. N. (1986). *Mental models*: Harvard University Press.
- Jonker, C. M., van Riemsdijk, M. B., & Vermeulen, B. (2011). Shared mental models: A Conceptual Analysis *Coordination, Organizations, Institutions, and Norms in Agent Systems VI* (pp. 132-151): Springer.
- Kaiser, R. B., Hogan, R., & Craig, S. B. (2008). Leadership and the fate of organizations. *American Psychologist*, 63(2), 96-110. doi: 10.1037/0003-066X.63.2.96
- Katzenbach, J. R., & Smith, D. K. (1993). *The discipline of teams* (Vol. 71): Harvard Business Press.
- Klein, C., DiazGranados, D., Salas, E., Le, H., Burke, C. S., Lyons, R., & Goodwin, G. F. (2009). Does team building work? *Small Group Research*, 40(2), 181-222.
- Kleinman, D. L., & Serfaty, D. (1989). *Team performance assessment in distributed decision making*. Paper presented at the Proceedings from the Symposium on Interactive Network Simulation for Training Conference, Orlando, FL: Naval Training System Center.
- Kozlowski, S. W. J. (in press). Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations *Organizational Psychology Review*.
- Kozlowski, S. W. J., & Bell, B. S. (2003). Work groups and teams in organizations. *Handbook of psychology*.
- Kozlowski, S. W. J., Chao, G. T., Chang, C.-H., & Fernandez, R. (in press). Team dynamics: Using "big data" to advance the science of team effectiveness In S. Tonidandel, E. King & J. Cortina (Eds.), *Big data at work: The data science revolution and organizational psychology*. New York: NY: Routledge Academic.
- Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulaokos (Eds.), *The changing nature of performance: Implications for staffing, motivation, and development* (pp. 240-292). San Francisco: Jossey-Bass.
- Kozlowski, S. W. J., Watola, D. J., Jensen, J. M., Kim, B. H., & Botero, I. C. (2009). Developing adaptive teams: a theory of dynamic team leadership. *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches*, 113-155.
- Krabberød, T. (2014). Task uncertainty and mission command in a naval context. *Small Group Research*, 1046496414532955.
- Langton, C. G. (1989). *Artificial life*: Addison-Wesley Publishing Company Redwood City, CA.

- Lim, B. C., & Klein, K. J. (2006). Team mental models and team performance: a field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior*, 27(4), 403-418.
- Lipsey, M. W., & Wilson, D. B. (1993). The efficacy of psychological, educational, and behavioral treatment: confirmation from meta-analysis. *American Psychologist*, 48(12), 1181.
- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26(3), 356-376.
- Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of applied psychology*, 85(6), 971.
- Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of applied psychology*, 85(2), 273.
- McCracken, G. (1988). *The long interview*. SAGE Publications.
- McGrath, J. E. (1964). *Social psychology: A brief introduction*. Holt, Rinehart and Winston.
- McGrath, J. E. (1991). Time, interaction, and performance (TIP) A Theory of Groups. *Small Group Research*, 22(2), 147-174.
- McGrath, J. E., Arrow, H., & Berdahl, J. L. (2000). The Study of Groups: Past, Present, and Future. *Personality and Social Psychology Review*, 4(1), 95-105. doi: 10.1207/s15327957pspr0401_8
- Mills, T. M. (1984). *The sociology of small groups*. Prentice-Hall.
- Morgeson, F. P., DeRue, D. S., & Karam, E. P. (2010). Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of Management*, 36(1), 5-39.
- Orasanu, J., & Salas, E. (1993). Team decision making in complex environments. In G. A. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods*. Norwood: Ablex Publishing.
- Parsons, T., Bales, R. F., & Shils, E. A. (1953). *Working Papers in the Theory of Action*. Free Press.
- Pentland, A. (2008). *Honest signals* (T. Heibeck Ed.): MIT press Cambridge, MA.
- Pentland, A. (2012). The new science of building great teams. *Harvard Business Review*, 90(4), 60-69. doi: citeulike-article-id:10606943
- Pentland, A. (2014). *Social Physics: How Good Ideas Spread-The Lessons from a New Science*. Penguin Publishing Group.
- Polanyi, M. (1966). *The Tacit Dimension*. Peter Smith.
- Sachdev, I., & Bourhis, R. Y. (1991). Power and status differentials in minority and majority group relations. *European Journal of Social Psychology*, 21(1), 1-24. doi: 10.1002/ejsp.2420210102
- Salas, E., & Cannon-Bowers, J. A. (2001). The science of training: A decade of progress. *Annual review of psychology*, 52(1), 471-499.
- Salas, E., Cannon-bowers, J. A., & Johnston, J. H. (1997). *How can you turn a team of experts into an expert team?: Emerging Training Strategies*.
- Salas, E., Goodwin, G. F., & Burke, C. S. (2008). *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches*. Routledge.
- Salas, E., Rozell, D., Mullen, B., & Driskell, J. E. (1999). The Effect of Team Building on Performance An Integration. *Small Group Research*, 30(3), 309-329.
- Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a "big five" in teamwork? *Small Group Research*, 36(5), 555-599.
- Senor, D., & Singer, S. (2009). *Start-up Nation: The Story of Israel's Economic Miracle*. McClelland & Stewart.
- Simmel, G. (1955). *Conflict and the web of intergroup affiliations*. New York: Free Press.
- Sjøvold, E. (1995). *Groups in harmony and tension: the development of an analysis of polarization in groups and organizations based on the*

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- SYMLOG method.* (Doctoral dissertation), NTNU, Trondheim, Norway.
- Sjøvold, E. (2002). *The SPGR manual.* Trondheim: Endre Sjøvold AS Forlag.
- Sjøvold, E. (2006). *Teamet: Utvikling, effektivitet og endring i grupper.* Oslo: Universitetsforlaget.
- Sjøvold, E. (2007). Systematizing Person-Group Relations (SPGR) A Field Theory of Social Interaction. *Small Group Research*, 38(5), 615-635.
- Sjøvold, E. (2014a). Introduction to the special issue leadership and the group. *Small Group Research*, 45(4), 367-375.
- Sjøvold, E. (2014b). *Resultater igjennom team.* Oslo: Universitetsforlaget.
- Sjøvold, E., & Park, J. H. (2007). The “Systematizing Person-Group Relation (SPGR)” Method and its Application. A Study of Culture-based Differences in Team Dynamics Team Dynamics. *Korean Journal of Social and Personality Psychology*, 21(1), 19-34.
- Smith, J. A., Flowers, P., & Larkin, M. (2009). *Interpretative phenomenological analysis: Theory, method and research.* Sage.
- Stogdill, R. M., & Bass, B. M. (1981). *Stogdill's handbook of leadership: a survey of theory and research.* New York: Free Press.
- Stålsett, K., Olsen, T. R., & Sjøvold, E. (in press). Team Leadership within Integrated Operations in the Oil and Gas Industry.
- Wheen, F. (2005). *How mumbo-jumbo conquered the world: a short history of modern delusions.* PublicAffairs.
- Yin, R. K. (2014). *Case study research: design and methods.* Los Angeles, Calif.: SAGE.

article | TWO

AN EXHIBITION OF THE DYNAMICS IN TEAM PROCESSES: Using Retrospective Self-Reports and Big Data

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Abstract

Researchers' preference for methodological approaches that treat team processes as static constructs has for almost half a century decelerated the advancements in team effectiveness research. This is about to change, as the advent of "big data" technologies and modernized questionnaire-based assessment tools, increasingly fuel the quest to uncover the dynamics in team process phenomena. In the present empirical study, we engage in this quest as we use a combination of retrospective self-reports and electronic devices capable of capturing real-time interaction data, to investigate the concept of group dynamics during high fidelity simulations. Our findings suggest that big data, although showing great promise to capture aspects of human interaction and thereby revolutionize the way we investigate teams, could be even more applicable as a supplement to more traditional methodological approaches.

Keywords: Spin theory, SPGR, honest signals, sociometric badge, big data

INTRODUCTION

Ever since Kurt Lewin introduced the concept of *group dynamics* (Lewin, 1951), researchers have been highly devoted to shedding light on these elusive team process phenomena. Indeed, the increased prevalence of team-based organizational structures has propelled the empirical examination of group dynamics all the way to the frontier of current research (Kozlowski, in press). Scholars seem to have reached a universal agreement that team processes are inherently dynamic in nature (e.g. Bales, 1985, 1999; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Kozlowski & Ilgen, 2006; Salas, Stagl, & Burke, 2005; Sjøvold, 1995, 2006, 2007, 2014b), yet they are seldom researched that way once investigators attempt to translate theory about dynamics into data (Kozlowski, Chao, Chang, & Fernandez, in press). In fact, traditional research practice has been inclined to treat dynamic processes as static constructs (Cronin, Weingart, & Todorova, 2011; Kozlowski, in press). Kozlowski and Bell (2003) attribute this to the assumed causal linkage of McGrath's input – process – output (IPO) heuristic (McGrath, 1964), and the way process is represented as a mediating "box" in a model. The irony is that McGrath intended to use the IPO framework to categorize small

group research, and not to freeze processes into static constructs. Indeed, it is evident elsewhere in the same book that McGrath advocated research that tried to conceptualize team processes dynamically. However, it was the straightforward IPO model that spread throughout the research community, and became the dominant conceptual framework for studying team effectiveness for the next 50 years.

Not surprisingly, researchers therefore call for a combined evaluation of the content, context, and process of team interactions in order to enhance the understanding of team phenomena (Kim, McFee, Olguin, Waber, & Pentland, 2012; Kozlowski, in press; Kozlowski et al., in press; Sjøvold, 2006, 2014b). The key concern is to advance and invigorate empirical research and innovative technology that captures group dynamics, and simultaneously incorporate the dimension of team processes as something that not simply springs into being, but develops and emerges over time. In the current article, we champion this concern by offering a methodological research approach comprising two different assessment tools, which purportedly furnish the capacity to capture

these multilevel phenomena. The research question guiding this study is therefore as follows:

How can assessment tools enable us to unpack a team's dynamics, and thereby provide a learning mechanism for both instructors and teams under investigation?

The research design benefits from a combined use of observation, retrospective self-reports and electronic devices capable of “big data” capturing of real-time interaction patterns. As such, it accommodates the requests of a range of researchers to combine surveys with observational and/or real-time data in order to strengthen the levels of robustness and credibility of team effectiveness research (Kim et al., 2012; Kozlowski, in press; Sjøvold, 2014a). Our study involves teams that partake in high-fidelity simulation exercises at the Royal Norwegian Naval Academy (RNoNA). These exercises put stringent needs on the participating teams to adapt to high levels of mental stress, uncertainty and complexity. This, in turn, relates to how they interact, and whether they are able to exploit existing and new knowledge to produce innovative solutions. In effect, the teams' ability to align their group dynamics with contextual demands is rendered crucial. The article should be relevant for teams working at the sharp end of an organization; examples could include military teams, offshore teams, crisis action teams and similar.

Our main intention with this paper is to spark a discussion on how social scientists and practitioners could be enabled to map out detailed charts of a team's dynamic processes. If the research community can achieve this, it has several apparent advantages. On the one hand, it facilitates managers and instructors to prepare tailor-made educational programs for employees. On the other hand, it allows for efficient feedback systems, by which teams can be made aware of their current functioning so that they can initiate corrective measures or strengthening current practices. This should be of considerable interest, as a vast sum of money is spent on organizational training and

development each year, even though there are few reports of a positive effect (e.g. C. Klein et al., 2009; Salas, Rozell, Mullen, & Driskell, 1999). Nordhaug and Brandi (2004) even stated that Norwegian companies spent an estimated 17.7 billion NOK in 2004 on such interventions, and this amount is expected to be at least as high today. If assessment tools can help optimize these instructional programs, it could therefore also result in higher return on investment (ROI).

