PATTERNS OF TEAM INTERACTION UNDER ASYMMETRIC INFORMATION DISTRIBUTION CONDITIONS

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ABSTRACT

Over the last three decades, research on processing of asymmetrically distributed information in teams has been mostly dominated by studies in the hidden profile paradigm. Building on the groundbreaking studies by Stasser and Titus (1985, 1987), almost all studies in the hidden profile paradigm have been conducted under controlled experimental settings, with various design components closely following the original design by Stasser and Titus. In conducting the current research, I pursued two goals. First, I aimed to explore whether relaxing certain assumptions of the hidden profile would impact our understanding of team information processing. I designed my study so that participants did not develop any preferences before joining their team. Additionally, unlike the common design in the hidden profile studies, participants did not start with a clear list of alternatives; instead, they had to generate the alternatives as they progressed in the task. My second goal in conducting this research was to understand what behaviours and interaction patterns could lead to effective processing of asymmetrically distributed information in a team. Data were collected from 28 teams of MBA students who worked collaboratively on a problem-solving task in which information was asymmetrically distributed among team members. In addition to recording mentioning and repetition of shared and unshared pieces of information, building on a coding scheme developed by Scott Poole, I developed a coding scheme that captured information-oriented and solution-oriented behaviours of team members. I analysed the data using three techniques: analysis of aggregated coded behaviours, interaction pattern analysis, and phasic analysis. I found that even in the absence of initial preferences and a clear list of alternatives, team discussion is biased with shared information, with unshared information being mentioned and repeated significantly less than shared information. Furthermore, I found that compared with both average- and low-performing teams, high-performing teams tend to allocate a larger share of their discussion to information-oriented activities and less to solution-oriented activities. Additionally, the phasic analysis showed that low-performers, engaged in recurrent solution proposal and confirmation phases, suggesting that they engaged in alternative negotiation. Theoretical implications of these findings for team information processing and decision-making literatures are discussed.

In the memory of my father.

Dedicated to my mother and my best friend Hamid,

in gratitude for their unconditional love and boundless support.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

Organizations are increasingly relying on teams to make important decisions, believing that teams, compared with individuals, can make higher quality decisions (Brodbeck, Kerschreiter, Mojzisch, & Schulz-Hardt, 2007). This reliance on teams for decision making is based on the assumption that teams employ better decision-making strategies, have access to varied sources of information and make more informed, educated, and accurate decisions (Lavery, Franz, Winquist, & Larson, 1999; Lightle, Kagel, & Arkes, 2009). Although intuitively appealing, this assumption has been challenged.

In the last few decades, researchers have examined several team mechanisms that lead to process loss and ineffective decision making in teams (e.g. Bazerman, Giuliano, & Appelman, 1984; Janis, 1982; Steiner, 1972). The seminal study conducted by Stasser and Titus (1985) initiated a prominent line of research in this area, known as the hidden profile paradigm (Stasser, 1988). In the hidden profile studies, participants represent a decision-making committee in charge of evaluating available alternatives (e.g. job candidates) and choosing the best one. Information is distributed among members so that some information is known by all members (shared information) and some information is only available to one or two individuals in the team (unshared information). As a result of this asymmetric information distribution, no one person in the team has enough information to make an optimal decision and choose the best alternative. However, if members effectively pool the information available to the team and integrate it with their discussion, they will be able to make an informed decision and choose the best alternative. Stasser and Titus (1985, 1987) and almost all studies following their work in the hidden profile paradigm have consistently shown that teams often fail to effectively exchange and pool unique information distributed among members and consequently make suboptimal decisions. Not only do teams fail to communicate the unshared information, but also the communicated unshared information does not receive enough attention, its relevance is not recognized, and it is not effectively integrated with team discussion, resulting in a decision that is biased with shared information.

Over the last 25 years, researchers have examined this phenomenon from various perspectives and offered several explanations for the observed failure of teams in exchanging information and solving the hidden profiles. Almost all of these studies have been conducted under controlled experimental settings, with various components of the experimental setting closely following the original design by Stasser and Titus (1985). Adopting the same design has provided an opportunity for studies to build on previous research, resulting in development of a paradigm which offers a rich understanding of the phenomenon. Although this setting has highly contributed to our understanding of team decision making under the hidden profile setting, at the same time, it has imposed some limitations on the examination of team decision making under asymmetric information distribution. In particular, two components of the hidden profile studies are of interest in this research.

First, in the majority of the hidden profile studies, team members receive all the relevant information about the task and the alternatives in the beginning of the experiment and before meeting their team members (For an exception see Reimer, Reimer, & Hinsz, 2010b). Individuals are given enough time to review the information and tentatively decide the best alternative. Thus, when they meet their team members to decide which alternative to choose, they have formed an initial preference. This design is not congruent with the situation and context which most teams face in organizations. In many situations, teams do not receive the information before the discussion and information is presented to them in the meeting. In addition, even when the information is provided to team members in advance, individuals do not have enough time to review the information in order to form initial preferences and decide about their preferred course of action.

Second, teams in the hidden profile research start with a clearly defined problem and receive a list of alternatives among which they should choose the best option. Although this setting applies to certain organizational situations such as hiring committees, there are numerous other situations in which team members have to deal with asymmetrical information distribution but they do not have a menu of alternatives. Organizational setting is so dynamic and ambiguous that in most situations, teams do not have a clear list of alternatives and have to work together to generate possible alternatives.

Relaxing these two assumptions of the hidden profile paradigm, in this research, I explore the process of decision making under asymmetric information distribution in a broader context that is a better representation of real organizational situations in that individuals receive information in the team meeting, start with a problem and develop their alternatives as team discussion progresses. My general research question is: How do teams deal with asymmetric information distribution, effectively or ineffectively, when team members do not have any initial preferences and the team does not have a clear list of alternatives?

This dissertation is set out as follows. Chapter 2 presents an overview of the hidden profile literature and discusses the current study, the research gap that I set about to address, and the question driving this research. Chapter 3 details the research methodology, including a description of the simulation used for setting a decision-making situation characterized with asymmetric information distribution. Analysis and results are discussed in Chapter 4. In the last chapter, I discuss the theoretical contributions of this research, address study limitations, and offer guidelines for future research.

CHAPTER TWO: LITERATURE REVIEW AND THEORY DEVELOPMENT

The hidden profile paradigm started with groundbreaking studies conducted by Stasser and Titus (1985, 1987). In these studies, Stasser and Titus discovered that, when faced with a decision-making task, teams usually rely on their shared information (known to all members) and ignore most of the unshared information (known to only one member). The studies are structured such that failure to effectively pool knowledge available to the team results in a suboptimal decision. These studies inspired many scholars who attempted to understand the root cause of this problem and the contextual factors that would facilitate information sharing in decision-making teams. The majority of these studies are modeled after the early experiments designed by Stasser and Titus, and the abundance of these studies resulted in the formation of the "hidden profile paradigm".

In a classic hidden profile study, small teams (usually 3 to 6 members) of unacquainted undergraduate students take part in a decision-making task in which they decide among a set of pre-determined choices. For example, they may choose among candidates for student council president (Lightle et al., 2009; Stasser, Taylor, & Hanna, 1989; Stasser & Titus, 1985, 1987; Stasser, Vaughan, & Stewart, 2000; Stewart & Stasser, 1995), the suspects of a homicide investigation (Stasser & Stewart, 1992; Stasser, Stewart, & Wittenbaum, 1995; Stewart & Stasser, 1998), or faculty candidates to teach an introductory psychology course (Larson, Fosterfishman, & Keys, 1994).

Before meeting their team members, individuals receive an information sheet that provides some information about each choice, for example each job candidate or homicide suspect. The information provided to members of a team has some overlap (shared information) but each individual receives some unique information (unshared information) in addition to shared information. No one in the team has enough information to recognize the best candidate and make an optimal decision. In most studies, information is distributed so that critical clues that support the best alternative are unshared, and shared information focuses on negative characteristics of the best choice. In other words, the correct alternative is the one implied by unshared information that is not available to all individuals before their team discussion. Hence, individual participant information sheets are designed to lead team members to form a suboptimal preference. Reading these profiles and before starting any discussion with their team members, participants form an initial preference toward one of the candidates. Before meeting as a team, each individual reports his/her preferred choice and returns the information sheet to the researcher. Therefore, during the team discussion, members rely on memory and have no information at hand.

Stasser and Titus (1985, 1987), and almost all studies following their paradigm, have shown that these teams consistently fail to exchange and integrate information effectively and consequently conclude their discussion with a suboptimal decision. These findings led to a surge of research attempting to understand the processes that underlie these effects and contextual factors surrounding them. In the next section, I briefly describe theoretical explanations for the discussion bias in hidden profile tasks.

Theoretical Explanations for Discussion Bias in Hidden Profile

Table 1 provides an overview of the prominent explanations for the failure of teams to choose the best alternative and solve hidden profiles. The first two categories focus on the content of team discussion and the observation that teams tend to discuss shared information at the expense of unshared information. The third category offers a complementary argument that focuses on the process of decision making. Finally, the fourth category holds individual cognitive limitations accountable for the observed phenomenon.

Table 1

Overview of Theoretical Explanations for Discussion Bias in Hidden Profile

			Foundational Studies
Team-Level	Bias toward Shared Information	Probabilistic Sampling Advantage of Shared Information	Stasser (1992) Stasser and Titus (1987) Stasser, Taylor, & Hanna (1989)
		Social-Psychological Processes • Social Validation • Mutual Enhancement	Parks and Cowlin (1996) Larson, Foster-Fishman, & Keys (1994) Wittenbaum, Hubbell, and Zuckerman (1999)
	Premature Preference Negotiation		Gigone and Hastie (1993, 1997)
Individual-Level	Individual Preference Effect		Greitmeyer and Schulz-Hardt (2003) Faulmuller, Kerschreiter, Mojzisch, and Schulz-Hardt, (2010)

Bias toward Shared Information. A large number of studies that examine the content of team conversation have shown that team discussions are highly dominated by discussion of shared information at the expense of unshared information. Not only is shared information mentioned more than unshared information, but it is also more likely to be repeated once it is mentioned.

The collective information-sampling model (Stasser, 1992) mathematically demonstrates that team discussion is biased in favour of shared information merely because shared information has a higher chance of being mentioned. Assuming that information is being randomly sampled from team members' memories, shared information is more likely to be sampled because more members know this information. Accordingly, in contrast to unshared information that could be sampled from only one member's memory, shared information can be sampled from more members' minds. In other words, shared information is being mentioned more because it has a sampling advantage over unshared information.

While the collective information-sampling model focuses on explaining why shared information is more likely to be mentioned during the conversation, the social-psychological explanations, such as social validation (Parks & Cowlin, 1995) and mutual enhancement (Wittenbaum, Hubbell, & Zuckerman, 1999), attempt to explain why shared information is repeated more than unshared information. Social validation theory rests on the idea that team members are more willing to discuss shared information because this information can be socially validated. Individuals evaluate the information to be more valuable, relevant, and important when they realize that other team members possess the same information (Postmes, Spears, & Cihangir, 2001). Therefore, the communication of shared information leads to positive feelings for both the speaker and the listener. The listener feels positive because the speaker evaluated a piece of information in the listener's possession as valuable, important, and relevant enough to mention. The speaker, on the other hand, is evaluated as more competent because he/she contributed accurate and relevant information to the discussion. Receiving verbal and nonverbal (e.g. nodding) encouragement from team members leads to positive feelings of competence and task-related knowledge on the speaker's side. Thus, discussing shared information leads to team members developing positive evaluations of each others' competency, a process called *mutual enhancement* (Wittenbaum et al., 1999). In sum, social validation and mutual enhancement processes provide a theoretical explanation for why team members are more willing to discuss shared information.

Premature Preference Negotiation. Adopting a process-based perspective, Gigone and Hastie (1993, 1997) demonstrated that the impact of a piece of information on a team decision depends on the number of members who know that piece of information before the discussion. Referring to this observation as the common knowledge effect, Gigone and Hastie (1993, 1997) demonstrated that the more team members who were aware of a piece of information before team discussion, the higher the impact of that piece of information on team decisions. These researchers argued that the effect of shared information on team decisions is mediated by pre-discussion preferences and suggested that teams fail to solve hidden profiles because they focus on negotiating their pre-discussion preferences which are, by design, highly influenced by shared information (and not by unshared information). As mentioned before, hidden profile studies are usually designed so that individuals, before meeting their team members, form a suboptimal preference which is highly influenced by shared information. Therefore, if during the team discussion members discuss their preferences and try to reach a consensus, the final decision will be highly influenced by shared information.

Individual Preference Effect. Unlike previous theoretical explanations, this last category in Table 1 looks to individual cognition to unravel the hidden profile problem. Greitemeyer and Schulz-Hardt (2003) posited that individuals' evaluation of information is biased with their pre-discussion preference. They argued that individuals allocate more cognitive resources to preference-consistent information (information supporting their pre-discussion bias) and evaluate this information, compared with preference-inconsistent information, as more relevant and of higher quality. Due to this biased evaluation of information, exposure to unshared information during team discussion does not influence individual preferences, and team members stick to their initial preferences (Faulmuller, Kerschreiter, Mojzisch, & Schulz-Hardt, 2010) which are highly influenced by shared information.

In the next section, I discuss the current study, the research gap that I set about to address in this research, and the question that guided this endeavour.

The Current Study

As mentioned earlier, the majority of the studies that explored decision making under asymmetric information distribution conditions have closely followed the research setting that was used in the early research by Stasser and Titus (1985, 1987). An abundance of studies with similar designs has significantly contributed to the development of a rich understanding of decision making under these specific settings. However, these studies do not recognize that, in modern organizations, decision making rarely happens under such controlled situations. In numerous organizational settings, team members have to decide under conditions of asymmetric information distribution without being bounded by other components present in the hidden profile studies. In particular, in this research I focus on two components of the hidden profile studies: pre-determined alternatives and bias with initial preference. I argue that these two conditions are not necessarily present in all decision-making situations in which team members have to deal with asymmetric information distribution. Therefore, the constant presence of these two components in the examination of decision making under asymmetric information distribution, limits our knowledge of team dynamics and decision processes.

Issue of Pre-Determined Alternatives. As explained in the literature review section, in a typical hidden profile study, participants are presented with a set of alternatives (e.g. job candidates or homicide suspects) among which they should choose the best option. Granted that this setting is present in certain situations such as hiring committees or juries; however, teams in modern organizations usually do not have a menu of alternatives to choose from and generating proposals for possible courses of action and feasible alternatives is an essential element of problem-solving tasks (Fisher, 1970b; Poole & Roth, 1989b; Scheidel & Crowell, 1964).

In team task typologies developed by Hackman and McGrath, alternative generation was categorized as an independent category of task type. Hackman (Hackman, 1968, 1976; Hackman, Jones, & McGrath, 1967; Hackman & Morris, 1975, 1978) categorized team tasks as problem-solving, production, and discussion. The problem-solving category in his typology refers to tasks that require team to "carry out some plan of action" (McGrath, 1984, p.56). Later, McGrath (1984) developed a more comprehensive typology of team task types. In McGrath's typology, team tasks are categorized in four quadrants: generate, choose, negotiate, and execute. In the *generate* quadrant, he distinguishes between creativity tasks and planning tasks, with the former referring to idea generation and the latter referring to plan generation tasks. In the *choose* quadrant, McGrath distinguishes between *intellective tasks* that require team members to solve problems with a correct answer using decision-making tasks in which the correct answer is the agreed-on choice.

If we use this typology as a lens for examining the hidden profile literature, it becomes clear that this literature focuses on the second quadrant in McGrath's typology and does not recognize any connection between this quadrant and the generate quadrant. However, research on team decision development (Bales, 1950; Bales & Strodtbeck, 1951; Bales, Strodtbeck, Mills, & Roseborough, 1951; Pavitt & Johnson, 2001, 2002; Poole, 1981, 1983a, b; Poole & Roth, 1989a, b) shows that alternative generation is an integral element of team decision making.

Early studies that examined decision development over time (Bales, 1950; Bales & Strodtbeck, 1951; Bales et al., 1951) posited that decision develops through a linear sequence of decision phases. For example, Bales and colleagues (Bales, 1950; Bales & Strodtbeck, 1951; Bales et al., 1951) suggested a model of decision development as a linear sequence of three phases: orientation, evaluation, and control phase. In a similar vein, Fisher (1970a) proposed a four phase model of team decision making: orientation, conflict, emergence, and reinforcement. Other studies suggest that team decision making does not necessarily fit to a universal linear phase model. For example, adopting a proposal-centered approach to examination of team decision development, Scheidel and Crowell (1964) observed *reach-testing* and *spiralling* patterns in team decision making. Reach-testing refers to the idea that team members move back and forth between different proposals in short cycles that are characterized by the introduction of a new proposal, testing it through evaluation and clarification, and then dropping it with the introduction of another proposal. Spiralling refers to the tendency in teams to re-examine proposals that were discussed and dropped earlier in the discussion. In a more recent examination of team decision development, Poole and Roth (Poole & Roth, 1989a, b) developed and tested a contingency model of decision development which suggested 11 different decision paths, with solution activities (solution development and elaboration, solution analysis, and solution critique) present in all observed paths.

Building on research in team decision development, I argue that the generation of alternatives is an important element of these decision-making processes. Therefore, examining team dynamics when team members do not have a pre-determined menu of alternatives and possible solutions will broaden our understanding of how teams decide under conditions of asymmetric information distribution. In the next section, I discuss the second component of the hidden profile studies that is of interest here.

Issue of Bias with Initial Preference. As explained in the overview of the literature, in a typical hidden profile study, participants, upon arrival, receive their individual information sheets and are given enough time to review the information before joining the rest of their team. In some studies, individuals are asked to specify their preferred choice before joining their team. However, making the choice explicit is not a constant element of the design. Regardless of whether the participants have revealed their preferred choice to the researcher or not, having access to information before the meeting results in a setting in which participants join the team with preconceived opinions.

Past studies have shown that initial preferences influence team information processing and decision making through individual and team level processes. Development of preferences before team discussion influences how people perceive and process information. Individuals evaluate preference-consistent information more favourably (Faulmuller et al., 2010; Greitemeyer & Schulz-Hardt, 2003) and downplay the importance of information that is inconsistent with their initial preference. Demonstrating a similar effect at the team level, Schulz-Hardt and colleagues (Schulz-Hardt, Frey, Luthgens, & Moscovici, 2000) showed that when team members started the team discussion with the same preference in mind (homogenous teams), the team evaluated information confirming initial preferences as more relevant and important. Other studies showed that individuals tend to mention and repeat preference-consistent information more during team discussion (Brodbeck, Kerschreiter, Mojzisch, Frey, & Schulz-Hardt, 2002; Kelly & Karau, 1999; Reimer, Reimer, & Czienskowski, 2010a). Reimer and colleagues (Reimer et al., 2010b) contrasted naive teams (whose members received all the information in the beginning of the team session) with pre-decided teams (whose members received the information prior to the team session). The analysis of discussion content showed that naive teams, compared with pre-decided ones, exchanged fewer statements involving preference and more items of information, resulting in better performance in the hidden profile task.