CONCEPTUAL BACKGROUND

Four Basic Group Functions and the Concept of Balance

Sjøvold's Spin theory of groups (Sjøvold, 1995) offers guidance to help understand how the dimension of dynamism comes to play in a team setting. According to Sjøvold (2006, p. 17) a team or a group – the terms are used synonymously – is defined as “three or more people who share a common goal and interact to achieve this goal”. Notably, this implies that a dyad is not considered a team, which corresponds with Simmel's (1955) suggestion that the complexity of the interaction pattern is so drastically increased when a dyad is changed to a group of three people that it represents a completely different constellation.

A group's actions are not merely instrumentally related to the task, but also to the transactions in building (or de-building) of relationships within the team (Sjøvold, 1995); an idea which correlates with Bales' (1999) description of group dynamics as the perpetual shift between polarization and unification. These relationship transactions are encompassed in four basic group functions, which are labelled: *control*, *nurture*, *opposition*, and *dependence* (Sjøvold, 1995). First, the control function is supported by structured, analytical and task-oriented behaviour; second, the nurture function is supported by caring, socially oriented and empathic behaviour; third, the opposition function is supported by behaviour that is critical and assertive; and finally, the dependence function is supported by conformance, loyalty and submission. In the Spin theory, group dynamics relate to the

interplay between the four basic group functions.

The basic idea is that the team needs to balance the various group functions in a way that is best suited to deal with the tasks and problems it faces. A team will therefore benefit from both being able to employ all functions simultaneously, and being able to flexibly change between them if it is necessitated by the situation. Hence, operative effectiveness is dependent on the team's capability to align its group dynamics with contextual requirements. Whether a team is successful in doing so is rated along a continuous axis that ranges from withdrawal (dysfunctional behaviour) to synergy (functional). In particular, Sjøvold (1995, 2006, 2014b) stresses the importance of balancing the control (focus on task) and nurture (supportive behaviour) functions, which corresponds with Western traditions that underline the significance of both effective production and social relations to achieve successful performance (e.g. Blake & Mouton, 1964). Interestingly, this balance is also emphasized in research on behavioural markers (e.g. Flin & Patey, 2009; Parker, Yule, Flin, & McKinley, 2012; Salas, Sims, & Burke, 2005). An adaptable team is therefore likely to score high on the synergy dimension, balancing focus on task with supportive behaviour. However, over time the opposition and dependence functions must also be balanced, as a team could neither endure constant criticism (opposition) nor blind obedience (dependence).

To achieve balance, each team member could perform the needed social roles to fill the basic group functions, yet this represents a static and inflexible structure. A more robust solution is when all team members are capable of performing the different functional roles and change between them to adapt to new and unfolding circumstances (Sjøvold, 2006, 2014b). This conditional interchange follows from the dual presence of both balance and unbalance as team members dynamically activate necessary group functions; a paradoxical situation referred to in natural sciences as "the edge of chaos" (Langton, 1989). Moreover, interchange indicates that

balance is not simply a product of equally sized subgroups that adhere to opposing social role functions. Rather, the intensity of the behaviour determines the effect of the group function it is associated with. Sjøvold (2007) exemplifies this with a conflict scenario in which the emotional power oscillates between team members occupying opposing social role functions as they fight to gain influence. It follows that balance can be skewed towards a particular group function if individual team members exert considerable influence in the group. Consequently, Sjøvold (2014b) suggests that a team would benefit if team members are capable of balancing influence with passivity over time; a notion that correlates with the concept of shared leadership, described as an emergent team property that emanates from the distribution of leadership influence across team members (Carson, Tesluk, & Marrone, 2007). One would therefore expect members in a shared leadership team to exert rather similar degrees of influence over time.

TEAM LEADERSHIP

The field of leadership research is vast, yet most of it describes hows leaders are conceived and not how to effectively lead teams (Hogan, 2007; Kaiser, Hogan, & Craig, 2008). This has led several scholars to criticize a large part of leadership studies as too simplistic; especially following their negligence of the impact of structural contingencies that moderate a leader's behaviour. For example, Avolio (2007, p. 25) argued that "leadership studies have traditionally focused too narrowly on a limited set of elements, primarily highlighting the leader yet overlooking many other potentially relevant elements of leadership such as the follower [team member] and the context". Nevertheless, team leadership has consistently been identified as a key determinant of the successful functioning of work teams (Hogan, 2007; Kozlowski, Watola, Jensen, Kim, & Botero, 2009), and of some even characterized as the most critical factor (e.g. Zaccaro, Rittman, & Marks, 2001) Indeed, several researchers have emphasized the importance of the team leader's ability to set standards and ensure a functional team climate (e.g.

Edmondson, 2012; Salas, Sims, et al., 2005). Stogdill and Bass (1981) refer to this complex task, of both optimizing productivity and caring for employees simultaneously, as the “leadership dilemma”. With reference to the Spin theory, it would entail that a well-functioning team leader manages to balance the control and nurture functions, thereby scoring high on the synergy dimension.

Interestingly, this corresponds with the perception that an essential part of a leader’s job is to fill or bring to the team whatever functions are needed to accommodate the team’s needs (Zaccaro et al., 2001). McGrath (1962) describes the latter as the key assertion of the functional approach of leadership. The optimal course of leadership action is therefore contingent on the internal and external situation. It induces that instead of taking a normative approach, which defines one universal solution (e.g. Katzenbach & Smith, 1993), leadership is regarded with a more dynamic and continuous perspective (McGrath, Arrow, & Berdahl, 2000) - hereby tightly intertwined with the leader’s situational interpretation (Heldal & Antonsen, 2014). For instance, one would expect team leadership to be affected by environmental contingencies such as an increase in the team’s level of stress and/or the presence of uncertainty.

Hannah, Uhl-Bien, Avolio, and Cavarretta (2009) report that researchers have failed in the mission to reach a common understanding of what constitutes effective leadership in stressful and uncertain contexts. Bigley and Roberts (2001) propose to counter complexity and volatility in the task environment with highly bureaucratic team structures. Indeed, when facing stress and turbulent conditions some team members appreciate their leaders to taking an authoritative and instructive leadership style (Krabberød, 2014). It is human nature to favour predictability (Schein, 2006), and an authoritative leader may under such circumstances function as an anxiety reducer (Krabberød, 2014). Zander and Butler (2010) problematize, however, that this supposed favourability of single leadership is really just a lack of knowledge that there exists other

leadership styles. Sjøvold (2007) even asserts that such “one-person, one-functional role”-groups will not survive for long in complex and risky environments. Rather, he suggests that the leadership function should be a shared responsibility among the team’s members. In that way, the whole group can be activated in keeping an eye on the external world, in monitoring the situation and in exerting corrective measures if necessary.

It follows that such teams become specialized in learning from the outside world, as well as creating new knowledge themselves, thereby allowing them to readily capitalize on opportunities as they unfold. Stålsett, Olsen, and Sjøvold (in press) label these *innovative teams*, herein defined as “teams that are capable of interacting in a way that enables them to use technology in new ways, even during complex situations enhanced by mental pressure and uncertainty”. Danielsen (2012) exemplifies Special Operation Forces (SOF) teams as units that thrive under uncertainty and complexity, with capabilities that resemble those of innovative teams. The SOF soldiers are imprinted with the idea that changes and unexpected situations are the norm, and that chaos could be both destructive and lead to new opportunities. The outcome of chaos is, in turn, contingent on leadership, and whether leadership is performed in a way that empowers the team to utilize existing and new knowledge to create innovative solutions.

STRUCTURES OF SOCIAL INTERACTION AND COLLECTIVE PERCEPTIONS

Honest signals

Several voices highlight the importance of the capacity to make fast and instinctual choices based on the recognition of familiar cues in the internal and external environment (e.g. Kahneman, 2011; G. Klein, 1993; Simon, 1956). In a team setting, such intuition-based decision-making requires the ability to understand the social cues that propagate when our ancient reflexes for unconscious social coordination work in a dynamic interplay. Pentland (2008) defines these as *honest signals*,

and proposes that they form an additional and unexplored layer of the communication process. The basic idea is that these signals are so expensive and hard to fake that they become integrated into our behavioural repertoire - they have even been found to be effective in poorly lit and noisy environments (Pentland, 2008). It follows that honest signals become reliable predictors of human action, and in a team perspective this essentially indicates how advanced teams are able to coordinate their actions implicitly and non-verbally.

Curhan and Pentland (2007) explain that honest signals can be derived from fine-grained analyses of body movement patterns, and the timing, energy, and variability of speech. They emphasize four types: first, *engagement*¹ refers to the amount of control one person has on the other's behaviour; second, *mimicry* relates to the reflexive copying of one person by another during a conversation; third, *activity* is represented by the energy and time spent in a conversation; and finally, *consistency* is measured by the extent of variability in speech prosody and activity levels. It is important to emphasize that in real-life situations people employ a combination of these signals, rather than using them individually, and that they may have different meanings across different contexts. Researchers of honest signals must therefore be able to evaluate them in light of their social contexts.

However, Pentland (2008) also emphasizes that there are some generalities. For example, he asserts that the level of activity correlates with a team's level of productivity, and highly active groups are more productive than their counterparts. In most of their studies, Pentland and his colleagues have used speaking time as a measure of activity; a factor that has also been found to correlate with the dimension of individual influence (Mast, 2002; Stein & Heller, 1979). Another generality is the understanding that empathetic people are more likely to mimic their conversational partners,

which, in turn, could lead to *emotional contagion* (see Hatfield, Cacioppo, & Rapson, 1994) and higher trust levels in a team (Pentland, 2008). The significance of mimicry should therefore not be neglected, as trust is a prerequisite for the development of advanced group dynamics (Sjøvold, 2006, 2014b). Another important predictor of teamwork is the level of consistency in a team. In fact, the higher consistency in a team member's speech prosody and activity, the more mentally focused and task-oriented he/she is (Pentland, 2008). On the contrary, high variability indicates openness to influence and input from others. Naturally, variability in consistency could also ensue from the amounts of conflicting external and internal cues that emanate during turbulent and uncertain situations.

In fact, during chaotic conditions, Driskell, Salas, and Johnston (1999) argue that the arousal and information overload leads to a narrowing of team perspective as the attention becomes restricted to the most central or salient task cues, thus leading team members to disregard their teammates' social cues (or honest signals). This illustrates the importance of drill to the extent that task work becomes automatic, thereby freeing the mental resources needed in order for team members to take notice of their teammates' honest signals. The latter is a distinct characteristic of Special Operation Forces (SOF) operators, which has led Tucker and Lamb (2007) to name them as "quiet professionals". As these teams encounter situations where they are unable to use verbal communication, they have to rely on body language to move quietly, fast and determinedly to solve their missions. In their education, SOF soldiers therefore have to learn a professional body language, a *habitus* (Mauss, 1973) or *hexis* (Bourdieu, 1990), which becomes part of their individual practice. It follows that it is neither the physical strength nor size that make SOF soldiers frightening, but rather their mental focus and awareness (Simons, 1997).

¹ Pentland (2008) has later exchanged *engagement* with *influence*, but for the purpose of this discussion we use the former in order to avoid confusion with the term "influence" used in the Spin theory of groups.

In that way modern warfare is not only a matter of who has the most sophisticated technology, but also about who is mentally superior.

Shared mental models

Shared mental models (SMM) is a concept that has evolved from studies on individual mental models, and is defined as “team members’ shared, organized understanding and mental representation of knowledge about key elements of the team’s relevant environment” (Mohammed & Dumville, 2001, p. 97). As with honest signals, one of the purported benefits of SMMs are that they help team members predict their teammates’ future needs and actions, and resultantly facilitate the team’s coordinating mechanisms (Jonker, van Riemsdijk, & Vermeulen, 2011). In consequence, the potential for detrimental misunderstandings lowers, which allows the team to adapt more rapidly and instinctual to changing circumstances. In sum, this has led a growing body of research to advance the concept of SMMs as an underlying mechanism of effective team processes and team performance (e.g. Bolstad & Endsley, 1999; Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000); and it has even been found to be important for learning, communication, and safety (Eid, Helge Johnsen, Bartone, & Nissestad, 2008; Espevik, 2011; Espevik, Johnsen, Eid, & Thayer, 2006).

Yet, it is important to note that a complete overlap in team members’ mental models is not favourable. Indeed, accurate replications of mental models across all members in a team could reduce the team’s availability of alternative solutions and strategies, which, in turn, would entail decreased adaptability (Kozlowski, Gully, Nason, & Smith, 1999). Moreover, accurate mental models could lead to the emergence of groupthink, which Janis (1972) asserts is a potential consequence when team members are similar in background. Salas, Sims, et al. (2005) therefore suggest that team members should merely hold a sufficient level of similarity in their mental models so that the members are focused on the same team goals. From this it is inferred that team members

display reciprocal respect, understanding, and simultaneously show that they are inquisitive about the different perceptions and proclivities of their teammates. The acceptance of teammates’ dissimilar ways of viewing the world, could subsequently spark fruitful discussions and lead to learning opportunities and innovation.

The significance of developing SMMs, however, is also dependent on the context and the nature of the task. In fact, Marks, Zaccaro, and Mathieu (2000) found that SMMs are stronger predictors of team performance in novel than in routine environments. This is due to the fact that they could enhance a team’s coordination when performing complex, unpredictable, urgent, and/or novel tasks. As a team experiences an increase in stress levels, the amount of explicit communication tend to decrease, thereby forcing team members to rely on the use of implicit coordination work (Espevik et al., 2006; Kleinman & Serfaty, 1989; Orasanu & Salas, 1993). Such an implicit coordinated execution of tasks, however, is hard to accomplish and will be moderated by a range of factors. For example, Espevik et al. (2006) posit that this process is facilitated by SMMs, which they argue is a capacity that follows from team members’ knowledge of their teammates. They arrive at this proposition following empirical research of submarine attack crews, in which the intact teams outperformed those that were newly established. A logical implication is that if development of SMMs is a desired goal, keeping teams intact during training and operation is a necessity. Focusing through the lens of the Spin theory this may even prove particularly salient, as SMMs are considered a distinctive characteristic of a team operating with advanced group dynamics. Generally, the rationale is then that the propagation of honest signals builds the foundation for how team members perceive and understand each other, which in turn, creates the foundation for a collective cognitive environment of SMMs.

METHOD

Using an *embedded, single-case study* design (Yin, 2014) involving the Royal Norwegian Naval Academy (RNoNA), we undertook investigations using both qualitative and quantitative methods.

Participants

This study involved a total of 6 teams at the RNoNA. Four of the teams comprised 3 1st year cadets (age range = 20 - 27), whereas the remaining 2 comprised 5 experienced Officers with up to 20 years of prior military service (age range = 24 - 44). The participants included both female (F = 3) and male (M = 19) personnel. RNoNA staff functioned as instructors, subject matter experts (SMEs), and educators during the exercises. The SMEs were all Officers in the Norwegian Navy, with military ranks ranging from Sub Lieutenant to Commander.

Case Description

The empirical evidence in this article stems from the investigations undertaken during the simulation exercises *Aden* and *Carey*, which were performed at the RNoNA in November 2014 and January 2015, respectively. The exercise *Aden* involved the 5-people teams, whereas the 3-people teams participated in *Carey*. It should be noted, that in these simulations, military ranks are irrelevant. Both exercises are similar in that they represent scenarios set out in complex maritime environments. However, they differ in their missions and constraints. Whereas *Aden* is a modern and realistic anti-piracy scenario played out in the Gulf of Aden with high levels of sophisticated technology, *Carey* is based on actual historical events from World War II in the North Sea, which limits the level of technology available to the teams. The *Aden* scenario is an overt operation, in which one would expect to find similar communication, coordination and cooperation levels to what are found in modern naval military operations. *Carey*, on the other hand, is a covert operation where detection-avoidance is essential, thus restricting the intergroup communication. Notably, *Aden*, unlike *Carey*, is also

constrained by political influences, rules of engagement, and international regulations. The *Aden* simulation lasted for 1 hour and 20 minutes, and the duration of the *Carey* simulation was 2 hours and 30 minutes.

Both exercises were run as a *controlled free-play* (Mjelde & Smith, 2013). *Controlled* implies that the assignment has a pre-set framework, which includes a main mission, sub-missions, orders, intelligence reports, time schedules and a command & control hierarchy. On the other hand, *free-play* relates to the extensive leeway participants are given to execute their tasks based upon self-interpretation of their missions and current circumstances. A major implication of controlled free-play is that a blueprint of what represents a success or a failure is non-existent.

Data Collection

Observation. We observed three days of full lectures, including pre- and debriefs, as well as scheduled breaks. We focused solely on observing the 6 aforementioned teams, although it should be noted that several other teams were involved in the exercises at the same time. The observations were not designed as assessments in themselves. Rather, they were seen as a step towards achieving a more elaborate understanding of the work of the teams, as well as of the purpose of the simulations.

SPGR. The quantitative data were gathered using the Systematizing the Person-Group Relationship (SPGR) instrument (response rate = 95%), which is an operationalization of Sjøvold's Spin theory. It is a validated method for analysing team dynamics (Sjøvold, 2002). The present study is based on self and peer ratings using the standard SPGR 24-item behaviour scale, in which each item asks the respondent to provide ratings according to whether a specific behaviour *never or seldom occurred* (1), *sometimes* (2), or *often or always* (3). The scale has a well-documented construct and predictive validity (Sjøvold, 2002).

SPGR is founded on a factor analytical space comprising three dimensions: Control-Nurture

(C-N), Opposition-Dependence (O-D), and Withdrawal-Synergy (W-S). Whereas the pairs of the first two dimensions represent the basic group functions, the pairs of the third dimension serve as an indicator of the level of sophistication in the team's dynamics. As the basic group functions are supported by a distinct set of behaviours, respondents' ratings, on average, yield a snapshot of a group's most predominant behaviour. Moreover, the members' ratings of themselves and their peers illustrate how they view each other's mental models by displaying how often they notice a certain behaviour (Sjøvold, 1995). The SPGR instrument constitutes a set of analyses that are extracted from more fine-grained analyses of the social fields, patterns of polarization and group typology (Sjøvold & Park, 2007), and allows the researcher to map a group's dynamics.

SPGR-analysis. In this study the discussion revolves around the application of the Average Field analysis, which is an efficient feedback measure when investigating group dynamics (Sjøvold & Park, 2007). The SPGR field analyses are presented on a template composed of three sectors. Behaviours that support the "Control" group function are plotted in the upper sector, behaviours supporting "Nurture" in the bottom right, and finally, behaviours supporting "Opposition" are plotted in the bottom left sector. Individual members are presented as circles of different sizes and colours. The size of the circle illustrates a team member's influence in the group, whereas the colour indicates a person's predominant display of behaviours that support the different group functions. A yellow circle indicates that the team member displays a balanced spectrum of behaviours; a blue circle indicates task-oriented and analytical behaviour; a green circle indicates friendly, informal, open, and democratic behaviour; red indicates an intolerance for control and authorities; a light grey circle indicates cautious and obedient behaviour; and finally, dark grey, small circles in the red sector indicates a person that is perceived as resigned and uninterested in the team as a whole.

The Euclidian distance between the circles displays the relational closeness between different team members. As such, the field analysis displays the presence of subgroups, and thus polarizations in the team. It should further be noted that the Average Field analysis displays each individual respondent's rating as dotted circles. Thus, the wider the clustering of dotted circles, the more different the team members' mental models. Finally, the colours in the periphery delimit sectors of behaviour that hold vital importance for a team's interplay. First, the yellow border encapsulates an area that supports constructive and goal-oriented teamwork; second, the light grey border indicates behaviour that is sometimes necessary, but in excessive amounts is damaging for the team; and finally, the dark grey border indicates behaviour that restricts constructive teamwork.

Sociometric Badges. We collected additional data by equipping the participants in the study with sociometric badges; devices that capture and characterize team interactions through fine-scaled data of speech patterns, body movement, face-to-face interactions, and measure individual and collective patterns of human behaviour (Kim et al., 2012; Olguin et al., 2009; Pentland, 2008, 2012). The sociometric badge is carried around the neck like an identification badge and collects precise real-time data in a highly efficient manner. In sum, four types of signals are captured. First, radio sensors detect physical proximity between badge wearers. Second, infrared (IR) sensors measure whether two badge wearers are facing each other. Third, the badges capture speech features without recording conversational content, thereby ensuring participant privacy. Fourth, an accelerometer measures the energy levels of the badge wearer. Participants were briefed about the purpose and technical features of the sociometric badge prior to the exercises, as they had not previously been acquainted with this technology. In total, we collected 43.3 hours of data (an average of 1.97 hours per participant). Subsequently, the data was imported into software, in which the results could be imported to a spread-sheet for further analyses.

Sociometric data analysis. The sociometric data tries to understand people in the context of their social network and not as isolated individuals (Pentland, 2008). An analysis of sociometrics should therefore be comparative in design, and in the current study we compare both intragroup and intergroup figures. The data obtained from the sociometric badges may serve as the basis for a number of different analyses, and even though the teams are small, the data generated are big. Indeed, as big data

analyses must be based on the use of induction in discovery mode, one has to develop a clear-cut strategy to identify what data is purposeful and the ways to examine it (Kozlowski et al., in press). Our line of attack was to select a set of representative measures that we argued reflect relevant theory, and that we believed we could draw meaningful inductive inferences from, for the given research setting. These are presented in Table 1 below.

Table 1: Overview of sociometric data measures and their descriptions

Honest Signals	Description
Engagement	
Number of turns	The total number of turns taken by this badge, whether the turn is taken after another speaker or is a self-turn.
Successful interruption	The total number of successful interruptions made by the badge wearer.
Speech overlap	The amount of seconds each badge wearer was speaking at the same time as someone else.
Mimicry	
Bodymovement (BM) mirroring*	A value of how similar one badge's <i>Activity (BM)</i> data series is to another badge's <i>Activity (BM)</i> data series over time.
Audio volume mirroring*	A value of how similar one badge's <i>Activity (volume)</i> data series is to another badge's <i>Activity (volume)</i> data series over time.
Activity	
Speaking time	The amount of seconds the badge wearer was speaking, and no one else was speaking.
Consistency	
Consistency speech volume**	A value of the consistency of each badge's front audio amplitude, as measured in <i>Activity (volume)</i> .

*The values range from 0 to 1, where 0 indicates no similarity and 1 indicates the two data series are identical

**The values range from 0 to 1, where 1 indicates no changes in speech amplitudes, and 0 indicates the maximum amount of variation in speech amplitudes

RESULTS

The SPGR- and sociometric data from the Carey and Aden simulation exercises are shown in Figure 1 and Tables 2 and 3.