Considering the abundance of research suggesting that bias with initial preference influences team information processing and decision quality, the question is how this component influences our understanding of decision making under conditions of asymmetric information distribution. In fact, this setting is incongruent with most organizational settings. In many organizational team settings, individuals do not receive information regarding the decision-making task prior to the team meeting. In addition, even when they receive the information, they usually do not have enough time to review the information and form a judgment. Therefore, providing team members with information prior to the team meeting seems to be an unnecessary condition that limits our understanding of team decision making under asymmetric information distribution conditions.

In this dissertation, I explore team decision making under asymmetric information distribution when team members are not biased with initial preferences and do not have a menu of alternatives. The question driving my research is:

Research Question. How do teams deal with asymmetric information distribution, effectively or ineffectively, when team members do not have any initial preferences and the team does not have a clear list of alternatives?

In the next section, I introduce the method that I used to pursue this question and narrow down my research question, explicating what this question translates to in the context of team interaction analysis.

Analysis of Team Interaction

Team interaction analysis is a method for quantifying behaviour based on the systematic observation of "naturally occurring behavior observed in naturalistic contexts" (Bakeman & Gottman, 1997, p. 3). In this method, the occurrence of verbal and/or nonverbal behaviours and actions are recorded based on a coding scheme which is developed beforehand (Bakeman & Gottman, 1997; Meyers & Seibold, 2011).

Analysis of team interactions enables us to directly examine the dynamic nature of team processes (Weingart, 1997) and to gain a deep-level understanding of surface-level input-output relationships (Meyers & Seibold, 2011). The study of team processes offers greater insight into mechanisms through which "traditionally studied inputs" (Weingart, 1997, p. 190) affect team outputs.

Researchers interested in studying team processes should decide what kind of approach they want to take in this endeavour: static or dynamic. The choice between the static and dynamic approaches depends on the question driving the research. If the researcher is interested in understanding 'what teams do', s(he) should take a static approach and focus on the frequencies (either absolute or relative) of observed behaviours (Weingart, 1997). However, if the intention of the researcher is to gain knowledge into 'how teams do it', then the dynamic approach should be employed (Weingart, 1997). Instead of focusing on the frequencies of observed behaviours, the dynamic approach examines the sequential nature of team interactions (Weingart, 1997). Put differently, in addition to recording the occurrence of verbal and/or nonverbal behaviour, in the dynamic approach, the researcher records the timing as well as the actor of the behaviour. Then, advanced techniques of sequential behaviour analysis are employed to analyse team interaction patterns (Stachowski, Kaplan, & Waller, 2009).

Past research suggests that team interaction patterns vary across teams (Stachowski et al., 2009; Zijlstra, Waller, & Phillips, 2012) and that the variation in team interaction patterns is related to team performance (Stachowski et al., 2009; Zijlstra et al., 2012). For example, analysing team interactions of nuclear power plant crews, Stachowski and colleagues (2009) found *systematic differences* in interaction patterns of high-performing crews and average-performing crews. In their research, Stachowski and colleagues focused on structural characteristics of interaction patterns, namely: the frequency of observed patterns, the number of actors involved in the interaction, the number of switches between involved actors, the length of patterns, and the levels of pattern hierarchy.

Not only does pattern analysis provide insight into the structure of interaction patterns, it can also offer unique knowledge of the content of interaction patterns. For example, Kauffeld and Meyers' (2009) investigation of team interaction patterns focused on complaining and solution-oriented statements in team discussions. Using lag sequential analysis, Kauffeld and Meyer found "complaint and solution-oriented circles", suggesting that complaining encourages further complaining and solution-oriented statements encourage more solution-oriented statements (Kauffeld & Meyers, 2009).

Building on these studies (Kauffeld & Meyers, 2009; Stachowski et al., 2009; Zijlstra et al., 2012), the purpose of this research is to contrast interaction patterns of high-performing and average-performing teams that worked under conditions of asymmetric information distribution.

My goal is to explore both the structure and content of interaction patterns. Therefore, the proposed research question can be refined as:

Refined Research Question: Given the asymmetric information distribution, what patterns of team interaction differentiate high-performers from average-performers?

More specifically:

RQ1. Is the pattern structure (length of pattern, number of switches, number of actors, and number of patterns) of high-performing teams systematically different from average-performing teams?

RQ2. Is the pattern content (information, preference, suggestion, and opinion) of high-performing teams systematically different from average-performing teams?

In the next chapter, I explain the research design and the data collected to explore these research questions.

CHAPTER THREE: RESEARCH METHODOLOGY

Participants

Three hundred and eighty MBA students from a major business school in Canada (127 females) participated in the study as part of their course requirements. Their mean age was 28.2 years (SD = 4.12). Data were collected from 10 classes across three semesters. Participants were randomly assigned to 65 teams of five to seven members (average team size = 5.85). Due to technical problems, for seven teams audio-video recordings could not be made. These teams were excluded from further analyses, resulting in a total of 58 teams that participated in the study.

Task

Overview. The decision-making task used in this research is the Leadership and Team Simulation: Everest (Roberto & Edmondson, 2010). The storyline of this multimedia multi-user simulation involves a challenging expedition toward the summit of Mount Everest. Team members are randomly assigned to the role of leader, physician, photographer, marathoner, environmentalist, or observer (in teams with six or seven members). Teams start their journey at base camp on Mount Everest. In the beginning of the simulation, each member receives a personal profile that describes an individual's background and personal goals on this expedition. These profiles are provided in Appendix A. During their journey, participants are involved in five rounds of decision making. Over the first two rounds, teams should decide whether each member wants to stay in the current camp or move forward. During the next three rounds, the simulation presents team members with three challenges that are complex problem-solving tasks in which critical information is distributed asymmetrically among team members; while some information is available to all members, other critical information is unshared. As a result of the asymmetric information distribution, success in each challenge depends on how well individuals communicate their privately-held information and integrate the shared information in their team discussion.

Simulation Interface. The simulation interface is comprised of three sections: prepare, analyse, and decide. Snapshots of different screens are included in Appendix B. The prepare section provides a summary of the simulation, individual profiles (i.e. role descriptions which are available in Appendix A), instructions on how to play the simulation, and two introductory videos. Figure B.1 and Figure B.2 show snap shots of how to play and individual profile screens.

After reviewing these instructions and familiarizing themselves with their profiles, players move to the analyse section which provides information on their health status, the hiking speed of each team member, the weather conditions at different camps, their remaining supplies (food, water, and medical), and a summary of their individual goals. Figure B.3 to Figure B.7 show snap shots of these sections. In addition to these categories, the analyse section includes a record of *round information* which is received in the beginning of each day in a pop-up menu (please see Figure B.8). In the very beginning (i.e. Round 0), users receive the following message: "You are at the start of your 6 day climb of Mount Everest. You are starting at Base Camp". Similarly, in the beginning of Round 1, the following message appears on each player's screen: "You are on day 1 of your 6 day climb of Mount Everest. You have ascended to camp 1". The round information received in the next three days (Round 2 - Round 4) provides individuals with important information that they need for solving each challenge. As previously mentioned, this information is asymmetrically distributed among team members.

After reviewing the information provided in different subsections of the analyse section and making their decision, players move to decide section where they submit their decision. As shown in Figure B.9, under the decide section each player can decide to stay on the existing camp, move to the next camp or return to the lower camp. In addition to these options, the team physician decides whether she/he wants to administer one of the medical supplies (i.e. blood pressure monitor, asthma inhaler, or aspirin) to a team member. The team physician can only administer one supply per round. Once all team members have submitted their individual decisions, the next round begins and each individual receives the new round information.

Challenge Description. The first challenge (Round 2) involves the health of the environmentalist. If members share and discuss the information available to them as a team, they will learn that the environmentalist is experiencing an asthma attack and administering an inhaler from the medical kit would provide immediate relief with no need for delaying the climb. The second challenge (Round 3) involves weather condition. Participants are informed that the satellite communication equipment at base camp has malfunctioned and they have limited information to forecast the next day's weather. If members effectively pool information, they will learn that weather conditions at Camp 4 will be hazardous, and that they should rest for a day. Finally, on the last decision-making round (Round 4), members work collaboratively to calculate the optimum number of oxygen canisters that each team member needs to carry on his/her way to the summit. Again, success in this task depends on how effectively team members share and discuss the available shared and unshared information.

Performance Evaluation. The simulation ends once team members submit their decision on the third challenge. At this point, each team member receives a score on her/his individual performance and a score indicating team performance. Individual performance is evaluated based on the percentage of individual goals (i.e. goals detailed in the profile) achieved. The team performance score is calculated based on the percentage of team goals achieved. Team goals are an accumulation of individual performance goals as well as team performance in the three problem-solving tasks. Details of team performance calculation are available in Appendix C.

Procedure

Once all students were present in the classroom, I briefly introduced the simulation and explained that they are going to assume different roles on their team. Then, each individual received a personalized folder which contained instructions on how they can access the simulation, two copies of the consent form, a copy of their individual role description (the same description available under the individual profile section on the simulation) and a short questionnaire of some demographic information. Individuals were instructed that they should answer the questionnaire at this point before we moved forward. Once all questionnaires were completed and collected, I showed the introductory movies that are also available under the prepare section in the simulation. The first video provided overall information on climbing Mount Everest and the risk factors involved. The second video presented detailed technical instructions on how they should work with the simulation. After watching these videos, I reminded students that they have varied sources of information and they should thoroughly examine all available information. Students were encouraged to embrace their role and get fully involved with the simulation. I advised students to spend between 10 to 15 minutes to familiarize themselves with the simulation in the beginning. I informed the participants that completion of the simulation should take around 90 minutes. I did not impose any time limits although they knew that they would only be able to work until the end of the usual class hour. At this point, each team was directed to a small room with a square table to start the task. The entire session was audio-video recorded.

Task Selection

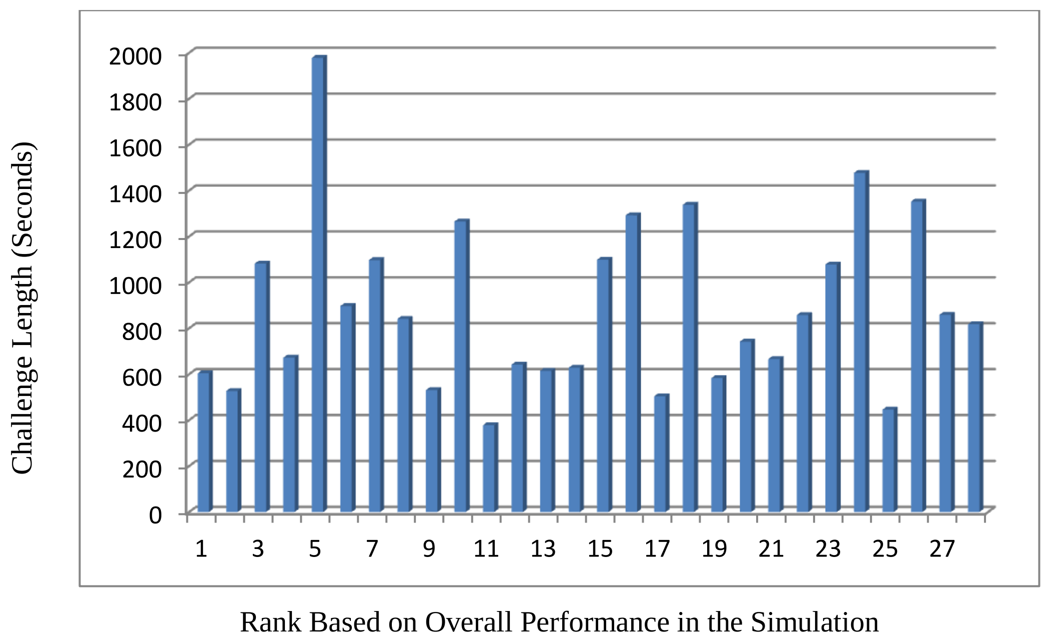
The Everest simulation is designed so that the level of task difficulty increases as a team progresses in the simulation. The increasing level of difficulty is driven by the growing importance of conducting accurate mathematical calculations for passing the second and third challenges. In the current dataset (sixty five teams), the failure rate is 50 percent in the first challenge, 60 percent in the second one, and 83 percent in the last challenge. Upon observing these rates, I contacted Dr. Amy Edmondson, Novartis Professor of Leadership and Management at Harvard Business School, who is one of the lead developers of the simulation and a well-known group dynamics researcher. Dr. Edmondson confirmed that the increasing level of difficulty had been an intentional aspect of the design. The challenges were designed so that a majority (over half) get the medical challenge right, less than half get the weather challenge right, and an even smaller number get the oxygen challenge right (Edmondson, 2011, Personal Correspondence).

After the medical challenge, team members receive feedback on their performance in the challenge. Therefore, teams have an opportunity to reflect on their performance in the previous challenge and improve their team dynamics as well as their decision-making process. In particular, they could realize the importance of information sharing and change their strategy on how they want to share the information available to each individual. Similar to the medical challenge, after the weather challenge, teams receive feedback on their performance in this challenge. In addition to receiving feedback on their decision, they learn how their decision influenced their health. Failure in the weather challenge can have severe consequences; teams who do not realize the severity of the weather conditions and move to the next camp can lose several of their team members, with one or two surviving members developing frostbite. In order to isolate the effect of performance feedback on team dynamics, in this research, I only focused on team interactions during the first challenge (medical challenge).

Team interactions related to this challenge start once someone in the team makes a comment about receiving the new round information and ends when they submit their decision at the end of Day 3. Figure 1 shows the distribution of challenge length[1].

Figure 1

Challenge Length in Seconds



Mean =888
Std. Dev. =374
N =28

Note: Rank 1 indicates lowest performing team

[1] In the next section (Team Selection), I explain the steps I followed to choose these 28 teams.

Measuring Performance in the Medical Challenge. As explained in the previous section, this study focuses on team interaction during the first of the three challenges (i.e. The Medical Challenge). The simulation considers this challenge successful if the team decides to administer an inhaler to the environmentalist regardless of whether they decided to move on to the next camp or stay on the current camp (Camp 2 for the majority of teams). However, if team members communicate all the available information, they realize that the inhaler would *provide immediate relief* from asthma attack and there is no need for the environmentalist to stay on Camp 2. Therefore, I created a three-category measure of performance in this challenge. The team is considered *successful* in this challenge if they administered the inhaler and the environmentalist moved on to the next camp. If the inhaler was administered, but the environmentalist stayed on Camp 2, the team is *partially successful*. Finally, the team is *unsuccessful* in this task if they failed to administer the inhaler, regardless of whether the environmentalist stayed on Camp 2 or moved on to the next one. These categories form *high-performing*, *average-performing*, and *low-performing* teams, respectively.

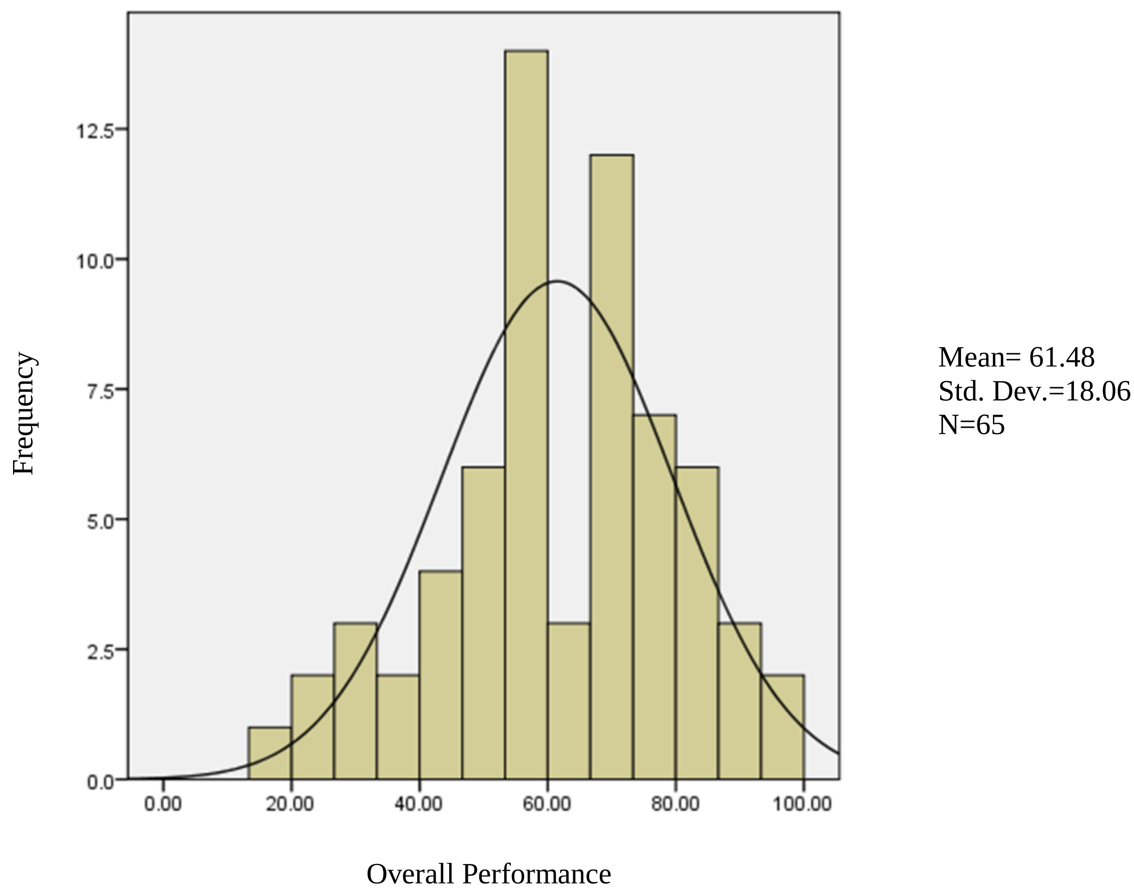
Team Selection

In similar studies (e.g. Tschan, 1995; Uitdewilligen, 2011; Waller, 1999; Waller, Gupta, & Giambatista, 2004), based on the assumption of bimodal performance distribution, high- and average-performing teams were chosen based on a median split on the performance score. Figure 2 shows the distribution of overall team performance for the current dataset.