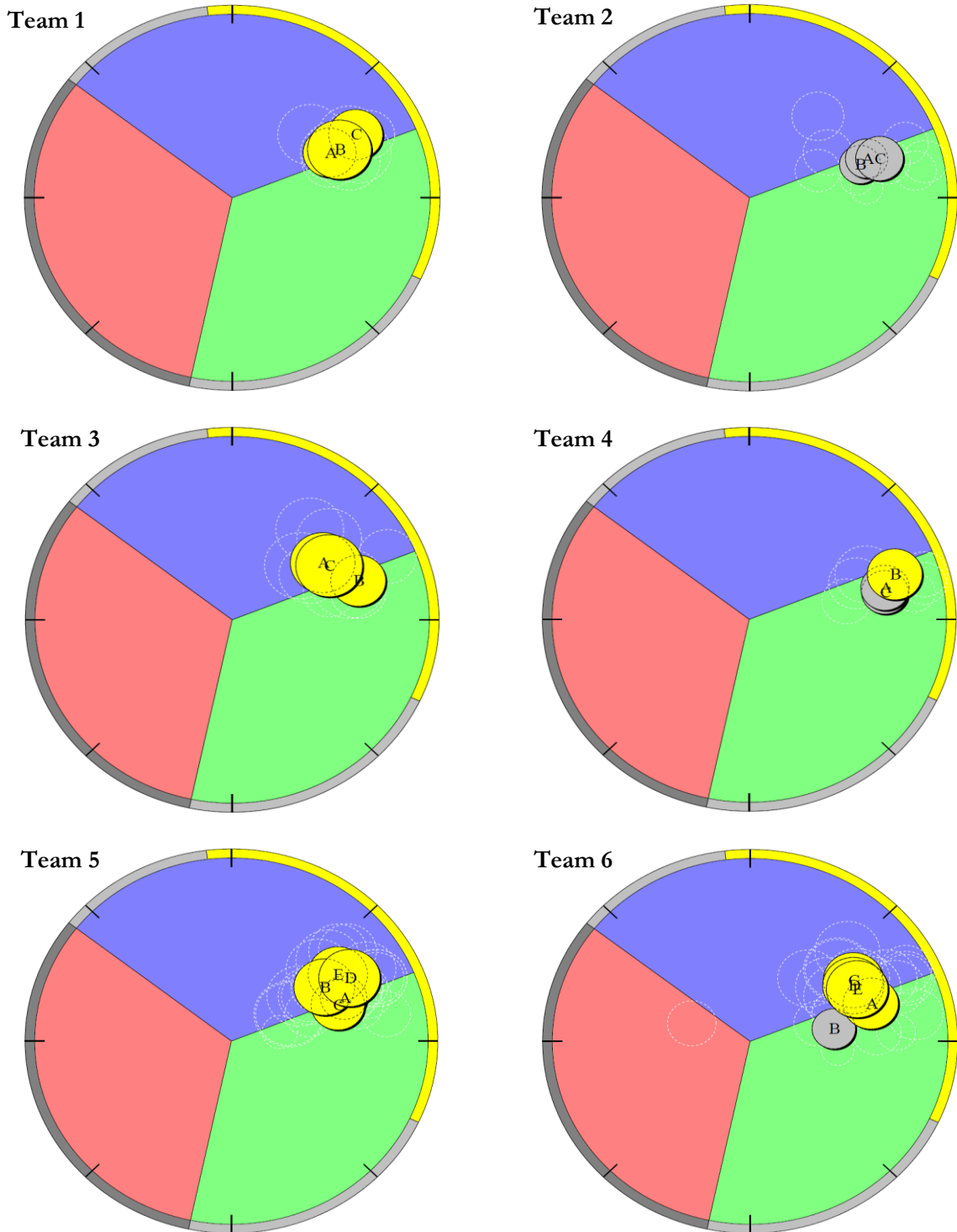


Figure 1: SPGR - Field Diagrams of teams participating in the exercises Carey (Team 1-4) and Aden (Team 5-6)

Table 2: Sociometric data figures for the teams participating in the Carey exercise

Engagement	Team 1			Team 2			Team 3			Team 4		
	A	B	C	A	B	C	A	B	C	A	B	C
Number of turns*	1475	1208	2112	2661	1890	2464	1639	1793	2053	3286	2962	3318
Successful interruptions	199 (11%)	147 (7%)	202 (5%)	602 (6%)	284 (7%)	439 (5%)	590 (5%)	677 (7%)	775 (6%)	806 (7%)	680 (6%)	996 (7%)
Speech overlap	272.7	287.3	298.4	389.3	181.7	420.6	629	642.1	791.4	669.9	671.8	564
Mimicry												
Bodymovement mirroring	0.238 (B)	0.254 (A)	0.219 (A)	0.234 (B)	0.190 (A)	0.212 (A)	0.220 (B)	0.236 (A)	0.238 (A)	0.213 (B)	0.250 (A)	0.203 (A)
Audio volume mirroring	0.222 (C)	0.224 (C)	0.233 (B)	0.210 (C)	0.205 (C)	0.201 (B)	0.210 (C)	0.205 (C)	0.205 (B)	0.218 (C)	0.230 (C)	0.226 (B)
Activity	0.221 (B)	0.166 (A)	0.174 (A)	0.160 (B)	0.161 (A)	0.153 (A)	0.152 (B)	0.169 (A)	0.176 (A)	0.226 (B)	0.181 (A)	0.233 (A)
Speaking time (fraction)	0.170 (C)	0.166 (C)	0.222 (B)	0.211 (C)	0.147 (C)	0.146 (B)	0.169 (C)	0.149 (C)	0.232 (B)	0.172 (C)	0.165 (C)	0.260 (B)
Consistency	1533 (27%)	1824 (32%)	2307 (41%)	1743 (36%)	999 (21%)	1921 (41%)	3050 (37%)	2102 (25%)	3167 (38%)	2488 (37%)	2338 (35%)	1841 (28%)
Consistency speech volume	0.847	0.805	0.639	0.738	0.804	0.717	0.581	0.722	0.655	0.633	0.654	0.822

*Including self-turns

Table 3: Sociometric data figures for the teams participating in the Aden exercise

Engagement	Team 5					Team 6				
	A	B	C	D	E	A	B	C	D	E
Number of turns*	2099	3318	2594	2479	2625	1460	793	919	1258	1174
Successful interruptions	1118 (7%)	1035 (4%)	1262 (6%)	1345 (7%)	1128 (5%)	395 (4%)	357 (9%)	329 (5%)	448 (6%)	465 (7%)
Speech overlap	659.4	903	921.4	850.5	748.3	501.9	336.2	463.8	475.9	611
Mimicry										
Bodymovement mirroring	0.236 (B)	0.233 (A)	0.225 (A)	0.237 (A)	0.228 (A)	0.217 (B)	0.218 (A)	0.224 (A)	0.239 (A)	0.236 (A)
Audio volume mirroring	0.222 (C)	0.223 (C)	0.233 (B)	0.244 (B)	0.225 (B)	0.217 (C)	0.224 (C)	0.217 (B)	0.224 (B)	0.230 (B)
Activity	0.223 (D)	0.232 (D)	0.238 (D)	0.238 (C)	0.226 (C)	0.238 (D)	0.232 (D)	0.231 (D)	0.232 (C)	0.228 (C)
Speaking time (fraction)	0.225 (B)	0.234 (B)	0.223 (B)	0.233 (B)	0.229 (D)	0.234 (B)	0.225 (B)	0.221 (B)	0.235 (B)	0.254 (D)
Consistency	0.218 (B)	0.172 (A)	0.156 (A)	0.231 (A)	0.163 (A)	0.148 (B)	0.176 (A)	0.196 (A)	0.172 (A)	0.153 (A)
Consistency speech volume	0.192 (C)	0.174 (C)	0.256 (B)	0.226 (B)	0.186 (B)	0.145 (C)	0.145 (C)	0.142 (B)	0.147 (B)	0.159 (B)
*Including self-turns	0.152 (D)	0.173 (D)	0.151 (D)	0.218 (C)	0.167 (C)	0.168 (D)	0.152 (D)	0.146 (D)	0.150 (C)	0.144 (C)
	0.163 (B)	0.186 (B)	0.170 (B)	0.156 (B)	0.177 (D)	0.167 (B)	0.150 (B)	0.138 (B)	0.165 (B)	0.169 (D)
	902 (15%)	1449 (23%)	1367 (22%)	1279 (21%)	1193 (19%)	765 (18%)	633 (15%)	677 (16%)	964 (23%)	1152 (27%)
	0.686	0.369	0.497	0.584	0.615	0.780	0.676	0.756	0.587	0.419

*Including self-turns

SPGR - Carey Simulation

Team 1. The team shows an inclination to display balanced behaviour between control and nurture functions, and the relational closeness between team members shows that there are no subgroups. All team members exhibit synergistic behaviour and a willingness to support goal-oriented and constructive teamwork. The influence is distributed equally between Person A and C, while Person B has a much larger influence than that of his/hers teammates. Finally, the team members' mental models are similar, but given that the group merely comprises three individuals there is potential for further improvement.

Team 2. The team shows a preponderance of behaviours supporting the nurture function, but also to some extent the control function. Further, there are no apparent subgroups, and all team members are displayed as light grey circles, indicating that they are rated as cautious and obedient. As a group, the individual members are considered to support goal-oriented and constructive teamwork. The influence levels are similar for A and B, whilst Person C holds the most dominant position. Team members' mental models diverge, especially considering the small size of the team.

Team 3. The individual team members show a tendency to display behaviours that support the control function, but to a varying extent also the nurture function. Moreover, the relational closeness between team members illustrates that there are no apparent subgroups. All individuals display synergistic behaviour, as well as a willingness to support constructive and goal-oriented teamwork, yet the influence levels vary with persons A and C being the most influential. Person B has the lowest degree of influence in the group. Finally, for a group of three people, the differences in mental models are considerable.

Team 4. The team shows an inclination to display behaviour that supports the nurture function, but Person B also displays behaviour that supports the control function. There are no apparent subgroups in the team, which

indicates that the team works as a cohesive whole. The latter also relates to the team's way of performing goal-oriented and constructive teamwork. Person B is rated as synergistic, whilst the two others are seen as obedient and cautious team players. Moreover, the influence varies with team member B occupying the most influential position, and persons A and C having a more similar degree of influence. Lastly, the team members' mental models are different.

Comparative analysis. All the teams display a preponderance of behaviour that supports either the control or nurture functions. Team 1 is the team that to the largest extent is capable of balancing these two functions, whereas Teams 2 and 4 tend to mostly fill the nurture function, and Team 3 the control function. Moreover, there are no teams that show any signs of existing subgroups. In two of the teams (Team 1 and Team 3), all members are rated as synergistic, whereas Team 2 is the only team where all members are rated as cautious and obedient. In terms of the current level of teamwork, all teams are able to be constructive and goal-oriented. However, there are differences in how able the teams are to activate the opposition function. With its close proximity to the periphery, Team 4 seems to be the least capable of doing so. The degree of influence in the different teams varies to a great extent with the special cases being Team 2 for its low degree across all members, and Team 3 for its high degrees. Finally, the teams are widely different in the extent by which the team members' mental models diverge. Team 1's mental models are the most aligned, whereas Team 2's are the least similar.

SPGR - Aden Simulation

Team 5. The team displays an ability to balance the control and nurture functions, but with a stronger inclination towards the control function. There is no apparent presence of subgroups. All individuals are rated as synergistic, and the individual members support constructive and goal-oriented teamwork. The influence varies across team members, with Person D, B, and E as the most dominant individuals, respectively. Team members A and

C are by far the least influential. Finally, for a team of five people, the team members' understanding of the team processes is considerably different.

Team 6. The team exhibits behaviours that support the control and nurture functions, and there are no indications of existing subgroups. All team members, except Person B, are rated as synergistic. Person B is viewed by his/her team members as a cautious and obedient team player, and he/she is also the team member who occupies the least influential position in the group. Moreover, Person A has a low degree of influence compared to the rest of the team members, with Persons E, D, and C, respectively, seen as the most dominant players. There are significant differences in team members' mental models, with one rating even suggesting that one of the team members for the most part supports the opposition function.

Comparative analysis. Both teams tend to display behaviour that balances the control and nurture functions, and there are no apparent subgroups in either team. Moreover, in both teams, four of the five members are rated as synergistic, whereas the last members are rated as cautious and obedient. The teamwork is constructive and goal-oriented in both Team 5 and Team 6, and the influence levels are similar in both teams. In fact, the three most influential members of both teams have equal degrees of influence. However, the least influential team member, both teams taken into account, is found in Team 6. Finally, the two teams diverge in the similarity of their team members' mental models. Team 5 has a higher level of SMMs than Team 6.

Sociometrics - Carey Simulation

Team 1. Person C far surpasses his teammates in the total number of turns taken (2112), and he/she also has the most successful interruptions (202), yet the ratio of successful to attempted interruptions (52%) is the lowest in the team. Person B has the highest success rate of successful interruptions (73%). The interval of speech overlap ranges from 272.7 to 298.4 seconds, which indicates that the team

members speak at the same time in a nearly equal amount. In terms of bodymovement, Person B is being mirrored the most by his/hers teammates. However, in terms of audio, B is mirrored the least, whereas C is mirrored the most. Further, Person B mirrors his/hers teammates with considerable amounts in terms of both bodymovement and audio. Moreover, team member A has the lowest amount of speaking time (27%). Person C has the most speaking time with 41% of the total amount. The consistency levels show that Person C has the lowest speech volume consistency (0.639), whereas Person A has the highest (0.847).

Team 2. Team member A has the largest number of turns (2661) and successful interruptions (602), whereas Person C has the longest speech overlap (420.6). The speech overlap differs significantly, with Person A and C exceeding Person B's figure with more than 100%. Moreover, B has the lowest scores in all engagement-measures; however, he/she has the highest rate of successful interruptions (76%). In terms of mimicry, A is the most mirrored in total both in terms of bodymovement and audio volume. On the other hand, Person B mirrors his/her teammates the most in bodymovement, whereas C mirrors his/her teammates most in audio. Regarding activity levels, B has the lowest figure of speaking time (21%). Person C has the most speaking time (41%), but exceeding Person A's score by a mere 5%. Person B has the highest consistency score in speech volume (0.804).

Team 3. Person A has the lowest numbers for all engagement measures, including the success ratio of interruptions (59%). Contrarily, C has the highest figures for total number of turns (2053), successful interruptions (775) and speech overlap (791.4), albeit Person B has the highest interruption success ratio (75%). In terms of both bodymovement and audio volume mirroring, C is being mirrored the most. Person A mirrors his/her teammates the most in bodymovement, whilst B mirrors his/her teammates the most in audio volume. Activity figures single out B for having the least speaking time (25%), whereas

the numbers for speaking time are quite similar for A (37%) and C (38%). Finally, consistency levels show that Person B has the highest speech volume consistency (0.722), whereas A has the lowest figure (0.581).

Team 4. Team member C has the highest figures in both total number of turns (3318) and successful interruptions (996), whereas Person A (669.9) and B (671.8) have the longest speech overlap. The success ratio of interruptions has a small range from 66% (Person B) to 73% (Person A). In terms of mimicry levels, B is mirrored the most in bodymovement, whilst team member C is mirrored the most in audio volume. On the other hand, A mirrors his/her teammates the most in bodymovement and B in audio volume. Moreover, the activity levels range from 28% (Person C) to 37% (Person A) in total speaking time. Finally, consistency figures show that Person C (0.822) has a much higher score in speech volume consistency than both A (0.633) and B (0.654).

Comparative analysis. Regarding the engagement measures, Team 4 has significantly higher figures for all members in total number of turns than the other teams, and also a higher average number of successful interruptions. Team 3 has the longest speech overlap, whereas, Team 1, on average, has the lowest figures for all engagement measures. In terms of average mimicry values, Team 4 has high numbers for both bodymovement (0.224) and audio mirroring (0.206), yet Team 1 has the highest figure in bodymovement (0.232). Team 2 has the lowest mirroring values for both measurements (0.208 and 0.163, respectively). The activity levels show that Team 3 has the longest speaking time, both in total and on average. Team 3 has the lowest consistency in speech volume. On the other hand, Team 1 has the highest speech volume consistency.

Sociometrics - Aden Simulation

Team 5. The engagement figures highlight Person B for his/hers highest total number of turns (3318), yet lowest score in success ratio of interruptions (40%), which is 36% less than Person D's score. Person D has both the

highest number of successful interruptions (1345) and the highest success ratio of interruptions (76%). The speech overlap numbers emphasize team member A for his/her low figure (659.4) relative to Person C (921.4), who has the highest score. In terms of mimicry numbers, Person D is the most mirrored both in bodymovement and audio volume. On the other hand, Person B is the team member who mirrors his/hers teammates the most in both mimicry measurements. Moreover, the total speaking time ranges from 19% (E) - 23% (B) between four members of the team, whilst team member A (15%) is singled out for having a low score. With respect to consistency figures, Person B has the lowest speech volume consistency (0.369). Person A has the highest speech volume consistency (0.686).

Team 6. Team member B has the lowest or second lowest scores on all engagement measures - 793, 357, and 336.2, respectively. However, he/she also has the highest success ratio of interruptions with 90%. Person A has the highest number of turns (1460), yet the lowest success ratio of interruptions (44%). Moreover, Person E has the most successful interruptions (465) and by far the longest speech overlap (611). Regarding mimicry, E is being the most mirrored in bodymovement, whereas Person D is being the most mirrored in audio volume. Both A and D mirror their teammates with high scores relative to the rest of the group for both mimicry measures. The activity figures emphasize team member E's high score (27%) and Person B's (15%) relatively low score. Furthermore, Person A has the highest speech volume consistency (0.780), whilst team member E has the lowest score (0.419).

Comparative analysis. For all three engagement measures, Team 5 has larger values than Team 6 - both in extreme and average values. In terms of mimicry, Team 5 has higher average values in both bodymovement (0.230) and audio volume (0.184) than Team 6 (0.229 and 0.157, respectively). Moreover, the activity scores illustrate that the average speaking time of the team members in Team 6 is 30% less

than that of Team 5. With respect to consistency figures, Team 6 has larger speech volume consistencies than Team 5 - both in extreme and average values.

DISCUSSION

We have illustrated how two widely different assessment tools can be utilized to derive insights on team process phenomena. Both revealed significant intergroup variations in terms of interaction patterns, social role structures, mental models, and leadership perspectives. Evaluated in light of the differences across the four cadet teams, this is particularly surprising, as they had undergone the same training and education prior to the simulations. As such, it emphasizes the importance of being able to provide teams with idiosyncratic feedback, so that they can be made aware of their current strengths and weaknesses, and thereby allow for appropriate actions. The salience of this is readily apparent, as a group must continuously align its group dynamics with the context in order to capitalize on opportunities in the external environment and develop innovative solutions to unforeseen problems.

So what did the SPGR-data really reveal?

The SPGR analyses illustrated that all the teams supported the control and/or nurture functions, however, there were clear differences across the investigated teams of the degree to which they balanced these functions. Furthermore, it is interesting to note that the teams' preponderance to fill certain functional role corresponded with that of the most influential member. One might therefore infer that dominant members have the capacity to alter the behaviour of the entire group. In fact, this has already been proven by empirical research, which uncovered that when influence is unequally shared among team members, the social role structure tends to freeze (Sjøvold, 2007). Thus, a logical conclusion from the SPGR analyses is that all the teams would benefit from a levelling of the influential power in the group, as this was unequally distributed. Subsequently, it would allow them to furnish a more flexible social role structure.

Flexibility is also contingent on the individual capacity to display synergistic behaviour (Sjøvold, 2006). As the analysed sample showed that several of the team members were rated to exhibit a more restricted range of behaviours, this is an additional issue that the teams should try to overcome. It is likely that the inflexibility in behavioural patterns ensues from the human preference of performing the functional role one is the most comfortable with; yet team development results from alterations in the social role structure (Mills, 1984). Sjøvold (2014b) thus asserts that team members must be willing to step out of their comfort zones in order to employ a more advanced set of group dynamics. On the other hand, the analyses still indicated that all teams were capable of constructive and goal-oriented performance. Moreover, the relational closeness between team members showed no signs of existing subgroups, and thereby latent conflicts. The question is, however, to what extent these teams would be able to adapt if the circumstances unexpectedly changed. Based on the apparent dependency on certain influential figures, and the sub optimality in the social role structures, one would assume that most of the teams would have a low degree of adaptability. Observational notes taken in situ strengthen this assumption. For example, when faced with increasing stress levels one team engaged in friendly fire, and another team ran its ship aground.

In part, we attribute these mistakes to team members' misinterpretations of external and internal cues, and a lack of collective situational awareness. However, given that the SPGR analyses did not illustrate a presence of SMMs, there is also reason to believe that the teams suffered from coordination overhead and unclear communication as the level of mental stress increased. In such situations, Driskell et al. (1999) argue that it is common that the team perspective is narrowed making coordination work difficult as team members restrict their attention to the most salient task cues. It has even been proven that mental models that diverge could inhibit a team's coordination. It follows that the differences in mental models found in the investigated teams, could indicate

that they would struggle under real-life military operations. Yet again, this points to the crucial part played by assessment tools, as the SPGR-instrument, in shedding light on needed points of improvement.

What about the sociometric data?

The engagement measures illustrated great differences both across team members and groups. According to Curhan and Pentland (2007), engagement refers to the level of impact a team member has on the conversational turn taking. The variations in the figures may therefore deduce that there were large individual dissimilarities in the power a certain team member had on the information flow during the exercises, and it would be reasonable to assume that this correlates with the distribution of decision-making power. If the teams had established a culture of shared leadership, one would have expected more equal figures, albeit the intergroup variations also imply that some teams had come closer to this achievement.

If all team members contribute in the decision-making process, Pentland (2008) further argues that the team will furnish high levels of mimicry, which, in turn, will strengthen the feeling of reciprocal trust between team members and lead to emotional contagion. Moreover, he explains that if you mimic someone, they are likely to mimic you as well, making the process of mimicry a mutually reinforcing effect. Hence, it would be reasonable to assume that mimicry figures would be similar in a team. In the studied sample, this suggestion is supported as the scores were placed within a interval of approximately 0.1, thereby occupying a mere 10% of the mimicry value range (0-1). Moreover, it is notable that the mimicry figures are similar in value for all the teams investigated.

The activity figures, however, are considerably different. Generally, Pentland (2008) emphasizes that a high activity level in a group is beneficial, as active groups are more productive than the sum of its individual parts. On the other hand, he asserts that inactive

groups are no more effective than having their team members provide their individual contributions. From the data in the current study, one could therefore infer that the researched teams issue widely different degrees of productive teamwork. At the same time, one should address the intragroup differences in activity levels. Some researchers have pointed out that speaking time has a strong correlation with individual power in a group (e.g. Mast, 2002; Stein & Heller, 1979), which based on the findings would strengthen the assumption that all the teams, though to a varying extent, had struggled to incorporate a shared leadership style.

Moreover, there were apparent variations in the consistency of speech volume across team members. In general, the variability in consistency correlates with individual openness to input from others, whereas high consistency points to a perception of mental determination and focus on task (Pentland, 2008). One should, however, also acknowledge that variations in consistency could be a natural consequence of stressful and chaotic situations, which emphasizes that precaution should be taken when drawing conclusions about consistency levels. Still, it is interesting to note that the two 5-people teams had a lower consistency in speech volume than that of all the 3-people teams. Perhaps this is an indication that the members of the 5-people teams had a stronger focus on their team's interactions, whilst the 3-people teams were preoccupied with solving the tasks. If so, we find it reasonable to attribute this to the fact that the 5-people teams benefited from more prior experience with teamwork.

Overall, the sociometric badge data supported the SPGR-analyses in that the investigated teams have stark dissimilarities in their group dynamics. Whether the sociometric measures applied in the present study, alone, give a complete apprehension of the current functioning of the different teams, however, is another matter. The inference drawn from this work is that although the sociometric badge enables capturing of detailed team interaction contents, it is a qualitatively inadequate source

of data. Rather, it should be celebrated for its potential to quantitatively substantiate insights gained from other methodological approaches.