The graph shows that the overall performance in this dataset has a normal distribution and the Shapiro-Wilk test confirms this observation ($p = 0.38$). Considering the normal distribution of the performance score, I decided to choose high-performing teams from teams that scored one standard deviation above average and choose average-performers from those whose score was less than *mean + stdev*. However, only 10 teams out of 58 audio-video recorded teams scored above *mean + stdev*. These teams were selected as high-performers. Twenty teams were selected from the remaining 48 teams. I intended to choose these teams randomly. However, in some cases, once a team was randomly chosen and reviewed, I decided to exclude the team from the analyses. This decision was mainly driven by two factors. First, in some teams, either due to strong accent or low tone of voice, it was very difficult to understand the statements of one team member. Considering that I needed to capture the entire team conversation, I had to exclude such teams. Second, I stayed away from teams with very low performance scores due to

Figure 2

Overall Performance Histogram



concern regarding their commitment to the task. Participating students took part in the study as part of their course requirement but they were not graded based on their performance in the simulation[2]. Therefore, I was concerned that very low performance in the simulation could be attributed to lack of engagement and commitment to the task rather than less effective team dynamics.

Data Screening. After transcribing and coding all these teams I noticed that the behaviour of one of the high-performing teams (Team 37) was very suspicious and there was a strong possibility that they had received additional information about the simulation. So, I decided to remove this team from the dataset. As explained in detail in the next chapter, I used four different methods to analyse my data. In total, these methods used 38 variables. I used the outlier test in SPSS Software to look for potential outliers across all 38 variables. I compared teams in their respective categories (successful, partially successful, and unsuccessful). Table 2 shows teams that emerged as potential outliers in each category. Team 12 emerged as a potential outlier in the following eight variables: elaborate solution, evaluate solution, solution-oriented question, number of actor switches, number of actors in patterns, number of phases, repetition of information phase, and repetition of solution phase. Team 38 and Team 47 with *three* occurrences come in the second position. Six more teams (Team 16, Team 21, Team 27, Team 31, Team 33, and Team 58) emerged as potential outliers in two variables. Considering that Team 12 emerged as a potential outlier candidate in eight variables, I labeled Team 12 as an outlier and removed it from all analyses.

Figure 3 shows the overall performance distribution for these twenty eight teams. Nine of these twenty eight teams were successful in the medical challenge (i.e. the team administered the inhaler and the environmentalist moved to Camp 3), 11 were partially successful (i.e. they

[2] Four teams were graded based on their performance in the task. All these teams were included in the final analyses.

administered the inhaler but the environmentalist stayed on Camp 2), and eight were not successful in this challenge (i.e. they did not administer the inhaler).

Figure 3

Overall Performance Histogram (Selected and Coded Teams)

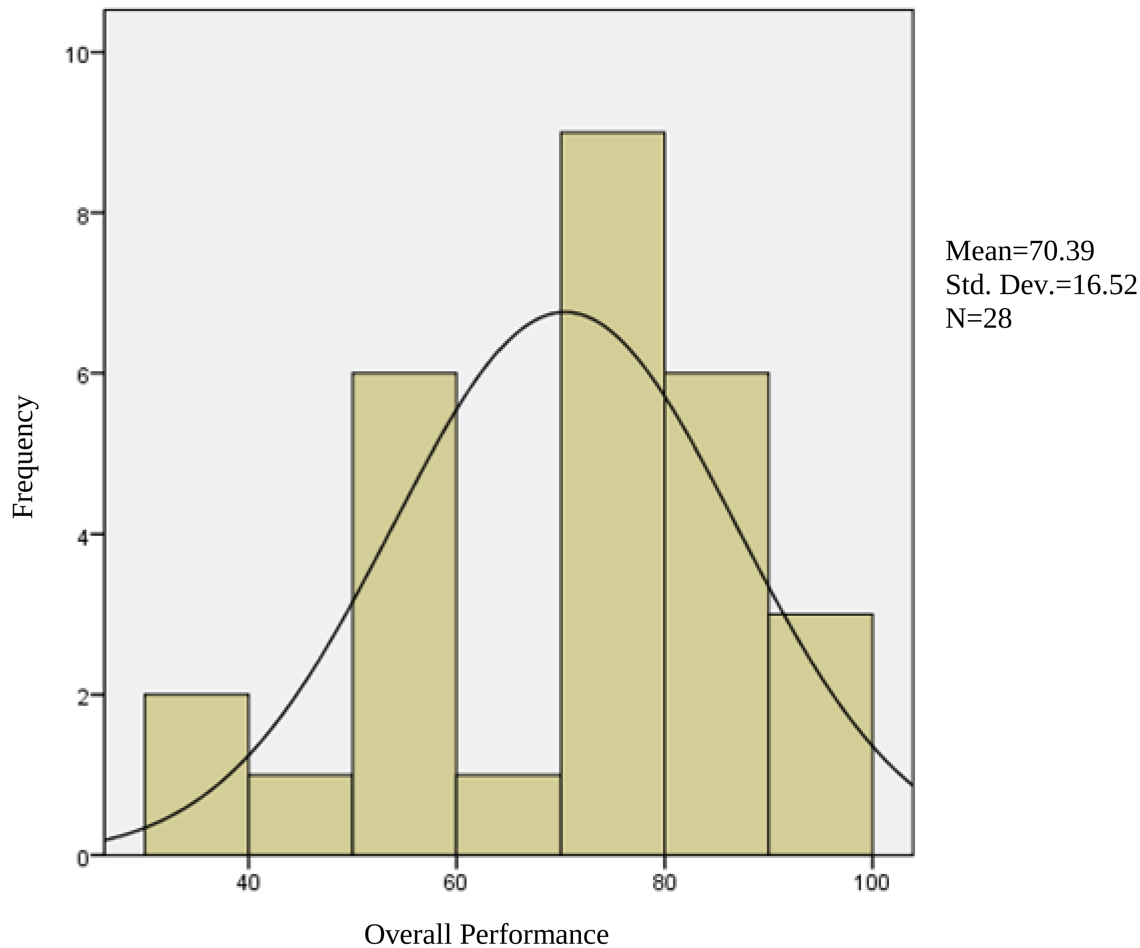


Table 2

Outlier Analysis

		Unsuccessful	Partially Successful	Successful
Coded Behaviours	Voluntary information provision			
	Request information			
	Answer			
	Executive activities			
	Ask/give opinion, evaluation, analysis		38	27
	Propose solution			
	Elaborate solution		58	12
	Evaluate solution			12
	Solution-oriented question		33	12
	Ask for confirmation			
	Confirm	47		
Pattern Statistics Parameters	Observation time			
	Number of interaction patterns		35	16
	Stability in number of interaction patterns		21, 33	16
	Pattern length			
	Stability in pattern length			
	Pattern hierarchy			
	Stability in pattern hierarchy	31		
	Number of actor switches		38	12
	Stability in number of actor switches		38	
	Number of actors in patterns			12
	Stability in number of actors in patterns			
Phasic Analysis Parameters	No of phases			12
	Proportion of phased to non-phased behaviour			
	Average phase length			
	Standard deviation of phase length		32	27, 39
	Share of information phases	31		
	Share of solution phases			
	Share of confirmation phases	47	21	
	Share of information-solution mixed phases			
	Share of info-conf and solution-conf mixed phases	47		
	Share of pure phases			
	Number of solution-information occurrences			
	Length of first information phase			
	Number of information phases		58	12
	Number of solution phases			12
	Number of confirmation phases			
	Number of mixed phases			

Data Coding

Developing the Coding Scheme. Identifying behaviours that one is going to study is a pivotal step in team interaction analysis and has a profound influence on the final results of the study (Weingart, 1997). The coding scheme can be theoretically derived from the existing literature (theory-driven) or developed based on the observation of team interaction (data-driven) (Weingart, 1997). However, the most recommended approach is a hybrid one which is based on an iterative process between the existing literature and data (Bakeman & Gottman, 1997; Meyers & Seibold, 2011; Weingart, 1997).

In developing my coding scheme, I borrowed from three literatures: adaptability, hidden profile, and team decision development. My initial attempts in creating the coding scheme were highly influenced by Mary Waller’s coding scheme which has been previously used in various studies (e.g. Stachowski et al., 2009; Waller, 1999). I spent several hours observing team interactions and comparing the nature of those interactions with the master coding scheme. As my research question matured, I reviewed existing research on information processing, problem solving, and decision making. After thorough examination of these literatures, I chose to build on team decision development literature (Bales, 1950; Bales & Strodtbeck, 1951; Bales et al., 1951; Poole & Roth, 1989a, b) to modify my coding scheme. Bales’ analysis of team discussion focuses on giving or asking for opinion, information, and suggestion. The coding scheme developed by Poole and Roth (Poole & Roth, 1989a, b) categorizes team task-related actions into three major categories of problem activities, solution activities, and executive activities. Building on these two coding schemes, I developed a coding scheme that fits my research question and dataset. The most important aspect of this new coding scheme is attention to information. Inclusion of information-oriented activities in the coding scheme enables me to examine how

Table 3

Summary of the Coding Scheme

Code	Brief Description
Information-Oriented Activities	
Voluntary information provision	Unsolicited fact or status sharing (Push Information)
Request information	Request for information; Questions seeking information regarding facts or status (Pull Information)
Answer	Supply information in response to a question (either information request or a solution-oriented question)
Information code[3]	This code can take 31 different values (23 cues and 8 codes related to the simulation (See Tables 4 and 5)). This code tracks which pieces of information receive attention during team discussion.
Solution-Oriented Activities	
Propose solution	Propose/suggest solutions
Elaborate solution	Any statement that modifies, elaborates, qualifies, clarifies, or provides details on proposed solution
Evaluate solution	Offer reasoning to support, reject, or evaluate the proposed solution
Solution-oriented question	Any solution related question (ask for clarification of the solution dimensions, ask for elaboration on different dimensions, asking for more details, asking critically)
Ask for confirmation	Explicitly asking for confirmation or vote
Confirm	Offer confirmation of the decision
Express individual decision	Express individual decision regarding ones choice to stay or move ahead
Ask for individual decision	Ask for ones individual decision
Ask/give opinion, evaluation, and analysis	Ask/ Give opinion, evaluations, or analysis
Executive activities	Statements that direct the group's process or help the group do its work
Simple agreement	Simple agreement with immediately preceding act
Simple disagreement	Simple disagreement with immediately preceding act
Residual	Any statement that does not fit in other categories

[3] This code is chosen whenever one of the other three information-oriented activities is selected.

teams use information and integrate it into the decision-making process. A summary of the coding scheme is presented in Table 3. A detailed coding guideline is included in Appendix D.

As indicated in Table 3, my coding scheme includes two major blocks of activities: *information-oriented activities* (three activities + information code) *and solution-oriented activities* (eight activities). In addition to these two major blocks, the coding scheme includes five codes that do not belong to any of these blocks. These codes are: executive activities, simple agreement, simple disagreement, give/ask opinion (or evaluation and analysis), and residual. Generally, each utterance should be assigned one of these codes and it cannot be assigned more than one code. The only exception to this rule is the *information code*. I created this code to closely record which pieces of information are discussed during team conversation. Whenever *voluntary information provision*, *request information*, or *answer* is selected, a code should be assigned to *information code*. This code was created following the common practice in the hidden profile literature to record the mentioning (both introduction and repetition) of different pieces of information (or cues). In alignment with this practice, I reviewed the content of five round information pop-ups (one for each role) and broke it down into 21 cues. In addition to these 21 cues, two pieces of information from individual profiles become relevant to this task. These pieces are labelled as Cue 12 and Cue 22. Table 4 lists these cues. Check marks in front of each cue show which member had access to that particular cue. The last column indicates the total number of team members who had access to the cue. A cue is *unshared* if only one member was aware of it; it is *partially shared* if two or three people received it, and it is *shared* if all five members had access to the cue.

Table 4

Cues and Their Distribution among Team Members

	Cue	**Leader**	**Physician**	**Photographer**	**Marathoner**	**Environmentalis**	**No of people who have the piece**
1	At each camp, you must decide whether to rest for a day, or continue to climb toward the next camp. The best teams are those that are quite judicious in deciding when they might need to stop at a particular camp. Sometimes, waiting for someone's health to improve, or waiting for better weather, can be very smart. However, you have a limited amount of time in which to climb the mountain, as well as limited amount of supplies. Thus, you cannot rest much on your way to the top.	✓	✓	✓	✓	✓	5
2	Health is always a concern on the mountain	✓	✓	✓	✓	✓	5
3	AMS is one of the dangers on Everest.	✓	x	✓	x	✓	3
4	Everest-type climbing can induce a severe form of AMS[4] called HAPE[5] which can be fatal within hours if not recognized and treated.	✓	x	x	✓	✓	3
5	A history of AMS before an attempt is correlated with failure in summiting Everest.	x	x	x	✓	x	1
6	At altitudes of 3500-5800 meters, arterial oxygen saturation goes below 90%. That makes climbing quite challenging, even for someone who is very physically fit and experienced at high altitudes.	✓	x	x	x	x	1
7	Physical fitness does NOT protect against altitude sickness. You recall a climb when a very fit climber became ill, while your college roommate who had a history of asthma had no trouble reaching the summit.	x	x	✓	x	x	1
8	It can be difficult but critical to distinguish between the symptoms of HAPE and asthma.	✓	x	x	✓	x	2
9	When an individual has HAPE, he or she tends to experience coughing and shortness of breath **in addition to** at least one of the following symptoms: nausea, vomiting, a pulse exceeding 120 beats per minute, and bluish color of fingernails, face, and lips.	✓	x	x	✓	x	2

[4] Acute Mountain Sickness
[5] High Altitude Pulmonary Edema

Table 4 (continued)

	Cue	Leader	Physician	Photographer	Marathoner	Environmentalist	No of people who have the piece
10	You are a bit concerned as you have started to cough and you have noticed that when you breathe out you are wheezing. You have not noticed any other symptoms.	x	x	x	x	✓	1
11	The primary treatment of HAPE, the most severe form of AMS, is descent.	x	x	x	x	✓	1
12	You experienced AMS in your last expedition on Himalayas (in role description)	x	x	x	x	✓	1
13	You have been trained in how to treat most common health conditions that may arise during the climb. You have the team's medical kit in your possession which you can allocate to another team member for "treatment" of a medical condition. The kit contains aspirin, an asthma inhaler, and a blood pressure monitor.	x	✓	x	x	x	1
14	There is one individual on the team who has a history of asthma	x	✓	x	x	x	1
15	AMS generally develops at elevations higher than 8,000 feet (about 2,400 meters) above sea level.	x	x	✓	x	x	1
16	You know from living with your roommate that symptoms of asthma include wheezing, shortness of breath, chest tightness and coughing. However, wheezing is the most prominent symptom of an acute asthma attack and it is most prominent during exhalation.	x	x	✓	x	x	1
17	You know that asthma can be effectively and immediately treated with the asthma inhaler/Use of an asthma inhaler provides immediate, effective releif and does not delay the climb[6].	x	✓	✓	x	x	2
18	An untreated, acute astham attack is a medical emergency	x	x	✓	x	x	1
19	Note that anyone can have an asthma attack at anytime, even if they do not have a history of asthma.	x	x	✓	x	x	1
20	You recall being told by your roommate that asthma does not predispose someone for developing AMS.	x	x	✓	x	x	1
21	Descent does not aid in recovery from an asthma attack.	x	x	✓	x	x	1

[6] Both physician and photographer have the cue that inhaler provides immediate relief but the wording is not exactly the same.

Table 4 (continued)

	Cue	Leader	Physician	Photographer	Marathoner	Environmentalist	No of people who have the piece
22	Though you have asthma, it has never inhibited your running career (in role description)	x	x	x	✓	x	1
23	In fact, HAPE is the number one cause of death from AMS. While milder forms of AMS occur in about 30% to 60% of high altitude climbers, HAPE has an incidence of only 2%.	x	x	x	✓	x	1

In addition to these 23 cues, team members may discuss eight additional categories of information that are listed in Table 5. The first four items in this table (i.e. health, hiking speed, weather, and resource) provide information that individuals can see under the analyse section of the simulation. *System* refers to information about the structure and functioning of the simulation. One source of *system* information is the two-part video watched in the beginning of the simulation. Additionally, individuals learn about the structure of the simulation by exploring the simulation and navigating through different menus and tabs. The sixth item in Table 5 is *role* which refers to the role description that each member received in the beginning of the simulation. *General Knowledge* refers to individuals' personal knowledge. For example, occasionally a team member might explain *High Altitude Pulmonary Edema*, which is mentioned in the pop-up menu but not explained, to other team members. Finally, *NIP* is used when a member expresses lack of knowledge on an issue using statements such as "I don't know" or "we don't know how this works". Note that unlike cues listed in Table 4, items listed in Table 5 are not specific statements; instead, they are broad categories that include a wide range of statements.

Table 5

Information Codes Available through Simulation Environment

Code	Brief Description
Health	Information about health of individual team members
Hiking Speed	Information about the hiking speed of individual team members
Weather	Information about weather condition
Resource	Information about available resources (food and water supply; slack days)
System	Information about the structure/functioning of the simulation. Any information related to the videos. Any information regarding general rules of the simulation.
Role	Any information that was mentioned in the role sheet individuals received in the beginning[7]
General Knowledge	Personal knowledge (e.g. explaining edema)
NIP	Expressing lack of knowledge (e.g. I/we don't know) in response to a question

Transcription and Unitization. In my data, 5 to 7 individuals talk rapidly and in many cases several team members talk simultaneously or two independent conversations occur at the same time. As a result, coding directly from the video recordings would be unreliable. Therefore, I decided to transcribe all videos verbatim. In the first step, I recorded the speaking turns. A speaking turn is "statements made by an individual while he or she holds the floor" (Weingart, 1997, p. 220). Once the transcription was completed based on speaking turns, I unitized the data.