IMPLICATIONS AND CONCLUSIVE REMARKS

The emergence of new technology and modernized methodological approaches continues to invigorate team process research, and is increasingly pushing more attention towards the concept of process dynamics. This is crucial, as our knowledge of team process phenomena have been largely affected by our inclination to treat them as static concepts, even though they are inherently dynamic in nature. As it stands, we know little about team processes, as their dynamics are essentially understudied (Cronin et al., 2011; Kozlowski, in press; Kozlowski & Bell, 2003). However, this long lasting inertia in the team effectiveness literature is finally about to be challenged. The newfound opportunities of big data capturing can help advance the research frontier of dynamics, and may well demolish the need for costly psychologists and observers to analyse human interaction. Managers and practitioners should be aware, though, that this kind of technology is more likely to function as a supplement to other methodological approaches, such as traditional surveying, in order to yield a holistic picture of team interaction. If we adopt such a complete apprehension of how a group functions in a given context, it would lead to substantial theoretical, as well as practical implications.

LIMITATIONS OF STUDY

We acknowledge that there are certain limitations to our research design, and that these impact on the implications and conclusions that can be deduced from the findings. As this study is first and foremost methodological in nature, so are the limitations. A few of these relate to the use of the SPGR-instrument, which due to its subjective and retrospective structure has potential for biases. These include selective memory, social desirability bias, and lack of in-depth information. The biases may in part ensue from

the extensive use of the tool during the educational program at the RNoNA, which could make memory effects more profound. Nevertheless, the SPGR is a validated method (Sjøvold, 2007), and is considered a complete assessment tool to measure group dynamics.

Moreover, there are limitations to the use of sociometric badges. One is that there are no measures of construct validity (Curhan & Pentland, 2007), however, as we were present to observe the simulations we could, to some extent, ascertain that the badges measured what was intended. Another challenge was related to the shift of focus from a self-report survey to behavioural observations, as we were no longer provided the answers we were seeking directly. Indeed, if you want to investigate the phenomenon of power you could include questions on the topic directly in a survey, yet analysing sociometrics meant that we had to determine what particular behaviours reflected power. We were also aware that certain behaviours might have different meanings across various contexts, which made the interpretation of sociometric data more difficult. In studies like this, one must therefore find ways of integrating context into the interpretations of results. To some degree we were able to address this issue due to our presence during the simulations and knowledge about the case, which enabled us to analyse and interpret the sociometric data in light of actual events and the tenets of RNoNA's educational program. In general, however, we believe that interviews and other qualitative data may be necessary to assess how differences across contexts affect sociometric data findings.

The newness of the sociometric badge represented a more surprising and unexpected challenge. In fact, as this methodological tool is yet to be widely tapped, we could not find any studies applying the sociometric badge in similar contexts. This, in turn, meant that prior research could not help confirm our findings. Actually, we find it surprising that Pentland and his colleagues have yet to study teams in more complex contexts. In particular as increased complexity entails that teams are even more reliant on advancing their team process

dynamics. Further, we argue that these researchers' sole focus on predictable environments have, albeit unintentionally, led to negligence of the group dimension of opposition, described as team member's capacity and willingness to criticize and challenge the status quo (Sjøvold, 2014b). This is, indeed, an essential function to facilitate team development, and should thereby be devoted attention.

DIRECTIONS FOR FUTURE RESEARCH

From our outlook, the limitations in this study also highlight possibilities for future research. First and foremost, they highlighted a significant challenge related to the use of sociometric badges, in that one would have to determine what behaviours reflect a particular dimension in a given context. We therefore assert that the sociometric badge, unlike the SPGR-instrument, could not be seen as an approach to evaluate group dynamics by itself, yet it is considered as a highly purposeful way to facilitate and support other research methodologies. In particular, as it allows for objective, real-time data, this could pave the way for instantaneous feedback systems. At the same time, it is intriguing to note that it could help overcome the classical problems of subjectivity and memory-effects associated with questionnaire-based measurement and interviews, and thereby provide a more realistic picture of team process phenomena.

As we analysed the SPGR data in the current study, it became evident that it would be fruitful to support this methodological tool with sociometric data. In fact, during our analyses we observed what we argue are several apparent linkages in the results yielded from the two approaches. For example, there seems to be a strong correlation between speaking time in the sociometric data and the influence scores in the SPGR. Indeed, if we look at Team 6, Person B has the lowest influence in the SPGR and the least speaking time in the sociometric data. On the other hand, Person E has the most dominant position in the SPGR and the most speaking time. Moreover, if we look at

Team 2, the SPGR reflects a team operating with a restricted interaction pattern, which Sjøvold (2006) explains is a common characterization of unsophisticated group dynamics. Similarly, the sociometric data points to a perception of a low activity level and a relatively high consistency. Pentland (2008) sees this as a group with highly task-oriented individuals who do not produce more than what their individual contributions would entail; i.e. underdeveloped group dynamics.

In general, we also hypothesize that there could be a correlation between the SPGR-dimension of influence and the sociometric measure of successful interruptions, and that this may be linked to the opposition function in the SPGR framework. Furthermore, the measure of unsuccessful interruptions could point to a perception of low influence. On the other hand, this may in other cases simply illustrate that the person performs a nurturing role by uttering verbalizations like "OK", "yes", "right", as well as non-lexical vocalizations such as "mm-hmm", to support and give confirmation to their teammates during interaction episodes. In order to verify or falsify these hypotheses, however, one would have to investigate a large number of groups, which perform their work in identical contexts. This emphasizes that future research should devote considerable effort into compiling large pools of data – a research foundation – that provides descriptive information and guides specification of big data-analyses. The integration of traditional survey-approaches with big data-technology, such as sociometric badges, could facilitate this process enormously; and this article may well be seen as a first step towards this achievement. In the future we hope that the research community will further the advancements of such an approach, with the purpose of adopting a more holistic understanding of team process dynamics and how they relate to context.

REFERENCES

- Avolio, B. J. (2007). Promoting more integrative strategies for leadership theory-building. *American Psychologist*, 62(1), 25.
- Bales, R. F. (1985). The new field theory in social psychology. *International Journal of Small Group Research*, 1(1), 1-18.
- Bales, R. F. (1999). *Social interaction systems : theory and measurement*. New Brunswick, N.J. ; London: Transaction Publishers.
- Bigley, G. A., & Roberts, K. H. (2001). The Incident Command System: High-Reliability Organizing for Complex and Volatile Task Environments. *The Academy of Management Journal*, 44(6), 1281-1299. doi: 10.2307/3069401
- Blake, R., & Mouton, J. (1964). *The Managerial Grid*. Houston, TX: Gulf.
- Bolstad, C. A., & Endsley, M. R. (1999). *Shared mental models and shared displays: An empirical evaluation of team performance*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.
- Bourdieu, P. (1990). *The logic of practice*. Stanford University Press.
- Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecedent conditions and performance. *Academy of Management Journal*, 50(5), 1217-1234.
- Cronin, M. A., Weingart, L. R., & Todorova, G. (2011). Dynamics in groups: Are we there yet? *The Academy of Management Annals*, 5(1), 571-612.
- Curhan, J. R., & Pentland, A. (2007). Thin slices of negotiation: Predicting outcomes from conversational dynamics within the first 5 minutes. *Journal of applied psychology*, 92(3), 802-811. doi: 10.1037/0021-9010.92.3.802
- Danielsen, T. (2012). "Hos oss sitter kulturen i hjertet" - en antropologisk studie av kultur i Marinejegerkommandoen. FFI-Rapport 2012/00516.
- Driskell, J. E., Salas, E., & Johnston, J. (1999). Does stress lead to a loss of team perspective? *Group Dynamics: Theory, Research, and Practice*, 3(4), 291-302.
- Edmondson, A. C. (2012). Teamwork On the Fly: How to master the new art of teaming. *Harvard Business Review*.
- Eid, J., Helge Johnsen, B., Bartone, P. T., & Nissestad, O. A. (2008). Growing transformational leaders: exploring the role of personality hardiness. *Leadership & Organization Development Journal*, 29(1), 4-23.
- Espevik, R. (2011). "Expert teams: Do Shared mental Models make a difference?". (Doctoral thesis), Universitetet i Bergen.
- Espevik, R., Johnsen, B. H., Eid, J., & Thayer, J. F. (2006). Shared mental models and operational effectiveness: Effects on performance and team processes in submarine attack teams. *Military Psychology*, 18(Suppl), 23-36.
- Flin, R., & Patey, R. (2009). Improving patient safety through training in non-technical skills. *BMJ*, 339.
- Hannah, S. T., Uhl-Bien, M., Avolio, B. J., & Cavarretta, F. L. (2009). A framework for examining leadership in extreme contexts. *The Leadership Quarterly*, 20(6), 897-919.
- Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1994). *Emotional Contagion*. Cambridge University Press.
- Heldal, F., & Antonsen, S. (2014). Team Leadership in a High-Risk Organization: The Role of Contextual Factors. *Small Group Research*. doi: 10.1177/1046496414533617
- Hogan, R. (2007). *Personality and the fate of organizations*. Mahwah, NJ, US:

-
- Lawrence Erlbaum Associates Publishers.
- Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMO models. *Annu. Rev. Psychol.*, *56*, 517-543.
- Janis, I. L. (1972). *Victims of groupthink: A psychological study of foreign-policy decisions and fiascoes*. Oxford, England: Houghton Mifflin.
- Jonker, C. M., van Riemsdijk, M. B., & Vermeulen, B. (2011). Shared mental models: A Conceptual Analysis *Coordination, Organizations, Institutions, and Norms in Agent Systems VI* (pp. 132-151): Springer.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.
- Kaiser, R. B., Hogan, R., & Craig, S. B. (2008). Leadership and the fate of organizations. *American Psychologist*, *63*(2), 96-110. doi: 10.1037/0003-066X.63.2.96
- Katzenbach, J. R., & Smith, D. K. (1993). *The discipline of teams* (Vol. 71): Harvard Business Press.
- Kim, T., McFee, E., Olguin, D. O., Waber, B., & Pentland, A. (2012). Sociometric badges: Using sensor technology to capture new forms of collaboration. *Journal of Organizational Behavior*, *33*(3), 412-427. doi: 10.1002/job.1776
- Klein, C., DiazGranados, D., Salas, E., Le, H., Burke, C. S., Lyons, R., & Goodwin, G. F. (2009). Does team building work? *Small Group Research*, *40*(2), 181-222.
- Klein, G. (1993). A recognition-primed decision (RPD) model of rapid decision making. In G. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods* (pp. 138-147). Norwood, New Jersey: Ablex Publishing Corporation.
- Kleinman, D. L., & Serfaty, D. (1989). *Team performance assessment in distributed decision making*. Paper presented at the Proceedings from the Symposium on Interactive Network Simulation for Training Conference, Orlando, FL: Naval Training System Center.
- Kozlowski, S. W. J. (in press). Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations *Organizational Psychology Review*.
- Kozlowski, S. W. J., & Bell, B. S. (2003). Work groups and teams in organizations. *Handbook of psychology*.
- Kozlowski, S. W. J., Chao, G. T., Chang, C.-H., & Fernandez, R. (in press). Team dynamics: Using "big data" to advance the science of team effectiveness In S. Tonidandel, E. King & J. Cortina (Eds.), *Big data at work: The data science revolution and organizational psychology*. New York: NY: Routledge Academic.
- Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulaokos (Eds.), *The changing nature of performance: Implications for staffing, motivation, and development* (pp. 240-292). San Francisco: Jossey-Bass.
- Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the Effectiveness of Work Groups and Teams. *Psychological Science in the Public Interest*, *7*(3), 77-124. doi: 10.1111/j.1529-1006.2006.00030.x
- Kozlowski, S. W. J., Watola, D. J., Jensen, J. M., Kim, B. H., & Botero, I. C. (2009). Developing adaptive teams: a theory of dynamic team leadership. *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches*, 113-155.
- Krabberød, T. (2014). Task uncertainty and mission command in a naval context. *Small Group Research*, 1046496414532955.
-