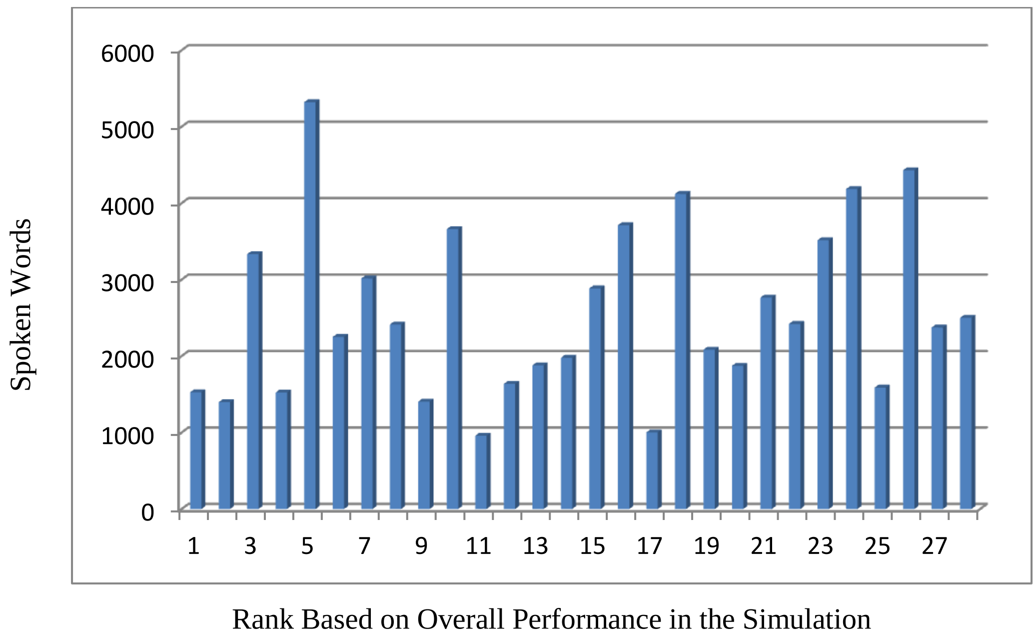
Research question and coding scheme guide the choice of unit of analysis (Meyers & Seibold, 2011, p. 7) as well as the unitization process. Since I intended to track the function of the team discussion, I chose "thought unit" or utterance (McLaughlin, 1984; Meyers & Seibold, 2011) as the unit of analysis, with each utterance carrying one function. Each speaking turn was analysed for its function. If the entire speaking turn focused on one function, it formed one unit;

[7] Cues 12 and 22 are by nature role information. However, since they are used frequently, they are assigned a separate code as shown in Table 4.

otherwise, the speaking turn was broken down into smaller units with each communicating one function according to the coding scheme. The final unitized data indicates the exact time of an utterance, the actor, and the utterance itself. The distribution of the total spoken words and the units of analysis are shown in Figure 4 and Figure 5.

Figure 4

Spoken Words

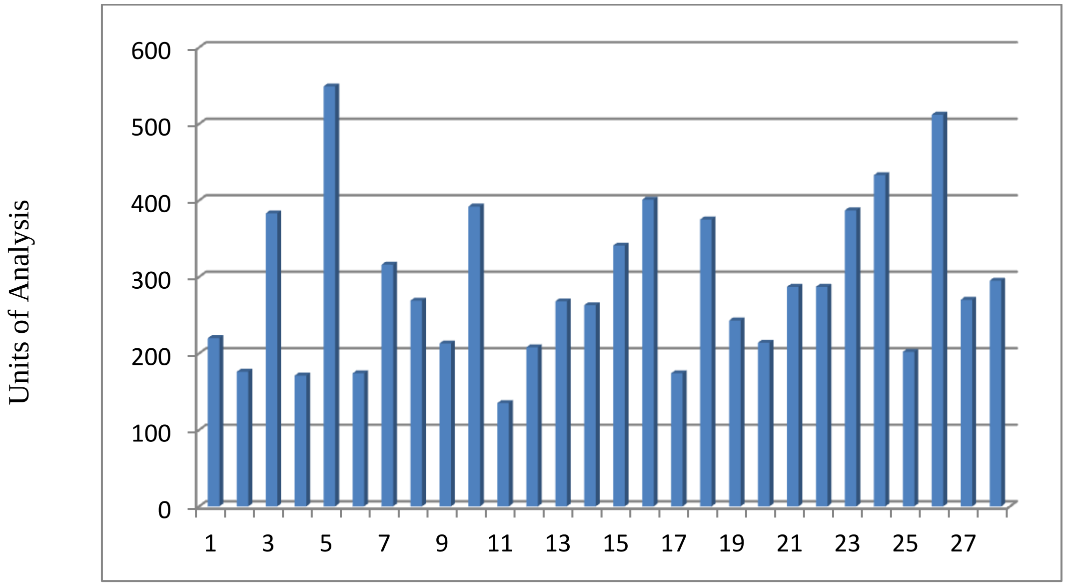


Mean =2563
Std. Dev. =1120
N =28

Note: Rank 1 indicates lowest performing team

Figure 5

Units of Analysis



Mean =291
Std. Dev. =106
N =28

Rank Based on Overall Performance in the Simulation

Note: Rank 1 indicates lowest performing team

Coding. I was the main coder for all the videos. In the beginning of the coding process, I hired a research assistant to code 20 percent (6 videos) of the videos with me. After coding each video independently, we sat together to discuss and resolve the discrepancies. Three formulas are commonly used by researchers to determine inter-coder agreement: Cohen's Kappa (1960), Scott's pi (1955), and Krippendorff's alpha (1980, 2004). Among these measures, Cohen's Kappa is most recommended (Weingart, 1997). Therefore, I used this measure to determine inter-coder reliability. Kappa is calculated using the following formula (Weingart, 1997):

$$Kappa = (P' - P_C) / (1 - P_C)$$

In this formula, P' stands for “the observed percentage agreement among coders” (Weingart, 1997, p. 223) and P_C stands for “the proportion of chance agreement” (Weingart, 1997, p. 223) which is one divided by the number of items in the coding scheme (sixteen in this study). The average Kappa score for the six videos was 0.72. Table 6 shows descriptive statistics for the coded behaviours.

Table 6

Descriptive Statistics on Coded Behaviours

	Mean	**STDV**	**Minimum**	**Maximum**
Voluntary information provision	42.07	19.70	14	85
Request information	29.43	14.91	9	73
Answer	26.68	13.41	6	62
Propose solution	11.68	5.00	2	24
Elaborate solution	8.79	5.81	0	25
Evaluate solution	31.75	19.01	6	66
Solution-oriented question	10.11	6.23	3	27
Ask for confirmation	2.36	2.18	0	7
Confirm	6.89	3.60	1	16
Express individual decision	1.36	2.13	0	8
Ask for individual decision	.68	1.79	0	9
Ask/give opinion, evaluation, & analysis	10.50	8.21	0	37
Executive activities	36.00	19.44	11	85
Simple agreement	7.07	4.40	1	21
Simple disagreement	.71	1.12	0	4
Residual	65.71	35.96	16	150

N=28

Variables and Measures

In addition to the coded behaviours, I created two variables to combine all relevant variables in information-oriented activities and solution-oriented activities categories. I combined voluntary information provision, request information, and answer to create the *information-oriented activities* variable. I combined propose solution, elaborate solution, evaluate solution, solution-oriented question, ask for confirmation, confirm, ask for individual decision, and express individual decision to create the *solution-oriented activities* variable. In the next chapter, I explain the details of analyses and discuss the results.

CHAPTER FOUR: ANALYSES AND RESULTS

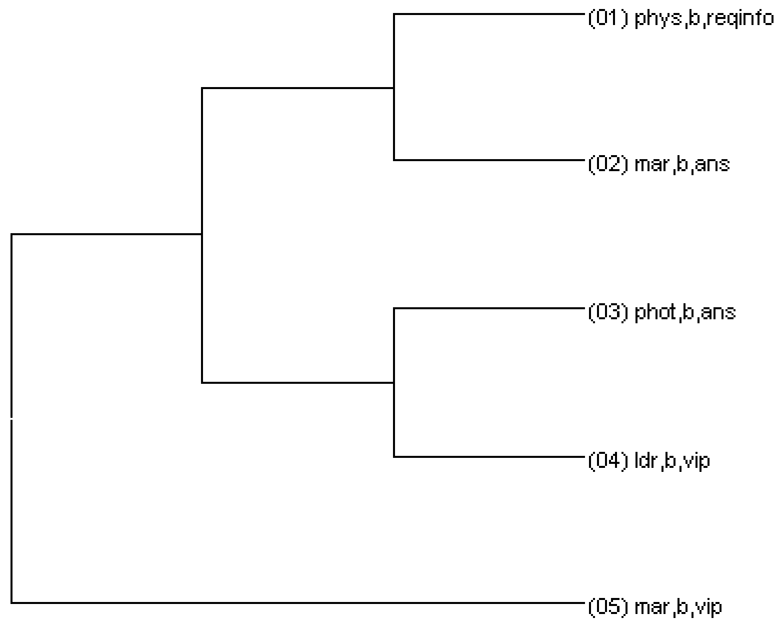
The primary question driving this research was whether interaction patterns of high- and average-performing teams are systematically different in terms of their structural characteristics and their content. In order to answer these questions, I used Theme (Noldus Software) to analyse the structure (RQ1) and content (RQ2) of team interaction patterns. In the next section, I provide more details on this technique before presenting the results of my analysis.

Interaction Pattern Analysis

The goal in conducting interaction pattern analysis is to identify "hidden or nonobvious temporal patterns" (Magnusson, 2000, p. 93) in behaviours of team members. A pattern refers to a *sequence of events* that repeats regularly over the course of the team interaction. Each event has two elements: the actor and the behaviour, either verbal or nonverbal. I use an example to clarify these concepts and explain different components of a pattern. Figure 6 illustrates a pattern that was detected in one of the teams in the current dataset. This sequence, which is comprised of five events, was repeated three times in Team 32. The sequence shows that an information request by the physician was followed by an answer by the marathoner which in turn was followed by an answer by the photographer and a voluntary information provision by the team leader. The sequence ends with the marathoner voluntarily providing a piece of information. This pattern also shows three levels of hierarchy in the emerged sequence. The hierarchy in this context shows that the information request by the physician and the answer by the marathoner form a sub-sequence that has repeated more frequently than the main sequence. Similarly, an answer by the photographer has repeatedly been followed by providing information by the leader. Then, in several points over the course of the team interaction, the latter sub-sequence has followed the former. Finally, in fewer incidents, this combination has been followed by the marathoner voluntarily providing information.

Figure 6

Sample Interaction Pattern



Each event string in a pattern is consisted of three terms which are separated with a comma. The first term stands for the actor of the behaviour. The second term could be either b, standing for the beginning of the behaviour, or e, standing for the end of the behaviour. If a researcher is interested in exploring the time interval between the end of one event and the beginning of another event, she/he can record both the beginning and the end of the behaviour. In such situations, the second term in the event string would reflect the beginning or the end. In the current research, I only recorded the beginning of each event. Finally, the third term in the event string shows the behaviour. The actors and behaviours observed in this pattern are defined below:

Actors	**Behaviours**
phys: Physician	reqinfo: Request Information
mar: Marathoner	ans: Answer
phot: Photographer	vip: Voluntary Information Provision
ldr: Leader	

The prevalent practice among team researchers who are interested in studying temporal patterns is to use Markov chain analysis (see Smith, Olekalns, & Weingart, 2005) or lag-sequential analysis (see Bakeman & Gottman, 1997). In conducting the Markov chain analysis, the researcher examines the probabilities of a sequence of events following a certain event (Poole, Folger, & Hewes, 1987). Lag sequential analysis is in essence an extension of Markov chain analysis in that the researcher examines the probabilities of sequences of events following a specific event with a lag (e.g. lag 2 or lag 3) (Poole et al., 1987). In recent years, researchers (Ballard, Tschan, & Waller, 2008; Stachowski et al., 2009; Zijlstra et al., 2012) have introduced a different pattern-recognition algorithm to detect hidden patterns of team interaction. This algorithm is typically conducted by using a pattern-recognition software called Theme (Noldus Software) or with a similar software algorithm, Interact Software (Mangold, 2005). In the current research, I used Theme.

Theme uses an algorithm developed by Magnus S. Magnusson (2000) which is based on identifying *T-patterns* in any dataset that includes a sequence of events that occurred over time. Unlike the Markov chain and lag-sequential analyses, Theme does not look for sequences of events that occurred immediately (or with a specific lag) after one another. Instead, Theme examines the time interval between the two events and estimates the probability that event B followed event A in a certain time period. As a result, when Theme recognizes AB as a T-pattern it means that after an occurrence of A, there is a time interval called *critical interval* “that tends to contain at least one occurrence of B more often than would be expected by chance” (Magnusson, 2000, p. 94-95). Using time interval to detect recurrent interaction sequences has an important implication for research in that this algorithm can detect the pattern even if several other events took place between the two occurrences of events of interest. For example, a subpattern of the larger pattern illustrated in Figure 6 shows that an information request by the physician was followed by an answer by the marathoner. Even though these two events have followed each other repeatedly in the critical interval, it is not necessary for the marathoner's answer to follow the information request immediately. For example, it is possible that in that short time interval another team member proposed a question, and someone else made a joke or provided some information. Theme enables us to detect that a request by the physician was answered by the marathoner in a certain time interval and this sequence repeated at least three times.

Pattern Structure. T-patterns that are recognized in a dataset can vary widely in terms of their structure. Theme software generates several pattern statistics parameters that can be used to understand the structure of interaction patterns. Table 7 lists these parameters along with their definitions.

Table 7

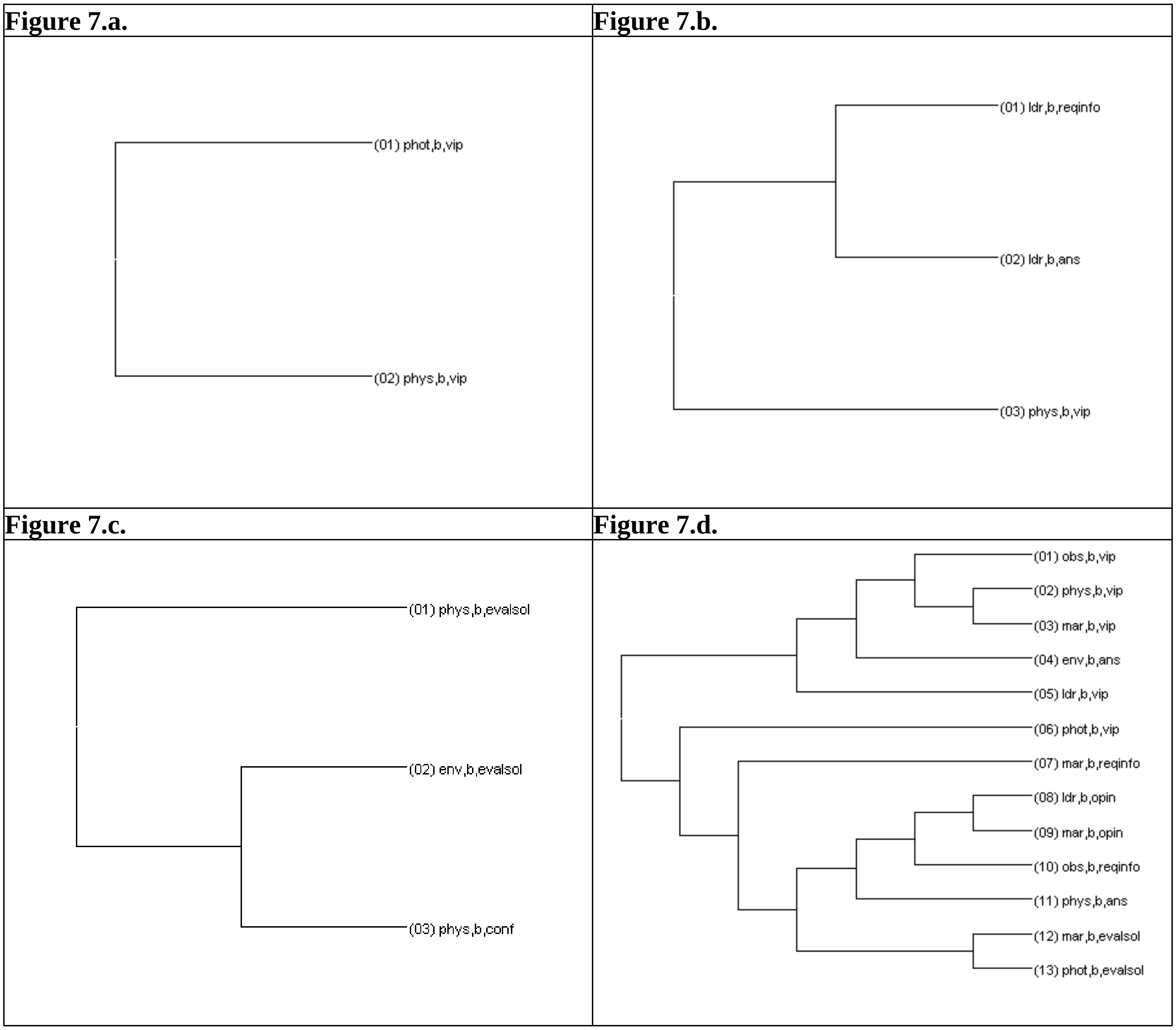
Theme Pattern Statistics Parameters

Parameter	**Definition**
N	Number of pattern occurrences
Length	Number of event types in a pattern
Level	Number of hierarchical levels in a pattern
Nswitches	Number of switches between actors in a pattern
Nactors	Number of actors involved in a pattern

To further clarify the meaning of these structural differences, Figure 7 shows four patterns. Figure 7.a. shows a simple pattern that is comprised of two events (the photographer providing information and the physician providing information). This simple pattern has a length of two, involves two actors, and has only one level of hierarchy. Figure 7.b. shows a longer pattern that is comprised of three events (i.e. length of three). The first two events (information

Figure 7

Example Patterns



The actors and behaviours observed in these patterns are defined below:

Actors	Behaviours
ldr: Leader	vip: Voluntary Information Provision
phys: Physician	reqinfo: Request Information
phot: Photographer	ans: Answer
mar: Marathoner	prosol: Propose Solution
env: Environmentalist	elabsol: Elaborate Solution
obs: Observer	evalsol: Evaluate Solution
	solq: Solution-Oriented Question
	opin: Ask/Give Opinion, Evaluation, and Analysis
	conf: Ask for Confirmation or Confirm

request and answer by the leader) form the first level (Magnusson, 2000). This first level is then combined with a third event (the physician providing information) to form a second level pattern. Therefore, this pattern has a length of three, has two levels of hierarchy, involves two actors and one switch between those actors (the leader and the physician). Figure 7.c. shows a similar pattern which has a length of three events, involves two actors and is comprised of two levels of hierarchy. However, unlike the pattern illustrated in Figure 7.b, this pattern involves two switches between actors (the physician and the environmentalist). Finally, Figure 7.d. shows a very complex pattern which is comprised of 13 events that form seven levels of hierarchy. This pattern involves six actors and 12 switches between these actors.

My first research question (RQ1) asked whether the pattern structure of high-performing teams is systematically different from average-performing teams. Examination of pattern statistics parameters of high- and average-performing teams would enable me to address this question.

With Theme, one can set several search parameters that would influence what patterns are detected. Similar to previous studies (Stachowski et al., 2009; Zijlstra et al., 2012), I set these parameters so that only patterns that have occurred at least three times for a given team are detected. Additionally, a pattern is detected if there is at least a 95% probability that it occurred above and beyond chance.

I ran an independent sample t-test to examine RQ1 and compare pattern statistics parameters across high- and average-performing teams. I did not find any significant differences in the structural characteristics of interaction patterns of high- and average-performing teams. At times, a detailed coding scheme such as the one used in this research results in small frequencies for some codes which could impact Theme Software’s capacity to recognize the more meaningful patterns. In such situations, *scaling*, which refers to the process of combining two or more codes into a single code, (Boyatzis, 1998) could enable the researcher to recognize relationships that would have been lost otherwise.