- Langton, C. G. (1989). *Artificial life*: Addison-Wesley Publishing Company Redwood City, CA.
- Lewin, K. (1951). *Field theory in social science: selected theoretical papers*: Harper.
- Lim, B. C., & Klein, K. J. (2006). Team mental models and team performance: a field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior*, 27(4), 403-418.
- Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of applied psychology*, 85(6), 971.
- Mast, M. S. (2002). Dominance as Expressed and Inferred Through Speaking Time. *Human communication research*, 28(3), 420-450. doi: 10.1111/j.1468-2958.2002.tb00814.x
- Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of applied psychology*, 85(2), 273.
- Mauss, M. (1973). Techniques of the body*. *Economy and society*, 2(1), 70-88.
- McGrath, J. E. (1962). Leadership behavior: Some requirements for leadership training: Washington, DC: US Civil Service Commission.
- McGrath, J. E. (1964). *Social psychology: A brief introduction*: Holt, Rinehart and Winston.
- McGrath, J. E., Arrow, H., & Berdahl, J. L. (2000). The Study of Groups: Past, Present, and Future. *Personality and Social Psychology Review*, 4(1), 95-105. doi: 10.1207/s15327957pspr0401_8
- Mills, T. M. (1984). *The sociology of small groups*: Prentice-Hall.
- Mjelde, F. V., & Smith, K. (2013). *Performance Assessment of Military Team-Training for Resilience in Complex Maritime Environments*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.
- Mohammed, S., & Dumville, B. C. (2001). Team mental models in a team knowledge framework: expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior*, 22(2), 89-106. doi: 10.1002/job.86
- Nordhaug, O., & Brandi, S. (2004). *Strategisk kompetanseledelse: teori og praksis*. Oslo: Universitetsforl.
- Olguin, D. O., Waber, B. N., Taemie, K., Mohan, A., Ara, K., & Pentland, A. (2009). Sensible Organizations: Technology and Methodology for Automatically Measuring Organizational Behavior. *Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on*, 39(1), 43-55. doi: 10.1109/TSMCB.2008.2006638
- Orasanu, J., & Salas, E. (1993). Team decision making in complex environments. In G. A. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods*. Norwood: Ablex Publishing.
- Parker, S. H., Yule, S., Flin, R., & McKinley, A. (2012). Surgeons' leadership in the operating room: an observational study. *The American Journal of Surgery*, 204(3), 347-354.
- Pentland, A. (2008). *Honest signals* (T. Heibeck Ed.): MIT press Cambridge, MA.
- Pentland, A. (2012). The new science of building great teams. *Harvard Business Review*, 90(4), 60-69. doi: citeulike-article-id:10606943
- Salas, E., Rozell, D., Mullen, B., & Driskell, J. E. (1999). The Effect of Team Building on Performance An Integration. *Small Group Research*, 30(3), 309-329.

-
- Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a “big five” in teamwork? *Small Group Research*, 36(5), 555-599.
- Salas, E., Stagl, K. C., & Burke, C. S. (2005). 25 Years of Team Effectiveness in Organizations: Research Themes and Emerging Needs *International Review of Industrial and Organizational Psychology 2004* (pp. 47-91): John Wiley & Sons, Ltd.
- Schein, E. H. (2006). *Organizational Culture and Leadership* (3 ed.). San Francisco: Jossey Bass.
- Simmel, G. (1955). *Conflict and the web of intergroup affiliations*. New York: Free Press.
- Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, 63(2), 129-138.
- Simons, A. (1997). *The company they keep life inside the US Army Special Forces*: Free Press New York.
- Sjøvold, E. (1995). *Groups in harmony and tension: the development of an analysis of polarization in groups and organizations based on the SYMLOG method*. (Doctoral dissertation), NTNU, Trondheim, Norway.
- Sjøvold, E. (2002). *The SPGR manual*. Trondheim: Endre Sjøvold AS Forlag.
- Sjøvold, E. (2006). *Teamet: Utvikling, effektivitet og endring i grupper*. Oslo: Universitetsforlaget.
- Sjøvold, E. (2007). Systematizing Person-Group Relations (SPGR) A Field Theory of Social Interaction. *Small Group Research*, 38(5), 615-635.
- Sjøvold, E. (2014a). Introduction to the special issue leadership and the group. *Small Group Research*, 45(4), 367-375.
- Sjøvold, E. (2014b). *Resultater igjennom team*. Oslo: Universitetsforlaget.
- Sjøvold, E., & Park, J. H. (2007). The “Systematizing Person-Group Relation (SPGR)” Method and its Application. A Study of Culture-based Differences in Team Dynamics Team Dynamics. *Korean Journal of Social and Personality Psychology*, 21(1), 19-34.
- Stein, R. T., & Heller, T. (1979). An empirical analysis of the correlations between leadership status and participation rates reported in the literature. *Journal of Personality and Social Psychology*, 37(11), 1993.
- Stogdill, R. M., & Bass, B. M. (1981). *Stogdill's handbook of leadership: a survey of theory and research*. New York: Free Press.
- Stålsett, K., Olsen, T. R., & Sjøvold, E. (in press). Team Leadership within Integrated Operations in the Oil and Gas Industry.
- Tucker, D., & Lamb, C. J. (2007). *United States Special Operations Forces*: Columbia University Press.
- Yin, R. K. (2014). *Case study research: design and methods*. Los Angeles, Calif.: SAGE.
- Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2001). Team leadership. *The Leadership Quarterly*, 12(4), 451-483.
- Zander, L., & Butler, C. L. (2010). Leadership modes: Success strategies for multicultural teams. *Scandinavian Journal of Management*, 26(3), 258-267.
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CONCLUSIVE REMARKS

We have demonstrated that even over a relatively short time span, a team can face significant changes in its inner workings. Moreover, we have illustrated that there exists more than one way to unpack a team's dynamics. Why researchers continue to treat them as static constructs in empirical research is therefore considered a mystery. We argue that now is the time to acknowledge that the IPO-framework should be challenged as the primary model to evaluate teamwork. It will still have utility of course, however, researchers should learn to acknowledge that its negligence of the dynamic nature of team processes has decelerated the advancements in the team effectiveness literature for almost half a century. The advent of new and improved methodologies to capture group dynamics should therefore be celebrated, yet as many of these are in an early stage, more research is required to ensure their validity. If researchers continue on this path, it will result in a more advanced and nuanced understanding of team-related issues, and the theoretical, as well as practical implications, will be profound.

COMPLETE LIST OF REFERENCES

- Avolio, B. J. (2007). Promoting more integrative strategies for leadership theory-building. *American Psychologist*, 62(1), 25.
- Avolio, B. J., Reichard, R. J., Hannah, S. T., Walumbwa, F. O., & Chan, A. (2009). A meta-analytic review of leadership impact research: Experimental and quasi-experimental studies. *The Leadership Quarterly*, 20(5), 764-784.
- Bales, R. F. (1985). The new field theory in social psychology. *International Journal of Small Group Research*, 1(1), 1-18.
- Bales, R. F. (1999). *Social interaction systems : theory and measurement*. New Brunswick, N.J. ; London: Transaction Publishers.
- Bales, R. F., Cohen, S. P., & Williamson, S. A. (1979). *SYMLOG: A system for the multiple level observation of groups*. New York, NY: Free Press.
- Ben-Ari, E. (1998). *Mastering soldiers: Conflict, emotions, and the enemy in an Israeli military unit* (Vol. 10): Berghahn Books.
- Bigley, G. A., & Roberts, K. H. (2001). The Incident Command System: High-Reliability Organizing for Complex and Volatile Task Environments. *The Academy of Management Journal*, 44(6), 1281-1299. doi: 10.2307/3069401
- Bion, W. R. (1961). *Experiences in groups: And other papers*. New York, NY: Basic Books.
- Blake, R., & Mouton, J. (1964). *The Managerial Grid*. Houston, TX: Gulf.
- Bolstad, C. A., & Endsley, M. R. (1999). *Shared mental models and shared displays: An empirical evaluation of team performance*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.
- Bourdieu, P. (1990). *The logic of practice*. Stanford University Press.
- Brannick, M. T., Salas, E., & Prince, C. W. (1997). *Team performance assessment and measurement: Theory, methods, and applications*: Psychology Press.
- Broom, A. (2005). Medical specialists' accounts of the impact of the Internet on the doctor/patient relationship. *Health*, 9(3), 319-338.
- Burgess, H., & Burgess, G. (1996). Constructive confrontation: A transformative approach to intractable conflicts. *Mediation Quarterly*, 13(4), 305-322. doi: 10.1002/crq.3900130407
- Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecedent conditions and performance. *Academy of Management Journal*, 50(5), 1217-1234.
- Cartwright, D., & Zander, A. F. (1968). *Group dynamics: research and theory*: Harper & Row.
- Collins, D. B., & Holton, E. F. (2004). The effectiveness of managerial leadership development programs: A meta-analysis of studies from 1982 to 2001. *Human resource development quarterly*, 15(2), 217-248.
- Cronin, M. A., Weingart, L. R., & Todorova, G. (2011). Dynamics in groups: Are we there yet? *The Academy of Management Annals*, 5(1), 571-612.
- Csikszentmihalyi, M. (1975). Play and intrinsic rewards. *Journal of Humanistic Psychology*, 15(3), 41-63.
- Curhan, J. R., & Pentland, A. (2007). Thin slices of negotiation: Predicting outcomes from conversational dynamics within the first 5 minutes. *Journal of applied psychology*, 92(3), 802-811. doi: 10.1037/0021-9010.92.3.802
- Danielsen, T. (2012). "Hos oss sitter kulturen i hjertet" - en antropologisk studie av kultur i Marinejegerkommandoen. FFI-Rapport 2012/00516.
- Danielsen, T. (in press). Making Warriors in the Global Era: An anthropological study of institutional apprenticeship: selection, training, education, and everyday life in the Norwegian Naval Special Operations Commando.
- Delise, L. A., Gorman, A. C., Brooks, A. M., Rentsch, J. R., & Steele-Johnson, D. (2010). The

- effects of team training on team outcomes: A meta-analysis. *Performance Improvement Quarterly*, 22(4), 53-80. doi: 10.1002/piq.20068
- Driskell, J. E., Salas, E., & Johnston, J. (1999). Does stress lead to a loss of team perspective? *Group Dynamics: Theory, Research, and Practice*, 3(4), 291-302.
- Eckes, G. (2002). *Six Sigma Team Dynamics: The Elusive Key to Project Success*: Wiley.
- Edmondson, A. C. (2012). *Teaming: How Organizations Learn, Innovate, and Compete in the Knowledge Economy*. San Francisco: Jossey-Bass.
- Edmondson, A. C. (2012). Teamwork On the Fly: How to master the new art of teaming. *Harvard Business Review*.
- Eid, J., Helge Johnsen, B., Bartone, P. T., & Nissestad, O. A. (2008). Growing transformational leaders: exploring the role of personality hardiness. *Leadership & Organization Development Journal*, 29(1), 4-23.
- Espevik, R. (2011). "Expert teams: Do Shared mental Models make a difference?". (Doctoral thesis), Universitetet i Bergen.
- Espevik, R., Johnsen, B. H., Eid, J., & Thayer, J. F. (2006). Shared mental models and operational effectiveness: Effects on performance and team processes in submarine attack teams. *Military Psychology*, 18(Suppl), 23-36.
- Flin, R., & Patey, R. (2009). Improving patient safety through training in non-technical skills. *BMJ*, 339.
- Foster, R. E., & Fletcher, J. D. (2013). Toward training transformation. *Military Psychology*, 25(3), 308-317. doi: 10.1037/h0094971
- Gibb, C. A. (1954). Leadership. In G. Lindzey (Ed.), *Handbook of social psychology* (Vol. 2). Reading, MA: Addison-Wesley.
- Grossman, D. (1995). *On Killing: The Psychological Cost of Learning to Kill in War and Society*: Little, Brown.
- Hannah, S. T., Uhl-Bien, M., Avolio, B. J., & Cavarretta, F. L. (2009). A framework for examining leadership in extreme contexts. *The Leadership Quarterly*, 20(6), 897-919.
- Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1994). *Emotional Contagion*: Cambridge University Press.
- Heldal, F., & Antonsen, S. (2014). Team Leadership in a High-Risk Organization: The Role of Contextual Factors. *Small Group Research*. doi: 10.1177/1046496414533617
- Hogan, R. (2007). *Personality and the fate of organizations*. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.
- Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annu. Rev. Psychol.*, 56, 517-543.
- Janis, I. L. (1972). *Victims of groupthink: A psychological study of foreign-policy decisions and fiascoes*. Oxford, England: Houghton Mifflin.
- Johnson-Laird, P. N. (1986). *Mental models*: Harvard University Press.
- Jonker, C. M., van Riemsdijk, M. B., & Vermeulen, B. (2011). Shared mental models: A Conceptual Analysis *Coordination, Organizations, Institutions, and Norms in Agent Systems VI* (pp. 132-151): Springer.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.
- Kaiser, R. B., Hogan, R., & Craig, S. B. (2008). Leadership and the fate of organizations. *American Psychologist*, 63(2), 96-110. doi: 10.1037/0003-066X.63.2.96
- Katzenbach, J. R., & Smith, D. K. (1993). *The discipline of teams* (Vol. 71): Harvard Business Press.
- Kim, T., McFee, E., Olguin, D. O., Waber, B., & Pentland, A. (2012). Sociometric badges: Using sensor technology to capture new forms of collaboration. *Journal of Organizational Behavior*, 33(3), 412-427. doi: 10.1002/job.1776
- Klein, C., DiazGranados, D., Salas, E., Le, H., Burke, C. S., Lyons, R., & Goodwin, G. F. (2009). Does team building work? *Small Group Research*, 40(2), 181-222.