I reviewed the frequency of the coded behaviours as shown in Table 6. The frequency of simple agreement, simple disagreement, express individual decision, ask for individual decision, confirm, ask for confirmation, and elaborate solution are relatively low (the average on all these variables is below 10). Considering the small frequency of these behaviours, I decided to merge them into more meaningful categories. Simple agreement, simple disagreement, ask for individual decision, and express individual decision were merged together to form a new category named *solution activities*. Furthermore, confirm and ask for confirmation were merged together. Finally, I merged elaborate solution with evaluate solution.

Table 8 shows the results of the independent sample t-test based on these new merged codes. As indicated in Table 8, there are no significant differences in the structural characteristics of interaction patterns of high- and average-performing teams.

The first research question (RQ1) was concerned with differences in pattern structures of high- and average-performing teams. The results of the independent sample t-test showed that there are no structural differences between these two groups. In the next section, I address the second research question (RQ2).

Pattern Content. The second research question (RQ2) was concerned with the content of interaction patterns of high- and average-performing teams. In other words, I wanted to understand whether certain patterns are observed more in teams in one category than those in the other category. In order to explore this question, I drew each detected pattern on a post-it note and attached all the notes for each team on a card. I started by reviewing patterns in different

Table 8

Mean Frequency, Standard Deviations, and T Tests of Pattern Structural Factors for High- and Average-Performing Teams

	High-Performers		Average-Performers			
Outcome Variable	M	SD	M	SD	t	P
No. of interaction patterns	3.39	.15	3.42	2.34	.234	.75
Stability in no. of interaction patterns	.84	.36	.85	.46	.012	.99
Pattern length	3.72	1.19	3.61	1.38	.179	.86
Stability in pattern length	1.58	.75	1.45	.89	.345	.73
Pattern hierarchy	2.21	.78	2.19	.87	.051	.96
Stability in pattern hierarchy	1.01	.41	1.03	.53	.085	.93
No. of actors in patterns	2.74	.54	2.67	.65	.249	.81
Stability in no. of actors in patterns	.81	.36	.75	.33	.388	.70
No. of actor switches	2.30	1.00	2.25	1.27	.107	.92
Stability in no. of actor switches	1.38	.72	1.29	.79	.292	.77

Note: Results based on 9 high-performing and 11 average-performing teams.

teams, reflecting on the meaning of each pattern, and recording common themes. In the initial round, I did not observe any pattern that was clearly observed in one category more than the other. Then, I categorized the observed common patterns as:

- Patterns that only consisted of information-oriented behaviours
- Patterns that only consisted of solution-oriented behaviours
- Patterns that suggested the integration of information into the decision making process. For example, a pattern in which a solution-oriented question is followed by an information-based answer, would suggest an integration of information into the decision-making process.

- Patterns that suggested critical examination of proposed solutions. For example, patterns in which a solution proposal is followed by a solution-oriented question would suggest critical examination of solution proposals.

Comparison of patterns according to these new categories did not provide any further insights into possible differences in the content of interaction patterns of high- and average-performing teams. Therefore, I did not find any systematic differences between high- and average-performing teams in terms of the content of their interaction patterns.

In sum, I used Theme software to conduct interaction pattern analysis and to examine whether high-performing teams and average-performing teams have systematic differences in terms of the structure (RQ1) and content (RQ2) of their interaction patterns; I did not find any differences. Upon observing these results, I decided to go back to my original research question and examine other methods to answer that question.

Digging Deeper

The primary question driving this research was: How do teams deal with asymmetric information distribution, effectively or ineffectively, when team members do not have any initial preferences and the team does not have a clear list of alternatives?

Further exploring this question, I reviewed the hidden profile literature and other resources on the study of team dynamics to learn about other research methods and techniques that would help me understand team behaviours and/or dynamics that result in effective information processing. As a result, I expanded my analyses on five grounds.

Firstly, when I started this research, my implicit goal was to look for factors that differentiate high-performing teams from average-performing ones. Put differently, I was looking for the secret ingredient that would enhance average performance to excellent performance. However, expanding my analyses to explore the potential differences between high-performers and low-performers could offer new insights that would be lost otherwise. Therefore, I decided to expand my analyses and included a comparison of high- and low-performers in all analyses. I used an independent sample t-test to compare pattern structure statistics of high- and low-performers. As indicated in Table 9, there are no significant differences in pattern statistics of high- and low-performers.

Table 9

Mean Frequency, Standard Deviations, and T Tests of Pattern Structural Factors for High- and Low-Performing Teams

	High-Performers		Low-Performers			
Outcome Variable	M	SD	M	SD	t	P
No. of interaction patterns	3.39	.15	3.53	.33	1.11	.28
Stability in no. of interaction patterns	.84	.36	1.14	.89	.907	.38
Pattern length	3.72	1.19	3.11	.82	1.22	.24
Stability in pattern length	1.58	.75	1.10	.47	1.55	.14
Pattern hierarchy	2.21	.78	1.86	.51	1.09	.29
Stability in pattern hierarchy	1.01	.41	.82	.23	1.13	.28
No. of actors in patterns	2.74	.54	2.41	.37	1.43	.17
Stability in no. of actors in patterns	.81	.36	.69	.19	.87	.40
No. of actor switches	2.30	1.00	1.76	.75	1.25	.23
Stability in no. of actor switches	1.38	.72	1.02	.43	1.26	.22

Note: Results based on 9 high-performing and 8 low-performing teams.

Secondly, previous research in the hidden profile paradigm has been very consistent in showing that unshared information receives less attention than shared information; a lower percentage of unshared cues are mentioned during the discussion (for example see Cruz, Boster, & Rodriguez, 1997; Franz & Larson, 2002; Stasser et al., 1989; Stasser & Titus, 1985, 1987) and those cues that are mentioned are less likely to be repeated during the discussion (for example see Larson, Christensen, Abbott, & Franz, 1996; Larson, Christensen, Franz, & Abbott, 1998a; Larson et al., 1994; Parks & Cowlin, 1995; Savadori, Van Swol, & Sniezek, 2001). Considering that in this study I relaxed the assumption of initial preferences and a clear list of alternatives, it is important to understand whether the difference in revealing and repetition of unshared and shared information is observed in this setting. Hence, I conducted some analyses to answer the following question:

RQ3: In the absence of initial preferences and a clear list of alternatives, does asymmetric information distribution result in shared information being revealed and repeated more than unshared information?

Thirdly, the assumption underlying previous analyses was that teams who successfully solved the task were also successful in revealing information and integrating the revealed information into their discussion. However, it is possible for a team to reveal all the information but make the wrong decision. Additionally, it is plausible that a team arrives at the right decision without revealing and discussing all important cues. Therefore, I decided to conduct more analyses to understand whether high-performing teams revealed more cues and integrated them more into their decision-making process. The following question guided this analysis:

RQ4: Is higher performance in the task associated with a higher number of cues revealed and repeated during discussion?

RQ4a: Do high-performers reveal more shared and unshared information than average- and/or low-performers?

RQ4b: Do high-performers integrate revealed information more than average- and/or low-performers?

Fourthly, as previously discussed in Chapter 2, the dynamic approach to the study of team processes, similar to the interaction pattern analysis reported here, is used when the researcher is interested in understanding 'how teams do it' (Weingart, 1997). Alternatively, adoption of a static approach would help a researcher to understand 'what teams do' (Weingart, 1997). Although this method does not take into account the effect of time or "unique person to person interaction" (Weingart, 1997, p. 199), the aggregation of coded behaviours is useful in explaining the effect of various behaviours on team performance (Weingart, 1997); in fact, the static approach is the most common practice in studying team dynamics (Weingart, 1997). In this approach, the researcher examines the aggregation of team behaviours over the course of their interaction. Therefore, I conducted more analysis to understand whether the nature of behaviours in which high-performers engaged is different from the behaviour of low- or average-performers. The following question guided this analysis:

RQ5: Is the nature of behaviour of high-performers different from the behaviour of average- and/or low-performers?

Finally, I went back to the literature to gain insight on other methods previously used for studying temporal patterns of team interaction. Hewes and Poole (2011) identify two approaches: sequential contingency analysis and phasic analysis. As previously explained, sequential contingency analysis includes techniques such as the Markov chain analysis, lag-sequential analysis, and analysis of T-patterns, as reported in the current research. While sequential contingency analysis techniques examine patterns at the micro-level, phasic analysis explores "larger segments of interaction with common functions" (Hewes & Poole, 2011, p. 365). Phasic analysis enables the researcher to examine both the development of team interactions over time and the types of sequences that occur (Holmes & Poole, 1991). In addition to offering a macro perspective, this technique enables the researcher to explore the possible effects of low-frequency but critical events. Hence, I adopted *flexible phase mapping* technique developed by Poole and Holmes (Holmes & Poole, 1991; Poole & Roth, 1989a) to gain insight on development of team interactions over time and explore the effect of low frequency but critical events on team dynamics. I asked the following question:

RQ6: Are the temporal trajectories of information-oriented and solution-oriented interactions in high-performing teams different from those of average- and/or low-performing teams?

In what follows, I explain the analyses conducted to answer these questions.

Cue Mentioning and Repetition

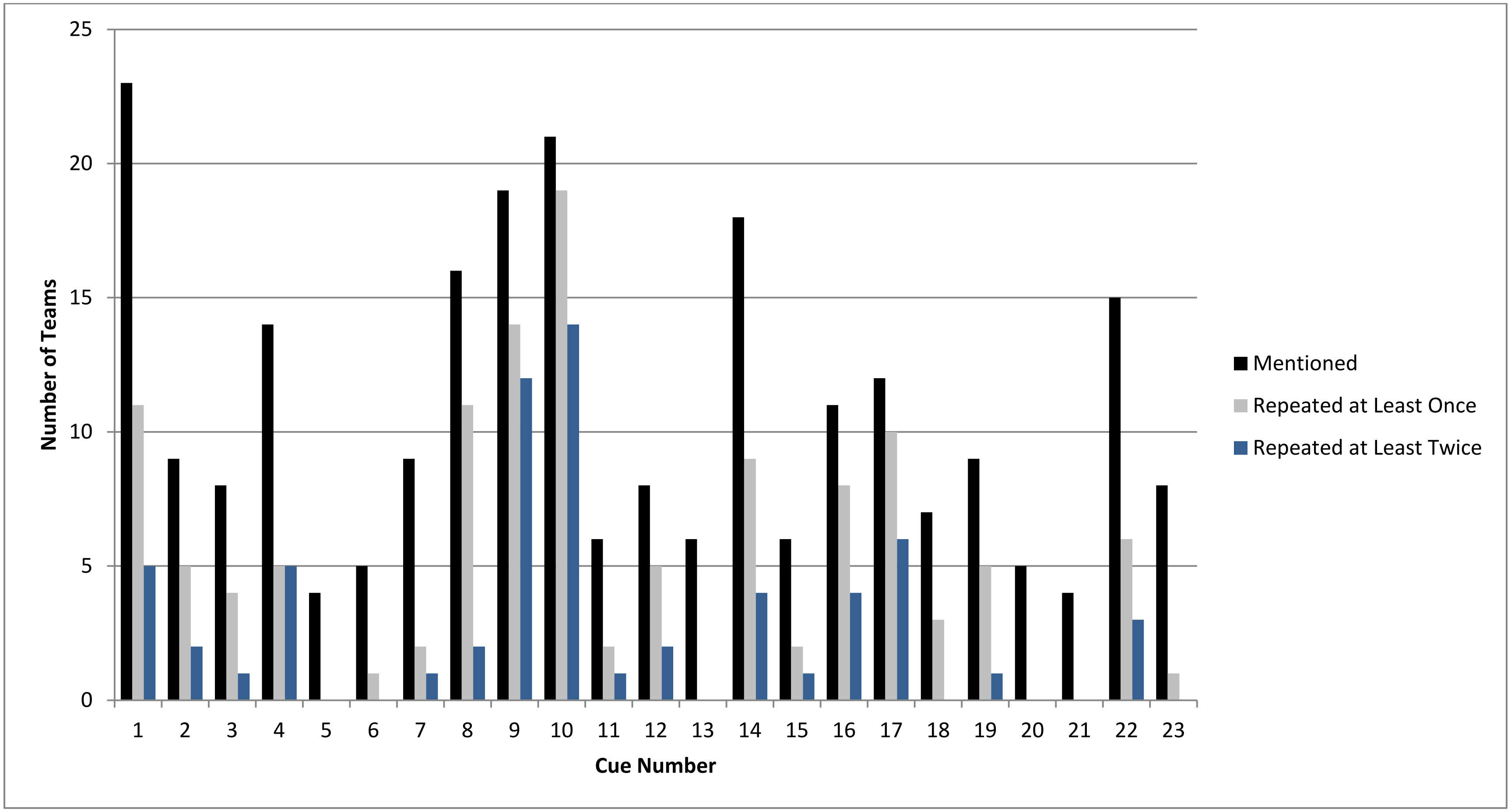
The third research question (RQ3) was concerned with understanding whether, in the absence of initial preferences and a clear list of alternatives, which are two essential aspects of hidden profile studies, the difference in mentioning and the repetition of shared and unshared information is observed. As explained under 'Data Coding' section in Chapter 3, I broke down the information available to team members into 23 cues. As indicated in Table 4, two of these 23 cues are fully shared, five are partially shared, and the remaining 16 cues are only available to one team member (i.e. unshared).

In order to explore whether unshared information was mentioned less and repeated less, for each cue, I calculated the number of teams in which that cue was mentioned. To measure repetition, I created two variables: repeated at least once and repeated at least twice, with the latter showing a higher level of information utilization. Figure 8 shows the number of teams that mentioned each cue during their discussion, repeated it at least once, and repeated it at least twice. To get a more nuanced image, these factors are categorized based on the level of sharedness in Figure 9.

I ran an independent sample t-test to examine whether there is a difference between mentioning and repetition of shared and unshared cues (RQ3). Since there are sixteen unshared cues, two fully shared, and five partially shared cues, I combined fully shared and partially shared cues to form a new shared category. The results of the t-test show that when compared with unshared cues, shared cues were mentioned significantly more, $t(21) = 2.387$, $p < .05$, and repeated for at least once, $t(21) = 2.193$, $p < .05$. Cue 1 is the first line of the pop-up that team members see in the beginning of the simulation. It is possible that the frequency of mentioning and repetition of this cue is due more to its position in the pop-up than its sharedness. Therefore, I conducted a more conservative test and excluded this cue from the t-test. Even with Cue 1 excluded from the shared category, the independent sample t-test shows that shared cues were mentioned more, $t(20) = 1.782$, $p < .1$, and repeated at least once, $t(20) = 1.863$, $p < .1$. I did not observe any significant difference on repetition for at least two times, a measure that was developed to evaluate extra emphasis on a piece.

Figure 8

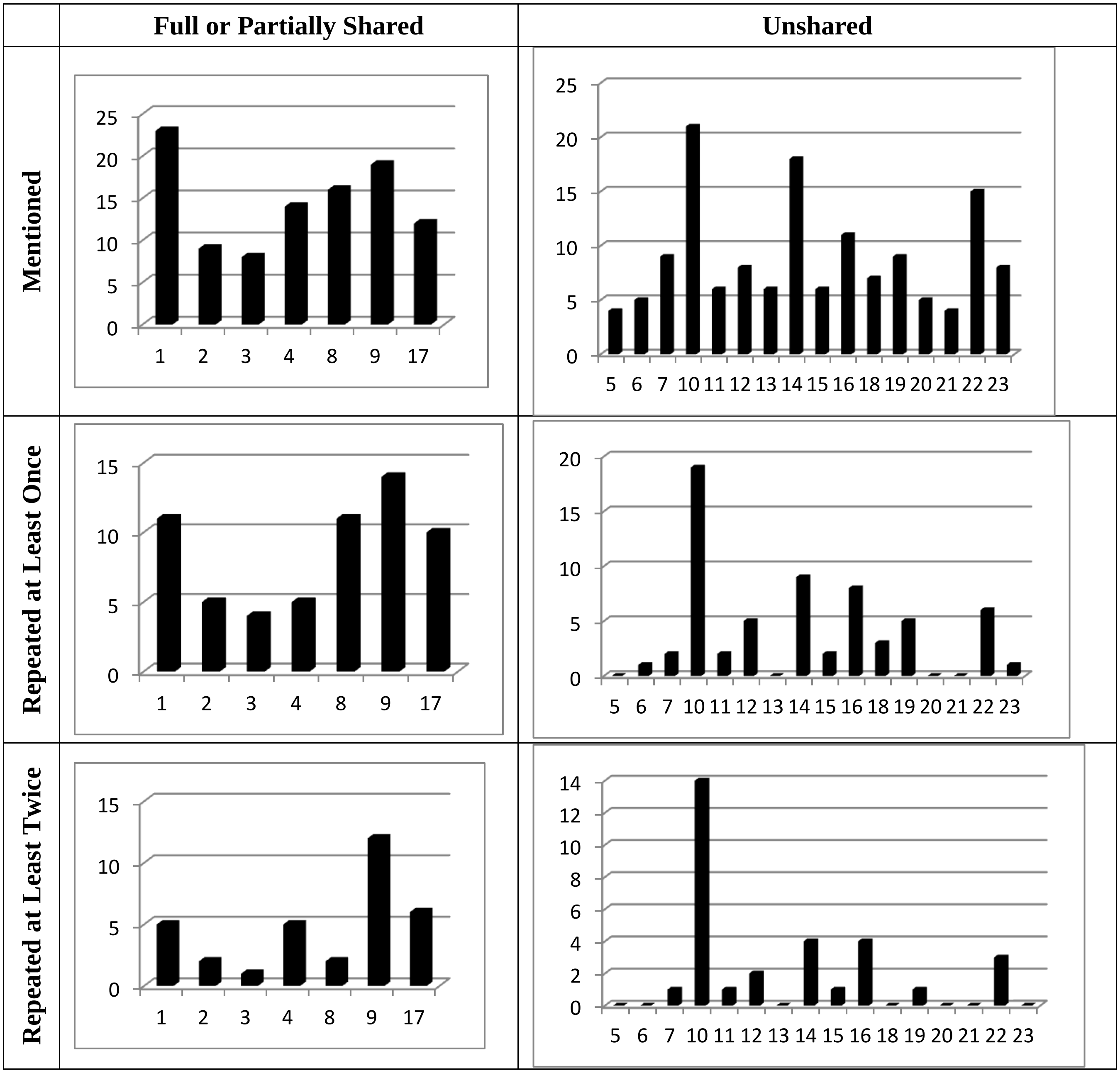
Cue Mentioning and Repetition



Note: Cues numbered according to Table 4.

Figure 9

Cue Mentioning and Repetition Categorized based on Level of Sharedness



Note: Horizontal axis shows cue numbers according to Table 4. Vertical axis shows number of teams that mentioned a cue, repeated it at least once, or repeated it at least twice.

These analyses investigated the third question (RQ3) and showed that even in the absence of initial preferences and a list of alternatives, unshared information receives less attention compared with shared information.

The fourth research question (RQ4) asked whether high-performers differ from average- and low-performers in revealing (RQ4a) and utilizing (RQ4b) information available to them as a team. To answer this question, I compared high-performers with average- and low-performers on nine variables. Table 10 and Table 11 indicate the results of conducted independent sample t-tests. The first three variables on these tables were measured based on the total number of cues (both shared and unshared) that were mentioned, repeated at least once, and repeated at least twice. The next six variables on these tables, break down these measures into shared and unshared categories.

Table 10

Mean Frequency, Standard Deviations, and T Tests of Information Mentioning and Repetition Variables for High- and Low-Performing Teams

	High-Performers		Low-Performers		t	p
Variable	M	SD	M	SD		
Cues revealed	11.00	6.48	6.63	3.78	1.670	.116
Cues repeated at least once	6.11	4.01	2.75	2.55	2.029	.061
Cues repeated at least twice	3.56	2.35	1.38	2.00	2.047	.059
Shared cues revealed	4.33	2.60	3.13	2.03	1.058	.307
Unshared cues revealed	6.67	4.12	3.50	1.93	2.064	.062
Shared cues repeated at least once	3.00	2.55	1.63	2.26	1.169	.261
Unshared cues repeated at least once	3.11	1.69	1.13	.99	2.902	.011
Shared cues repeated at least twice	1.89	1.69	0.88	1.46	1.315	.208
Unshared cues repeated at least twice	1.67	.87	.50	.76	2.941	.010

Note: Results based on 9 high-performing and 8 low-performing teams.

As indicated in Table 10, in general, high-performing teams did not reveal more cues than low-performing teams. However, more cues were repeated at least once, $t(15) = 2.029$, $p < .1$, and a larger number of cues were repeated at least twice, $t(15) = 2.047$, $p < .1$. The comparison of information utilization based on cues in shared and unshared categories shows no significant difference between high- and low-performers in terms of mentioning and repetition of shared information. However, high-performers revealed more unshared cues, $t(15) = 2.064$, $p < .1$, and repeated them more often. Additionally, a larger number of unshared cues were repeated at least once, $t(15) = 2.902$, $p < .05$, in high-performing teams. Similarly, a larger number of cues were repeated at least twice in high-performing teams, $t(15) = 2.941$, $p < .05$.

Table 11

Mean Frequency, Standard Deviations, and T Tests of Information Mentioning and Repetition Variables for High- and Average-Performing Teams

	High-Performers		Average-Performers			
Variable	M	SD	M	SD	t	p
Cues revealed	11.00	6.48	8.27	4.86	1.076	.296
Cues repeated at least once	6.11	4.01	4.18	3.34	1.174	.256
Cues repeated at least twice	3.56	2.35	1.91	1.97	1.705	.105
Shared cues revealed	4.33	2.60	3.36	2.42	.863	.400
Unshared cues revealed	6.67	4.12	4.91	2.95	1.111	.281
Shared cues repeated at least once	3.00	2.55	1.82	2.18	1.118	.278
Unshared cues repeated at least once	3.11	1.69	2.36	1.63	1.004	.329
Shared cues repeated at least twice	1.89	1.69	.82	1.08	1.720	.103
Unshared cues repeated at least twice	1.67	.87	1.09	1.04	1.322	.203

Note: Results based on 9 high-performing and 11 average-performing teams.

As indicated in Table 11, the independent sample t-test does not show any significant differences between high- and average-performers on any of the nine measures of information utilization.

In sum, these analyses addressed the fourth question (RQ4) which referred to differences between high-performers and average and/or low-performers in revealing information (RQ4a) and utilizing the revealed information (RQ4b). My analysis indicated that compared with average-performers, high-performers did not reveal more cues and did not repeat them more. However, when compared with low-performers, they revealed more unshared cues and repeated them more. In the next section, I discuss the analyses conducted to address the fifth research question (RQ5).

Comparison of Coded Behaviours

The fifth question (RQ5) was concerned with understanding whether the nature of behaviours of high-performing teams is different from that of average- and/or low-performers. The analyses conducted in this section do not account for the effect of time and order of events. Instead, the focus of these analyses is to understand 'what teams do' (Weingart, 1997). In order to understand with what kind of behaviour teams engaged, I calculated the frequency of each behaviour over the course of the team interaction. Analyses can be conducted based on absolute frequency or relative frequency (Weingart, 1997). Considering that in the current dataset, task duration is not equal for different teams, it is better to use relative frequencies of behaviours to have a more meaningful comparison across teams (Weingart, 1997). Relative frequencies were calculated by dividing the absolute frequency of the behaviour by the total units of analysis.

I used an independent sample t-test to compare these variables across different performance categories. Table 12 shows the result of comparison between high- and low-performers. These results show that, compared with low-performers, high-performers engaged in more voluntary information provision, $t(15) = 1.773$, $p < .1$, and answer, $t(15) = 2.314$, $p < .05$. They also tended to be more involved in asking/giving opinions and analysing the information, $t(15) = 2.190$, $p < .05$. Low-performers, on the other hand, engaged more in proposing solutions, $t(15) = 2.832$, $p < .05$, asking solution-oriented questions, $t(15) = 2.436$, $p < .05$, and asking for confirmation, $t(15) = 2.758$, $p < .05$. Together, these results suggest that high-performing teams engaged more in information-oriented activities and less in solution-oriented activities. The two aggregated variables at the bottom of the table provide further evidence supporting this proposition; information-oriented activities are higher in high-performing teams, $t(15) = 2.132$, $p < .1$, while solution-oriented activities are higher in low-performing teams, $t(15) = 3.213$, $p < .01$.

Table 13 shows the results of the independent sample t-test for high- and average-performing teams. As shown in this table, high-performing teams engaged more in voluntary information provision, $t(18) = 2.181$, $p < .05$, requesting information, $t(18) = 1.979$, $p < .1$, and responding to information requests, $t(18) = 2.660$, $p < .05$. Average-performing teams engaged more in evaluating solutions, $t(18) = 2.289$, $p < .05$, asking solution-oriented questions, $t(18) = 2.490$, $p < .05$, asking for confirmation, $t(18) = 2.807$, $p < .05$, and expressing individual decisions, $t(18) = 1.902$, $p < .1$. Again, the aggregated variables show that high-performing teams engaged in more information-oriented activities, $t(18) = 2.895$, $p < .05$, and less solution-oriented activities, $t(18) = 3.735$, $p < .01$.

Table 12

Mean Frequency, Standard Deviations, and T Tests of Relative Frequencies of Coded Behaviours for High- and Low-Performing Teams

Variable	High-Performers		Low-Performers		t	p
	M	SD	M	SD		
Voluntary information provision	.1644	.04065	.1275	.04528	1.773	.096
Request information	.1178	.03768	.0975	.04234	1.045	.312
Answer	.1111	.02472	.0812	.02850	2.314	.035
Propose solution	.0333	.01323	.0500	.01069	2.832	.013
Elaborate solution	.0244	.01878	.0363	.03378	.905	.380
Evaluate solution	.0800	.04664	.1063	.05502	1.065	.304
Solution-oriented question	.0222	.01202	.0450	.02507	2.436	.028
Ask for confirmation	.0011	.00333	.0113	.00991	2.758	.024
Confirm	.0200	.01414	.0338	.01996	1.655	.119
Ask for individual decision	.0000	.00000	.0025	.00707	1.00	.351
Express individual decision	.0011	.00333	.0050	.00756	1.344	.211
Simple agreement	.0256	.01878	.0250	.01852	.061	.952
Simple disagreement	.0011	.00333	.0038	.00518	1.233	.242
Executive activities	.1400	.04243	.1200	.04928	.900	.383
Ask/give opinion, evaluation, & analysis	.0511	.03333	.0225	.01669	2.190	.045
Information-oriented activities	.3956	.09515	.3075	.07166	2.132	.050
Solution-oriented activities	.2133	.06614	.3200	.07071	3.213	.006

Note: Results based on 9 high-performing and 8 low-performing teams.

Table 13

Mean Frequency, Standard Deviations, and T Tests of Relative Frequencies of Coded Behaviours for High- and Average-Performing Teams

	High-Performers		Average-Performers		t	p
Variable	M	SD	M	SD		
Voluntary information provision	.1644	.04065	.1327	.02370	2.181	.043
Request information	.1178	.03768	.0900	.02490	1.979	.063
Answer	.1111	.02472	.0782	.02960	2.660	.016
Propose solution	.0333	.01323	.0473	.02412	1.639	.121
Elaborate solution	.0244	.01878	.0382	.01662	1.735	.100
Evaluate solution	.0800	.04664	.1309	.05166	2.289	.034
Solution-oriented question	.0222	.01202	.0418	.02089	2.490	.023
Ask for confirmation	.0011	.00333	.0136	.01433	2.807	.017
Confirm	.0200	.01414	.0218	.00982	.339	.739
Ask for individual decision	.0000	.00000	.0027	.00647	1.399	.192
Express individual decision	.0011	.00333	.0073	.01009	1.902	.080
Simple agreement	.0256	.01878	.0273	.01421	.233	.818
Simple disagreement	.0011	.00333	.0018	.00405	.420	.679
Executive activities	.1400	.04243	.1055	.03174	2.084	.052
Ask/give opinion, evaluation, & analysis	.0511	.03333	.0336	.01433	1.466	.172
Information-oriented activities	.3956	.09515	.3018	.04579	2.895	.010
Solution-oriented activities	.2133	.06614	.3364	.07852	3.735	.002

Note: Results based on 9 high-performing and 11 average-performing teams.

All together, these results addressed the fifth research question (RQ5) which asked whether the nature of behaviour of high-performers is different from that of average- and/or low-performers. My analysis suggested that high-performing teams, compared with both low- and average-performing teams, devoted a larger portion of their interaction to information-oriented activities rather than solution-oriented activities.

Phasic Analysis

In this section, I discuss the flexible phase mapping method (Holmes & Poole, 1991; Poole & Dobosh, 2010) which I used to understand temporal trajectories of information-oriented and solution-oriented interactions of teams in different categories (the sixth research question, RQ6).

Flexible phase mapping involves a series of steps to transform raw team interactions into phase maps. First, coded behaviours are transformed into phase markers. Then, using a set of precise rules, sequences of phase markers are transformed into micro-phases. Then, these small phases are joined together to form larger and more substantial phases. At the end, phase maps are normalized to make it easier to compare phase maps across teams (Hewes & Poole, 2011; Holmes & Poole, 1991; Poole & Dobosh, 2010). More details on this technique and the steps that I followed are provided in Appendix E. Table 14, Table 15, and Table 16 show phase maps for teams in high-, average-, and low-performing categories. To make it easier to compare phase maps across the three categories, all phase maps are included in Table 17.

I calculated several variables to study the structural properties of the phase maps. These variables include *number of phases, average length of phases, standard deviation of phase length*, and *number of phases in each category (i.e. information, solution, confirmation, and mixed).* Additionally, I calculated the *proportion of various phase categories* (i.e. information, solution, confirmation, mix of information and solution, and other categories) to understand which type of activity dominates team interactions. Since I was interested in understanding whether teams in different performance categories differ in terms of the extent to which they integrate information and solution activities, I calculated the *proportion of pure phases* (information, solution, and confirmation), and the *number of times that solution is followed by* *information*. In addition, I recorded the *length of the first information phase*. In 28 out of 29 teams the first phase is the information phase. Therefore, the length of this phase could indicate how long teams spent on information search before engaging in solution-oriented activities. Finally, I calculated the *proportion of phased to non-phased behaviours* as an indicator of the extent to which team interaction is phasic in nature. This variable is calculated by dividing the number of behaviours in the final sequence (before normalization) into behaviours after removing residual and executive activities. Descriptive statistics for these variables are shown in Table 18.

Using an independent sample t-test, I compared the phasic variables across teams in different performance categories. As shown in Table 19 and Table 20, the share of information phases in high-performers are significantly larger than both low-performers, $t(15) = 3.332$, $p < .01$, and average-performers, $t\ (18) = 3.829$, $p < .01$. Additionally, these results show that solution phases take larger proportions of team discussion in low-performers, $t(15) = 2.655$, $p < .05$, and average-performers, $t(18) = 4.546$, $p < .01$. The confirmation phases take up a larger proportion of team discussion in low-performers, $t(15) = 2.707$, $p< .05$, but not in average-performers. These findings are in alignment with the findings based on the comparison of coded behaviours, as reported in the previous section, in that they show that high-performers spent more time on discussing the available information and less on solution-oriented activities.

In addition to the variables on information and solution phase length, the comparison of high- and low-performers shows significant results on three other variables: standard deviation of phase length, $t(15) = 1.977$, $p < .1$, number of solution phases, $t(15)=1.957$, $p < .1$, and number of confirmation phases, $t(15) = 2.055$, $p < .1$. In the absence of significant values on other variables, such as the number of phases or the average phase length, the difference in the

Table 14

Phase Maps of High-Performing Teams

Team ID	Phase Map
7	GGGGGGgUUuGGGGGGGgUUUuGGGGGGGgNNnGGGGGGHHHGGGgUUUGGGGGGGGGGGGGGGGGGGGgHHHhGGgHHHGGgUUuNNNHHHhGGGGGGGGGGGGGg
14	GGGGGGGGGGGGGGGGGGGGGGGGGGGgUUUUUuHHHHHHHhUUUuGGGGGGGGgHHHHHHHHHHHHHHHHHHHHHHhNNNnGGGgUUUUUUUuGGGgXXx
16	UuGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGHhGGGgUuGgUuGGGgUUGGGGgHHHhGGGGgHHhUuHHhGGHHhGHhUUHHHHHhGGHHHHHHHh
27	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGgNnHHGgHHhGGGGGGGGGGGgNN
28	GGGGGUUUUUuGgHHhGgHHHhUUuGGGGGGGHhGGGGGgHhGGHHHHHGGGGGGGGGGGGGGGGGGGGGGGGUuGGgHHhGgUuHHHhNnGGGgHHHhGgHhUuGgXXXX
34	GGGGGGGGGGgUuHhGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGgHHhGGGGGGGGGGGGGGGGHHHHHhGGGGGGGGgHHHHhGGGgXxHHhGGGGGGGXxNn
39	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGgUUuGGgHHHHHHHHHHhGgHHHHHHhGgKKkGGGGGg
46	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGgUUUuGGGGgHHHHHHHHGGGGGGGgHHHHHHhGGGHHhGgUuGGGGgHHhGGGGGGgNnHHhKKk
56	GGGGGGGGGGGUUUUUuGGGGGGGGgHHHHHHHHHHHHHhUuHHHHHHhUUUGGGUUuGGGGGGGGGgHHHUuGGGGGGgHHhUuGGGGgUuHHHHHHhXxGGGGg

Time →

Symbol	Definition
G	Information phase
H	Solution phase
X	Confirmation phase
U	Mixed solution and information phase
N	Mixed solution and confirmation phase
K	Mixed confirmation and information phase

Table 15

Phase Maps of Average-Performing Teams

Team ID	Phase Map
18	GGGGGGGGGGGGGGGGGGUUUUGGGGGGGGGGGGGGGGGUUUUUHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGGHHHHHHHHUUUNNNGGGGGGGGGKKKK
21	GGGGGGGGGGGGGGUUUUUUGGGGGGHHHXXXXXHHHHHHHHHHHHHHHHHHHHHHHHHUUUUUGGGGHHHHHHHHHHHHHXXXXUUUUUUUUHHHHHHHHHUUUUUXXXX
26	GGGUUUUHHHHGGGGGUUUGGGHHHGGGGGGGGGHHHHHHUUHHGGGGGGGGGGGGGGUUUHHHHGGGHHHNNNHHHHHHHHHHHHHHHHHHHHHHHHHKKKGGGG
30	GGGGGGGGGGGGGGGGGGHGGGHHHUGHGGGGGGGGGGGGHHHHGGGHHHGHGUHHHHGGGGGGGGHHHGHHHHHHGGGGHHHHUUHHHHHUUGHHHHHXXXXX
32	GGGGGGGGGGGGGGGGGGGGGGGGGGGHHHGGGGGHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHGGHHHHHHHKKHHHGGUUUUGGUUUU
33	GGGGGGHHHHHGGGGGGGGGGHHHHHHHHHHHHHGGGGGGGHHGGGGGUUGHUUHHHHGHHHGHHHHHHHHHHHUHHHHHGHHHHHHKKHHHHHHHXUXX
35	GGGGGGGGGGUUHHGGGGGGGGGGGGGGGGGGUUUGGGGGGGGGGGGGGGGGGGGHHHHHHHGGHHHGGGGGGGGGGHHHHHHGGGGGGHHHHHHXXNNXXX
36	GGGGGGGGGGGGGGGGGGGGGGGGHHHHHHHHKKKGGGGGGGGGGGGGGGGXXXHHHHHHHHHUUUUUUUHHHHHHHHHHHHUUUUUUHHHNNNXXXGGGUUU
38	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGHHHHGGGGGGHKHGGGGGGGNHKKGGHHHHHHHHHHHHHUUUGGHHUHHGGHHGGGGGHHHHHHHUHXXX
40	GGGGGGGGGGGGGGGGGGUUUGGGGGGGGGGGGGGGUUUUGGGHHHHHGGHHHGGGHHHHHHHHGGUUGGHHHHHHHUUUUUHHHHHHXXHHHUUUGGGGXXXKKK
58	GGGGGGGGGGGHHHGGUUGGHHHHGGHHUUGGGHHHHHHHGHGGHHHHGGGGGGGGXUHHGGHUGHHHHHGGGUGHHGGUUHHGGHHGGHHHHHHGHHHHHKNGGG

Time →

Symbol	Definition
G	Information phase
H	Solution phase
X	Confirmation phase
U	Mixed solution and information phase
N	Mixed solution and confirmation phase
K	Mixed confirmation and information phase

Table 16

Phase Maps of Low-Performing Teams

Team ID	Phase Map
10	GGGGGGGGGGGGGHGGGGGGGGHUGGGGUUUGGGHUUUHHGGGGGHHHHHHHXXHHHHHGGGGGGGGHHXXHHGGGGHHUUUUHHGHUUGGGG
6	GGGGGGGGGGGGGGGGGGGHHHHHGGGGGGGGGGHHHGGGGGGUUUHHUUGGGGGGUUUUUUUUXXXXUUUUUUUHHGGGGHHHHHHHHHHHHHH
19	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGHHGGGGHGGGUGHHHHHHHHGGGUHHUUUUHHHHHUUUUHHHXXHHHHHHHHHHGHUXXXGG
22	GGGGGGGGGGGGGGGGGGGHHHHHHHHHUUHHHHHHHHHHHHHHGGGGGGGGGHHHGGGGGHHHGGGHHHHHHHHHHHHHHHHHHHHHGGHHHXXX
29	GGGGGGGGGGGGGGGGGGGHHHUUGGGGGGGHHHHHHHGGGGGGUUUUHHGGGGHHHHHHHXXHHHHHUUHHHHHHHNNGGGUUUUGGGGGGGGGG
31	GGGGGGGGHHHHHHHHHHGGGGGGGHHHHHHHHHGGHHHHHHHUUUHHHHHHGGGGGHHHHHHHHHHHHHHHHHHHHHHGGGHHHHHHHHHHHHXXXX
47	GGGGGGGGKKGGGGUUUHHHUUGGGGNNNGGGXXGGGGGGGGXXXGGGGGGGGGHHHHGGGHHHNNGGGHHHGGGGGGGGHHKKKXX
52	GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGHUUHGHHHHHGGGGHHGGGGGGNGGGKHHHHHHUGHHHHHHHHKHUKHHHUUUU