- Klein, G. (1993). A recognition-primed decision (RPD) model of rapid decision making. In G. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods* (pp. 138-147). Norwood, New Jersey: Ablex Publishing Corporation.
- Kleinman, D. L., & Serfaty, D. (1989). *Team performance assessment in distributed decision making*. Paper presented at the Proceedings from the Symposium on Interactive Network Simulation for Training Conference, Orlando, FL: Naval Training System Center.
- Kozlowski, S. W. J. (in press). Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations *Organizational Psychology Review*.
- Kozlowski, S. W. J., & Bell, B. S. (2003). Work groups and teams in organizations. *Handbook of psychology*.
- Kozlowski, S. W. J., Chao, G. T., Chang, C.-H., & Fernandez, R. (in press). Team dynamics: Using "big data" to advance the science of team effectiveness In S. Tonidandel, E. King & J. Cortina (Eds.), *Big data at work: The data science revolution and organizational psychology*. New York: NY: Routledge Academic.
- Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulaokos (Eds.), *The changing nature of performance: Implications for staffing, motivation, and development* (pp. 240-292). San Francisco: Jossey-Bass.
- Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the Effectiveness of Work Groups and Teams. *Psychological Science in the Public Interest*, 7(3), 77-124. doi: 10.1111/j.1529-1006.2006.00030.x
- Kozlowski, S. W. J., Watola, D. J., Jensen, J. M., Kim, B. H., & Botero, I. C. (2009). Developing adaptive teams: a theory of dynamic team leadership. *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches*, 113-155.
- Krabberød, T. (2014). Task uncertainty and mission command in a naval context. *Small Group Research*, 1046496414532955.
- Langton, C. G. (1989). *Artificial life*: Addison-Wesley Publishing Company Redwood City, CA.
- Lewin, K. (1951). *Field theory in social science: selected theoretical papers*: Harper.
- Lim, B. C., & Klein, K. J. (2006). Team mental models and team performance: a field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior*, 27(4), 403-418.
- Lipsey, M. W., & Wilson, D. B. (1993). The efficacy of psychological, educational, and behavioral treatment: confirmation from meta-analysis. *American Psychologist*, 48(12), 1181.
- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26(3), 356-376.
- Marks, M. A., Zaccaro, S. J., & Mathieu, J. E. (2000). Performance implications of leader briefings and team-interaction training for team adaptation to novel environments. *Journal of applied psychology*, 85(6), 971.
- Mast, M. S. (2002). Dominance as Expressed and Inferred Through Speaking Time. *Human communication research*, 28(3), 420-450. doi: 10.1111/j.1468-2958.2002.tb00814.x
- Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of applied psychology*, 85(2), 273.
- Mauss, M. (1973). Techniques of the body*. *Economy and society*, 2(1), 70-88.
- McCracken, G. (1988). *The long interview*: SAGE Publications.
- McGrath, J. E. (1962). Leadership behavior: Some requirements for leadership training: Washington, DC: US Civil Service Commission.
- McGrath, J. E. (1964). *Social psychology: A brief introduction*: Holt, Rinehart and Winston.
- McGrath, J. E. (1991). Time, interaction, and performance (TIP) A Theory of Groups. *Small Group Research*, 22(2), 147-174.

- McGrath, J. E., Arrow, H., & Berdahl, J. L. (2000). The Study of Groups: Past, Present, and Future. *Personality and Social Psychology Review*, 4(1), 95-105. doi: 10.1207/s15327957pspr0401_8
- Mills, T. M. (1984). *The sociology of small groups*: Prentice-Hall.
- Mjelde, F. V., & Smith, K. (2013). *Performance Assessment of Military Team-Training for Resilience in Complex Maritime Environments*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting.
- Mohammed, S., & Dumville, B. C. (2001). Team mental models in a team knowledge framework: expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior*, 22(2), 89-106. doi: 10.1002/job.86
- Morgeson, F. P., DeRue, D. S., & Karam, E. P. (2010). Leadership in teams: A functional approach to understanding leadership structures and processes. *Journal of Management*, 36(1), 5-39.
- Morgeson, F. P., & Hofmann, D. A. (1999). The structure and function of collective constructs: Implications for multilevel research and theory development. *Academy of Management Review*, 24(2), 249-265.
- Morrison, E. (2010). OB in AMJ: What Is Hot and What Is Not? *Academy of Management Journal*, 53(5), 932-936. doi: 10.5465/amj.2010.54533166
- Nordhaug, O., & Brandi, S. (2004). *Strategisk kompetanseledelse: teori og praksis*. Oslo: Universitetsforl.
- Olguin, D. O., Waber, B. N., Taemie, K., Mohan, A., Ara, K., & Pentland, A. (2009). Sensible Organizations: Technology and Methodology for Automatically Measuring Organizational Behavior. *Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on*, 39(1), 43-55. doi: 10.1109/TSMCB.2008.2006638
- Orasanu, J., & Salas, E. (1993). Team decision making in complex environments. In G. A. Klein, J. Orasanu, R. Calderwood & C. E. Zsombok (Eds.), *Decision making in action: Models and methods*. Norwood: Ablex Publishing.
- Parker, S. H., Yule, S., Flin, R., & McKinley, A. (2012). Surgeons' leadership in the operating room: an observational study. *The American Journal of Surgery*, 204(3), 347-354.
- Parsons, T., Bales, R. F., & Shils, E. A. (1953). *Working Papers in the Theory of Action*: Free Press.
- Pentland, A. (2008). *Honest signals* (T. Heibeck Ed.): MIT press Cambridge, MA.
- Pentland, A. (2012). The new science of building great teams. *Harvard Business Review*, 90(4), 60-69. doi: citeulike-article-id:10606943
- Pentland, A. (2014). *Social Physics: How Good Ideas Spread-The Lessons from a New Science*: Penguin Publishing Group.
- Polanyi, M. (1966). *The Tacit Dimension*: Peter Smith.
- Sachdev, I., & Bourhis, R. Y. (1991). Power and status differentials in minority and majority group relations. *European Journal of Social Psychology*, 21(1), 1-24. doi: 10.1002/ejsp.2420210102
- Salas, E., & Cannon-Bowers, J. A. (2001). The science of training: A decade of progress. *Annual review of psychology*, 52(1), 471-499.
- Salas, E., Cannon-bowers, J. A., & Johnston, J. H. (1997). *How can you turn a team of experts into an expert team?: Emerging Training Strategies*.
- Salas, E., Goodwin, G. F., & Burke, C. S. (2008). *Team effectiveness in complex organizations: Cross-disciplinary perspectives and approaches*: Routledge.
- Salas, E., Rozell, D., Mullen, B., & Driskell, J. E. (1999). The Effect of Team Building on Performance An Integration. *Small Group Research*, 30(3), 309-329.
- Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a "big five" in teamwork? *Small Group Research*, 36(5), 555-599.
- Salas, E., Stagl, K. C., & Burke, C. S. (2005). 25 Years of Team Effectiveness in Organizations:

- Research Themes and Emerging Needs *International Review of Industrial and Organizational Psychology 2004* (pp. 47-91): John Wiley & Sons, Ltd.
- Schein, E. H. (2006). *Organizational Culture and Leadership* (3 ed.). San Francisco: Jossey Bass.
- Senor, D., & Singer, S. (2009). *Start-up Nation: The Story of Israel's Economic Miracle* McClelland & Stewart.
- Simmel, G. (1955). *Conflict and the web of intergroup affiliations*. New York: Free Press.
- Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, 63(2), 129-138.
- Simons, A. (1997). *The company they keep life inside the US Army Special Forces*: Free Press New York.
- Sjøvold, E. (1995). *Groups in harmony and tension: the development of an analysis of polarization in groups and organizations based on the SYMLOG method*. (Doctoral dissertation), NTNU, Trondheim, Norway.
- Sjøvold, E. (2002). *The SPGR manual*. Trondheim: Endre Sjøvold AS Forlag.
- Sjøvold, E. (2006). *Teamet: Utvikling, effektivitet og endring i grupper*. Oslo: Universitetsforlaget.
- Sjøvold, E. (2007). Systematizing Person-Group Relations (SPGR) A Field Theory of Social Interaction. *Small Group Research*, 38(5), 615-635.
- Sjøvold, E. (2014). Introduction to the special issue leadership and the group. *Small Group Research*, 45(4), 367-375.
- Sjøvold, E. (2014). *Resultater igjennom team*. Oslo: Universitetsforlaget.
- Sjøvold, E., & Park, J. H. (2007). The “Systematizing Person-Group Relation (SPGR)” Method and its Application. A Study of Culture-based Differences in Team Dynamics Team Dynamics. *Korean Journal of Social and Personality Psychology*, 21(1), 19-34.
- Smith, J. A., Flowers, P., & Larkin, M. (2009). *Interpretative phenomenological analysis: Theory, method and research*: Sage.
- Stein, R. T., & Heller, T. (1979). An empirical analysis of the correlations between leadership status and participation rates reported in the literature. *Journal of Personality and Social Psychology*, 37(11), 1993.
- Stogdill, R. M., & Bass, B. M. (1981). *Stogdill's handbook of leadership: a survey of theory and research*. New York: Free Press.
- Stålsett, K., Olsen, T. R., & Sjøvold, E. (in press). Team Leadership within Integrated Operations in the Oil and Gas Industry.
- Tucker, D., & Lamb, C. J. (2007). *United States Special Operations Forces*: Columbia University Press.
- Waber, B. N., Olguin Olguin, D., Kim, T., Mohan, A., Ara, K., & Pentland, A. (2007). Organizational engineering using sociometric badges. *Available at SSRN 1073342*.
- Wheen, F. (2005). *How mumbo-jumbo conquered the world: a short history of modern delusions*: PublicAffairs.
- Yin, R. K. (2014). *Case study research: design and methods*. Los Angeles, Calif.: SAGE.
- Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2001). Team leadership. *The Leadership Quarterly*, 12(4), 451-483.
- Zander, L., & Butler, C. L. (2010). Leadership modes: Success strategies for multicultural teams. *Scandinavian Journal of Management*, 26(3), 258-267.