Time →

Symbol	Definition
G	Information phase
H	Solution phase
X	Confirmation phase
U	Mixed solution and information phase
N	Mixed solution and confirmation phase
K	Mixed confirmation and information phase

Table 17

Comparative Phase Map Graph

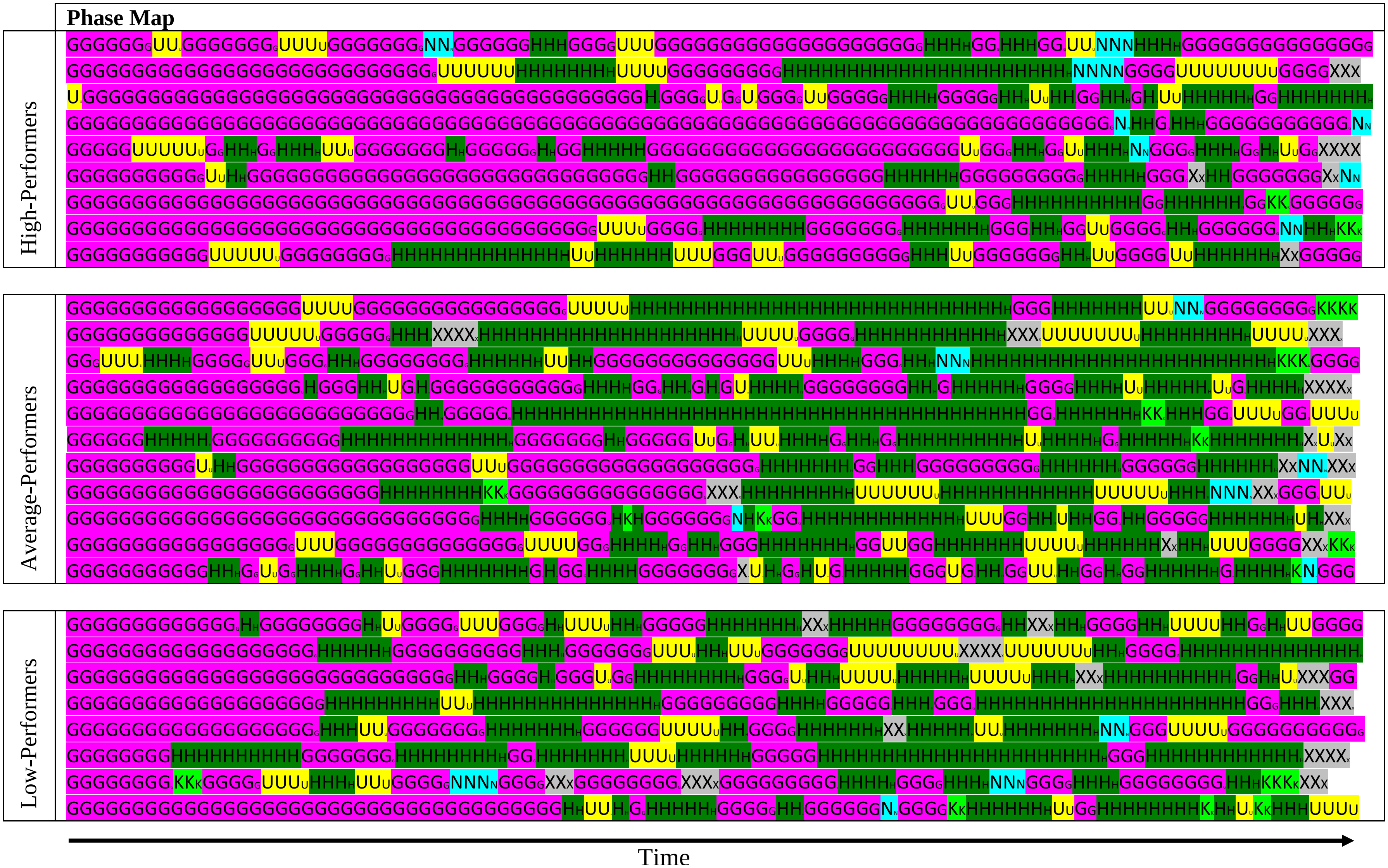


Table 18

Descriptive Statistics of Phasic Variables

Variable	Mean	STDV	Minimum	Maximum
No. of phases	18.82	7.15	7	40
Proportion of phased to non-phased behaviour	.98	.02	.91	1
Average phase length	6.15	2.58	2.5	14.29
Standard deviation of phase length	7.15	5.75	1.99	29.33
Share of information phases	52.12	15.76	23.66	92.66
Share of solution phases	32.69	13.87	4.63	66.67
Share of confirmation phases	2.91	2.79	0	10.75
Share of information-solution mixed phases	9.63	5.92	0	21.51
Share of info-conf and solution-conf mixed phases	2.65	2.87	0	12.73
Share of pure phases	87.72	6.26	78.43	97.45
No. of solution-information occurrences	15.82	6.53	5	27
Length of first information phase	22.43	18.26	2.56	80.31
No. of information phases	6.89	3.03	3	17
No. of solution phases	6.25	3.12	2	14
No. of confirmation phases	1.07	.94	0	3
No. of mixed phases	3.32	1.66	0	6

N=28

standard deviation of phase length does not provide any further insight beyond higher variation in phase length.

A higher number of solution, as well as confirmation phases in low-performing teams suggests that low-performers do not fully evaluate one option before moving on to the next one. Re-examination of the results reported on comparison of coded behaviours (Table 12) offers further insight on this issue. As indicated on Table 12, low-performers are higher in both propose solution and ask for confirmation variables but not on evaluate solution variable. Results of these

Table 19

Mean Frequency, Standard Deviations, and T Tests of Phasic Variables for High- and Low-Performing Teams

Variable	High-Performers		Low-Performers			
	M	SD	M	SD	t	p
No. of phases	16.44	6.82	19.13	5.17	.904	.380
Proportion of phased to non-phased behaviour	.98	.02	.97	.03	.840	.414
Average phase length	7.29	3.54	5.60	1.57	1.245	.232
Standard deviation of phase length	10.85	8.70	4.96	1.89	1.977	.080
Share of information phases	67.00	15.29	45.96	9.73	3.332	.005
Share of solution phases	20.70	8.83	36.95	15.84	2.655	.018
Share of confirmation phases	1.33	1.67	4.19	2.64	2.707	.016
Share of information-solution mixed phases	8.59	6.78	10.29	6.12	.540	.597
Share of info-conf and solution-conf mixed phases	2.38	1.82	2.61	4.59	.138	.892
Share of pure phases	89.03	6.88	87.10	6.62	.587	.566
No. of solution-information occurrences	15.00	7.78	14.50	5.29	.153	.881
Length of first information phase	32.57	27.55	19.42	10.30	1.331	.211
No. of information phases	6.89	2.80	6.50	1.69	.340	.738
No. of solution phases	4.67	2.55	6.88	2.03	1.957	.069
No. of confirmation phases	.56	.73	1.38	.92	2.055	.058
No. of mixed phases	3.00	2.18	3.25	1.67	.263	.796

Note: Results based on 9 high-performing and 8 low-performing teams.

Table 20

Mean Frequency, Standard Deviations, and T Tests of Phasic Variables for High- and Average-Performing Teams

Variable	High-Performers		Average-Performers			
	M	SD	M	SD	t	p
No. of phases	16.44	6.82	20.54	8.59	1.161	.261
Proportion of phased to non-phased behaviour	.98	.02	.98	.01	1.114	.280
Average phase length	7.29	3.54	5.61	2.11	1.314	.205
Standard deviation of phase length	10.85	8.70	5.71	2.77	1.702	.122
Share of information phases	67.00	15.29	44.42	11.07	3.829	.001
Share of solution phases	20.70	8.83	39.40	9.39	4.546	.000
Share of confirmation phases	1.33	1.67	3.28	3.20	1.648	.117
Share of information-solution mixed phases	8.59	6.78	10.00	5.49	.513	.614
Share of info-conf and solution-conf mixed phases	2.38	1.82	2.91	2.16	.578	.570
Share of pure phases	89.03	6.88	87.09	5.92	.676	.508
No. of solution-information occurrences	15.00	7.78	17.45	6.48	.770	.451
Length of first information phase	32.57	27.55	16.31	8.85	1.700	.122
No. of information phases	6.89	2.80	7.18	4.04	.184	.856
No. of solution phases	4.67	2.55	7.09	3.86	1.614	.124
No. of confirmation phases	.55	.73	1.27	1.00	1.784	.091
No. of mixed phases	3.00	2.18	3.64	1.21	.783	.449

Note: Results based on 9 high-performing and 11 average-performing teams.

two sets of analyses suggest that low-performers spent more time on solution-oriented activities but this extra time was not used on evaluating and analysing possible alternatives; instead, low-performers frequently offered new options and hastened to confirm them.

Comparison of high- and average-performers shows that the number of confirmation phases is higher in average-performing teams, $t(18) = 1.784$, $p < .1$. However, there is no significant difference in the number of solution phases. Re-examination of results report on comparison of coded behaviours (Table 13) shows that average-performers asked for confirmation more than high-performers; however, these teams did not propose more solutions. Instead, compared with high-performers, average-performers engaged in more solution evaluation.

Based on the visual comparison of phase maps of different categories, it seems that discussion of solution alternatives is delayed in high-performing teams. I used the *length of first information phase* to verify this observation and did not find any significant differences between high-performers and teams in the other two categories on this variable.

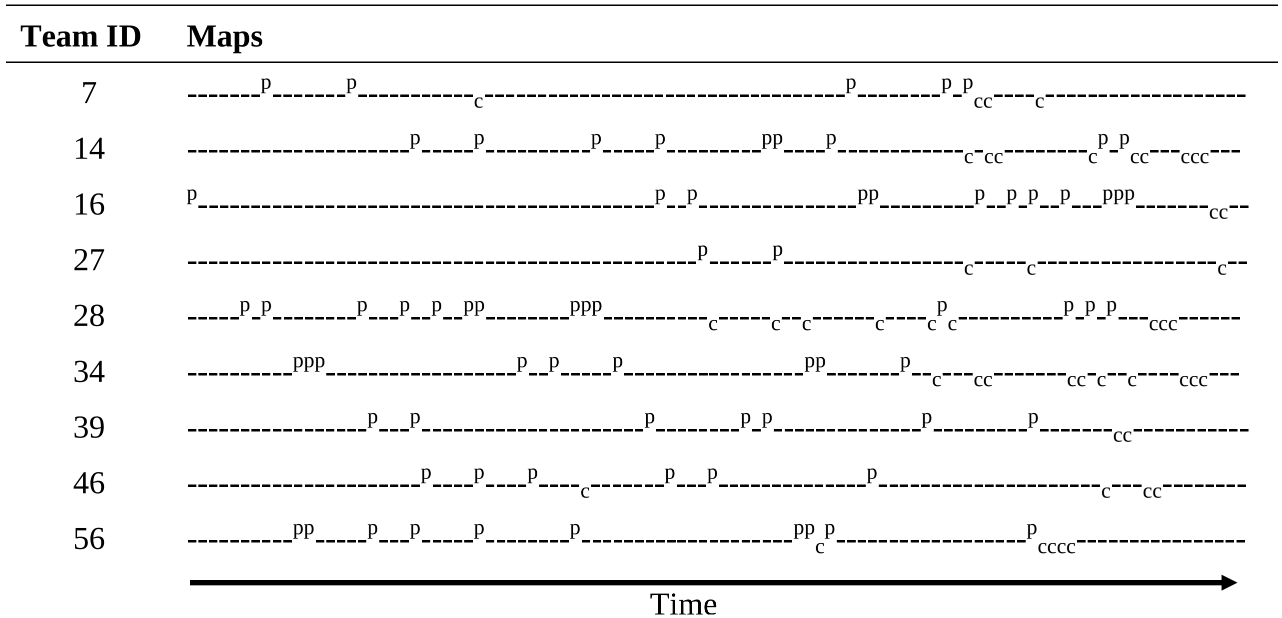
Breakpoints in Phase Maps. Phasic analysis also offers an opportunity to examine the effect of low-frequency but critical events on the development of team interactions. In the current dataset, solution proposals and confirmations could play a critical role in the development of team interaction. So, I decided to explore whether patterns of solution proposals and confirmations would be different across teams in the three categories. My gut feeling was that high-performing teams would focus on information-oriented activities in the beginning. Therefore, I expected the maps of these teams to rarely show any proposal or confirmation in the early stages and more toward the halfway point. In alignment with this line of thought, I expected maps of average-performing or low-performing teams to show proposals in the early stages. Additionally, during the coding process, I had noticed that in some teams, members go back and forth offering different proposals without any evaluation or analysis. For example, one member would suggest that they should stay and another member would immediately suggest that they should move on and administer an inhaler. My expectation was that such patterns should occur in low- or average-performing teams more than high-performing teams. To find support for this hypothesis, the patterns of low- or average-performing teams should include episodes including several proposals.

Instead of adding these “breakpoints” (Hewes & Poole, 2011; Poole, 1983b) to the phase maps, I decided to draw them on a separate set of maps to be able to focus on the patterns of these particular events. To create phase maps that only focus on solution proposal and confirmation, I calculated the rounded percentage point at which each event occurred and drew the normalized maps illustrated in Table 21 to Table 23. Based on a visual comparison of these maps, I do not observe any differences between these categories and do not find any strong evidence supporting my initial hypotheses.

In sum, the sixth research question (RQ6) asked whether temporal trajectories of information-oriented and solution-oriented interactions of high-performers are different from those of average- and/or low-performers. I conducted phasic analysis to understand temporal trajectories of team interactions. My analysis showed that, compared with both average- and low-performing teams, high-performers spent a larger share of their team time on discussing available information. Additionally, the results of phasic analysis in combination with the analysis of coded behaviours, as reported in the previous section, suggests that low-performers

Table 21

Breakpoint-Based Phase Maps of High-Performing Teams



Symbol	Definition
p	Solution proposal
c	Confirm solution

Table 22

Breakpoint-based Phase Maps of Average-Performing Teams

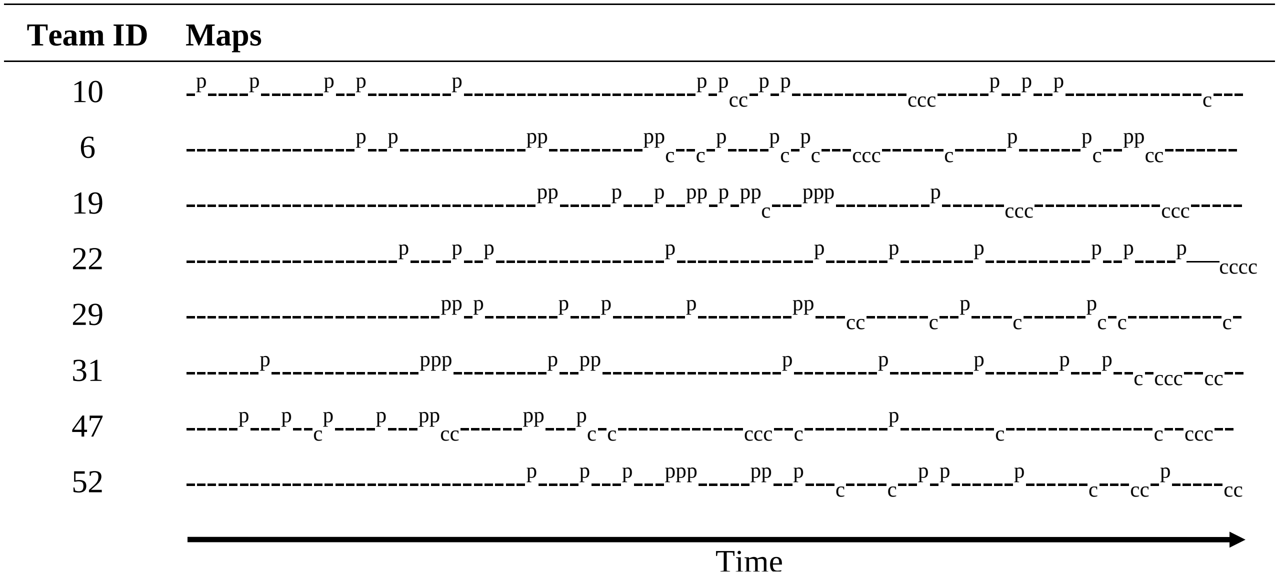
Team ID	Maps
18	-------p-----------p-----------------p------pp----p-pp-------------p------p--------cc---------c--cc-
21	---------------p--pp-----p--cccc--pp-c--p---------------------p--p----ccc------p----p-c-----ccc------
26	---pp-pp------p-p--pp--------ppp------------------------p-----pccc-------p-p-----------c---c--------
30	--------------p-----p-------------------p-p---p--p---pp---------p------------p-p-pc---pc-p---cccccc-
32	--------------p----------pp--------p--------------------p-------------------------c------------------
33	-----p--ppp--------------p-pp------------p-------p---pc--------p--p-p-----------cc--p-p-cp------c-cc-
35	--p---p--p-------------------p-------------------------p-----p----c------------p--------------ccc-cccc
36	------------------------p--p-pp----c---------------ccc--p-----p-------p---------------c--c-c---------
38	-----------------------p-----------------pc------pccc--------pp--p------cc-------------p-----cccc--c-
40	----p---p-------pp------------------pp---p-ppp--------pp---pp--pp---c--pp-p------p--ccc---pc---cccc--
58	---------p--p-ccp-p-p----p------p---------------pc------ppc----p-----------p--p-pp-p-----cc---c------

Time →

Symbol	Definition
p	Solution proposal
c	Confirm solution

Table 23

Breakpoint-Based Phase Maps of Low-Performing Teams



Symbol	Definition
p	Solution proposal
c	Confirm solution

kept throwing different options on the table and sought to confirm them without thoroughly evaluating the proposed options.

Table 24 provides a summary of the research questions, the method used to address each question, and the results of the analysis in each case. In the next chapter, I discuss how these results contribute to the decision-making and information processing literatures.

Table 24

Summary of Research Questions, Methods Used to Answer Each Question, and the Results

	Research Question	Method Used to Test the Question	Results
RQ1	Is the pattern structure of high-performing teams systematically different from average-performing teams?	Independent sample t-test to compare pattern structure statistics generated by Theme Software	No significant difference was observed.
RQ2	Is the pattern content of high-performing teams systematically different from average-performing teams?	Qualitative comparison of patterns recognized by Theme Software	No difference was observed.
RQ3	In the absence of initial preferences and a clear list of alternatives, does asymmetric information distribution result in shared information being revealed and repeated more than unshared information?	Independent sample t-test to compare mentioning and repetition of shared and unshared cues	Yes, unshared cues were mentioned and repeated significantly less than shared cues.
RQ4a	Do high-performers reveal more shared and unshared information than average- and/or low-performers?	Independent sample t-test to compare number of shared and unshared cues revealed in teams in different performance categories	Compared to low-performers, high-performers significantly revealed more unshared cues. No significant difference was observed between high- and average-performers.
RQ4b	Do high-performers integrate revealed information more than average- and/or low-performers?	Independent sample t-test to compare number of shared and unshared cues that were repeated at least once or twice in teams in different performance categories	Compared to low-performers, high-performers significantly repeated more unshared cues. No significant difference was observed between high- and average-performers.
RQ5	Is the nature of behaviour of high-performers different from the behaviour of average- and/or low-performers?	Independent sample t-test to compare relative frequency of coded behaviours in teams in different performance categories	Yes, compared to both average- and low-performers, high-performers spent a larger share of their interaction on information-oriented activities and smaller share on solution-oriented activities.
RQ6	Are the temporal trajectories of information-oriented and solution-oriented interactions in high-performing teams different from those of average- and/or low-performing teams?	Phasic Analysis – Independent sample t-test to compare phase map characteristics of teams in different performance categories	Compared to both low- and average-performers, high-performers spent more time on information processing. Low-performers fall into cycles of proposing solutions and asking for their confirmation.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

In this dissertation, I aimed to understand team interactions that lead to the effective use of asymmetrically distributed information. Building on the vast body of research in the hidden profile paradigm, I explored team information processing in a broader context that was a better representation of real organizational settings. To do so, I designed my study so that participants did not develop any preferences before joining their team. Additionally, unlike the common design in the hidden profile studies, participants did not start with a clear list of alternatives; instead, they had to generate the alternatives as they progressed in the task. Using behavioural observation methods, I sought to find the answer to my research questions by analysing aggregated coded behaviours, patterns of team interactions, and development of team interactions over time. In what follows, I summarize my findings and discuss how this research contributes to our knowledge of team information processing in particular and team effectiveness in general. Then, I discuss study limitations and conclude by exploring areas for future research.

Summary of Results

The general question guiding this research was concerned with understanding how teams deal effectively with asymmetrically distributed information, when team members do not have any initial preferences and the team does not have a clear list of alternatives. This broad question was narrowed down into six questions.

The purpose of the first two research questions was to translate the broad question into an interaction pattern analysis context. I asked whether the structure (RQ1) and content (RQ2) of interaction patterns of high-performing teams are different from those of average- and low-performing teams. I used Theme Software (Noldus Software) to answer this question. I did not find any differences in structure or content of interaction patterns of teams in different performance categories.

The next research question (RQ3) was concerned with understanding whether, in the absence of initial preferences and a list of alternatives, unshared information receives less attention during team discussion. Consistent with other studies in the hidden profile paradigm, I found that shared information was more likely to be mentioned and repeated at least once during team discussion.

The fourth research question (RQ4) asked whether performance in the task is associated with the extent to which shared and unshared information is revealed (RQ4a) and repeated (RQ4b) during discussion. I did not find any differences between high- and average-performers. However, when compared with low-performers, high-performers revealed more unshared cues and repeated them more.

The fifth research question (RQ5) guided my analyses in understanding the differences in the nature of behaviours of teams in different categories. Analysis of aggregated coded behaviours showed that high-performing teams significantly engaged in more information-oriented activities and less solution-oriented activities in comparison with both average- and low-performing teams.

Finally, the last research question (RQ6) was concerned with temporal trajectories of information-oriented and solution-oriented interactions of teams in different categories. The phasic analysis showed that high-performers spent more time on information processing while average- and low-performers spent more time on solution-oriented activities. Additionally, results of these analyses in combination with findings from analysis of coded behaviours suggest that the extra time that low-performing teams spent on solution-oriented activities was not due to extra effort put into evaluating and analysing the solution. Instead, these teams went into cycles of proposing a solution and asking for its confirmation.

In the next section, I discuss the theoretical implications of these findings.

Theoretical Implications

As mentioned in Chapter 2, previous research suggests that sampling bias, social-psychological processes (i.e. social validation and mutual enhancement), premature preference negotiation, and individuals' biased evaluation of information explain why shared information receives more attention during team discussion. Both premature preference negotiation and biased evaluation of information hinge on team members' initial preferences before team discussion. Therefore, in the absence of initial preferences in the current study, the observation that shared information was mentioned and repeated more than unshared information could provide further support for sampling bias and social-psychological explanations.

However, by using phasic analysis as well as analysis of coded behaviours, I was able to dig deeper into my data and demonstrated that low-performing teams, who revealed fewer unshared cues and repeated them less often than high-performing teams, engaged in recurrent solution proposal and confirmation phases. Therefore, it is possible that even in the absence of initial preferences, some teams engaged in *alternative negotiation*. Furthermore, results of the phasic analysis as well as aggregated coded behaviour showed that high-performing teams spent more time on information-oriented activities than solution-oriented activities. Therefore, it seems that high-performers put more emphasis on thorough analysis of information. Yet, it is important to note that they did not merely spend more time on revealing information; instead, they actively engaged in processing and analysing the revealed information. As shown in Table 12, high-performers significantly engaged more in the behaviour coded as "Ask/Give Opinion, Evaluation, & Analysis” which was chosen when a team member asked/gave an opinion or analysed information. Moreover, the finding that high-performers repeated unshared information more than low-performers, suggests that they were able to capture the importance of these cues in solving the problem.

These findings shed new light on our knowledge of information processing in decision-making teams. Building on the growing evidence that teams vary in the extent to which they utilize and analyse information, several scholars have suggested that team decision-making strategies can be broadly categorized as information-driven strategy and preference-driven strategy (see De Dreu, Nijstad, & van Knippenberg, 2008; Nijstad & Kaps, 2008; Stasser & Birchmeier, 2003). Teams that pursue preference-driven strategy are “characterized by the communication of opinions and preferences” (Stasser & Birchmeier, 2003, p. 87). These teams assess individual preferences and decide by aggregating these preferences (De Dreu et al., 2008). Findings of the current research extend the aforementioned categorization of team decision-making strategies by providing evidence that even in the absence of initial alternatives and individual preferences, we observe a variation in depth of information processing and behaviour patterns that suggest presence of a *proposal-driven* strategy.

Another aspect of the present research that extends past work is the attention to the relation between information-oriented and solution-oriented activities in processing of asymmetrically distributed information. With the exception of discussion of individual preferences, previous research has mostly ignored the impact of solution-oriented activities on team information processing (see Lu, Yuan, & McLeod, 2012; Mesmer-Magnus & DeChurch, 2009 for recent reviews of information processing and hidden profile literatures). By developing a coding scheme that captured a broader and more comprehensive range of team activities, I was able to demonstrate how high-performing teams differ from average- and low-performing teams in allocation of discussion time to different kinds of activities. Analysis of coded behaviours in combination with phasic analysis demonstrated that high-performing teams, compared with both average- and low-performing teams, allocated a larger share of their discussion time to information-oriented activities and a smaller share to solution-oriented activities.

At the end, it is important to examine the results of this study in relation with Stachowski and colleagues' (Stachowski et al., 2009) findings of interaction patterns of nuclear power plant control room crews. Stachowski and colleagues found that high-performing crews exhibited less complex interaction patterns which involved fewer actors with less back-and-forth communication. The authors encouraged future researchers to "examine such patterns in other contexts to shed light on the generalizability" (Stachowski et al., 2009, p. 1538) of their findings. This dissertation is the first step toward examining team interaction patterns under a broader range of contextual settings. The nuclear power plant crews in Stachowski and colleagues' study were working under a time-sensitive crises situation for which they had received regular prior training. Teams in the current study worked under low time-pressure on a novel task for which they had received no training. It is not clear which contextual factors have contributed to such different findings. However, the combination of these two studies attest to the importance of contextual factors in team functioning.

Study Limitations

This research has some limitations that should be mentioned here. First, the sample size was limited by the number of teams who could be categorized as high-performing based on the overall performance in the simulation. Although I had collected data from almost sixty teams, only ten teams scored one standard deviation above average. That said, working with a smaller sample made it possible to conduct thorough and in-depth analyses on a relatively large amount of data (almost 15 minutes of video recorded data) for each team (cf. Stachowski et al., 2009; Zijlstra et al., 2012).

Second, even though compared to a lab study, the setting of this research was a closer representation of natural settings, it still involved a simulation that is not the kind of task typically used in organizations. Furthermore, this task was novel and its premises were unknown to all team members. In most organizational settings, team members have some level of familiarity with the task for which they are responsible. In fact, in most cases team members have been trained for the task at hand and have been prepared for possible unexpected events. Therefore, the high level of novelty and ambiguity of this task could limit the generalizability of these findings to other contexts. Additionally, the existence of a correct answer for this task could limit the applicability of these findings to settings for which no correct answer exists and team members should use their best judgment. Notwithstanding these deviations from natural settings, this particular task made it possible to examine details of team interactions while maintaining the task description consistent across teams.

Third, in most organizational settings, individuals are aware that they would be held accountable for the team decision and that their team performance could directly or indirectly influence their compensation and promotion opportunities. Absence of such condition could have influenced individuals' engagement with the task and the effort they put into finding relevant information and sharing it with their teammates.

Fourth, the decision to develop a "task-specific coding scheme" (Weingart, 1997, P. 216-217), rather than a generic coding scheme, limits the generalizability of the results reported here. That said, in the absence of a generic coding scheme that would capture my research question, developing a task-specific coding scheme was the best available option. The most thorough coding scheme in the literature is the Decision Functions Coding System (Poole & Roth, 1989a) which I used as the basis of my coding scheme. However, this coding scheme does not capture information-related behaviours. Complementing this coding scheme with information-oriented activities enabled me to explore the interaction between information-oriented and solution-oriented activities.

Fifth, the role assignments in the study reported here were random, with no connection to the background or expertise of individual team members. This aspect of the research is particularly important in regard to the role of team leader. Previous research suggests that team leaders who are chosen based on their expertise could take on an information-management role (Larson et al., 1996; Larson et al., 1998a). For example, Larson and colleagues (Larson et al., 1996; Larson et al., 1998a) examined information processing in teams comprised of one medical student, one intern, and one resident (the leader). Team leaders in these studies asked more questions, repeated more shared and unshared information, and gradually increased their emphasis on unshared information. Larson and colleagues concluded that leaders enhance team decision-making quality by revisiting already pooled information and keeping it within the team's focus of attention (Larson et al., 1996). In the study reported here, I noticed some variation in the level at which the assigned leader took over the leadership role. While in some teams the assigned leader actively guided team decision-making processes, in other teams the assigned leader did not act as team leader. However, it should be noted that I compared participation of team leaders across teams in different categories and did not find any significant differences between the activity level of team leaders in successful and unsuccessful or partially successful teams.

Sixth, teams in this study had approximately two hours to work on a simulation that typically takes 90 minutes to complete. Furthermore, the medical challenge was the first challenge and most teams started working on this task within ten to fifteen minutes. Hence, in the absence of a tight timeframe, most teams must have experienced a significant lack of urgency in completing the simulation. Although many teams in organizations work without time constraints this aspect of the current research limits the generalizability of the reported findings to decision-making teams working under time pressure.

One last issue that needs to be addressed here is the possibility of increasing the type I error due to multiple T tests conducted in this study. Since conducting multiple tests could increase the chance of observing significant results, it is recommended to adjust for α inflation to decrease the type I error. The most common method for α adjustment is the Bonferroni Correction which sets the significant α level to α/n, with n representing the number of conducted tests. That said, while adjusting for multiple testing reduces the type I error, it increases the type II error (Rothman, 1990) and "the frequency of incorrect statements that assert no relation between two factors" (Rothman, 1990, p. 44). Additionally, several scholars argue that adjusting for multiple testing is "not strictly required" (Bender & Lange, 2001, p. 344) in exploratory studies that do not have pre-specified hypotheses (see Bender & Lange, 2001; Goeman & Solari, 2011). Goeman and Solari (2011) argue that multiple testing adjustments "have been designed for confirmatory data analysis and are ill-suited for the specific requirements of exploratory research" (p. 2). Hence, considering that the current study has an exploratory design with open-ended questions and no pre-specified hypotheses, conducting adjustment for α inflation does not seem to be appropriate.

Future Research

Many additional areas exist for future study of information processing in teams. Findings of this research suggested that high-performing teams pursued an information-driven strategy to solve the problem at hand to make a decision. However, this dissertation did not examine potential factors contributing to the observed differences between high- and low-performers. As evidenced by the wealth of research in the hidden profile paradigm, abundant factors at the individual and team level can contribute to the development of various information-processing patterns. In particular, I speculate that epistemic motivation (De Dreu et al., 2008) of individual team members could play a significant role in the development of information-oriented approaches to decision-making. De Dreu and colleagues (2008) defined epistemic motivation as "the willingness to expend effort to achieve a thorough, rich, and accurate understanding of the world, including the group task or decision problem at hand" (p. 23) and argued that at the team level "epistemic motivation influences the depth and thoroughness with which information is disseminated and combined" (p. 25). An important question in this context is whether all or the majority of team members should be motivated in delving into information for the team to adopt an information-driven strategy. Put differently, would it be possible for one or two team members with high levels of epistemic motivation to change the course of team action and extract the important information or not. Working with this data, I have observed many situations in which several team members were pushing for an early decision while one team member single-handedly worked hard to encourage them to go back to their round information and look for cues that could help them make an informed decision. I have also witnessed situations in which three or four team members worked hard while one team member rushed them to make a decision. Therefore, exploring team composition in terms of diversity in epistemic motivation of team members could shed new lights on antecedents of team information processing strategies.

Another promising area for future research is the study of temporal factors contributing to team information processing. In general, empirical research on temporal aspects of team functioning is very scant (Mathieu, Maynard, Rapp, & Gilson, 2008) and research on information processing is not an exception. To the best of my knowledge, the only research on temporal aspects of information processing is a series of studies by Larson and colleagues (Larson, 1997; Larson et al., 1996; Larson et al., 1998a; Larson, Foster-Fishman, & Franz, 1998b; Larson et al., 1994) in which they found that shared information, compared with unshared information, is more likely to be mentioned earlier in the discussion. In addition, these authors demonstrated that with the progress of team discussion, the probability of mentioning new (not yet discussed) unshared information increases while the likelihood of introducing new shared information decreases. In the current study, I studied temporal patterns of team interaction by using interaction pattern analysis and phasic analysis. Unfortunately, the interaction pattern analysis did not show any significant differences between high- and low-performing teams; similarly, the phasic analysis did not offer any conclusive findings in terms of the development of team interactions over time. I suspect that with a larger sample, these results would have been different. Future researchers should use these methods to study time and team development in relation to information processing.

Finally, future work should investigate the generalizability of the findings of this study. Using the coding scheme developed here, additional research should examine the relation between information-oriented and solution-oriented activities of teams working in other contexts.

Such research should particularly focus on addressing the shortcomings of this study as detailed in the previous section.

Conclusion

In a review of the hidden profile literature, Wittenbaum and colleagues (2004) criticized this paradigm for its narrow focus on a specific experimental setting which limits its relevance to natural team settings. Echoing these scholars, I would like to conclude by inviting researchers who are interested in the study of team information processing to move toward questioning the importance of the hidden profile assumptions to our understanding of this complex phenomenon. Information processing needs of organizations are not limited to hiring committees whose members have reviewed candidate profiles in advance and for some reason do not have access to those profiles during the meeting. So, why should almost 30 years of research on information processing be limited to that particular setting? Even though the wealth of research in this paradigm has made a prominent contribution to our understanding of team information processing, it is time to move toward the study of the information processing in diverse settings with more relevance to organization settings.

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APPENDIX A: ROLE PROFILES

Retrieved from the Facilitator's Guide, Leadership and Team Simulation: *Everest* (Roberto & Edmondson, 2010 p. 52-56). Reprinted with Permission from Harvard Business Publishing [8]

A.1. Leader's Role Description

You have been climbing in the Himalayas for more than 15 years. In fact, you have been to the summit of all the 8,000 meter peaks in the world (of which there are 14), and you have reached the summit of Everest 5 times. You are a far more experienced high-altitude mountaineer than anyone else on your team. No one else on your team has been to the top more than once. No one else has climbed more than four 8,000 meter peaks.

You have an interesting sponsorship deal with a major outdoor gear company. It is going to pay you $1 million, but only if you capture photos and video of yourself on the summit wearing the company's gear.

You would like the climbers on the expedition to reach the summit and would also like to reach the top yourself, as you have promised your spouse and children that this is the last time that you will tackle Everest. In short, this is your last shot to climb to the top of the world, and you want to make the most of it.

The following section shows how your score will be calculated.

DO NOT SHARE YOUR POINT SYSTEM DETAILS WITH YOUR TEAM MEMBERS.

Goal	**Points**
Reach summit	2
Avoid rescue	3
All climbers reach summit	5 (one per climber)
All climbers complete climb without needing to be rescued	5 (one per climber)
All climbers stay together through camp	1
All climbers stay together through summit	1
Total Points for Personal Goals	**17**
Bonus points (revealed during simulation)	3
Your Total Possible Points	**20**

[8] Please see Appendix F for Copyright Permission to reproduce these profiles

A.2. Physician's Role Description

You are a tenured professor at a major medical school and a world-renowned physician. Your publications have appeared in the top medical journals, such as The Lancet, Journal of American Medical Association, Nature, and the New England Journal of Medicine. You have climbed Mount McKinley, the highest peak in North America, as well as Aconcagua, the highest peak in South America. However, you have never climbed an 8,000 meter peak.

You have decided to go to Everest as part of your research. You are trying to capture the changes in cognitive functioning, heart functioning, and so on, as people climb above 15,000 feet. As part of your research, you would like to see how people adjust as they sleep and rest at a particular altitude. In other words, you would like to see if stopping for a day at a particular altitude helps the body adjust and, therefore, makes minds and bodies function better on the next day's climb. The best way to do this would be to get everyone to stop at one camp for one day sometime during the climb. Can one day make a difference? That is your key question. You would like to get to the summit, but it isn't absolutely necessary for your research.

You have a wonderful family including your spouse and three children -- ages 2, 6, and 8. You have promised them that you won't do anything foolish in your quest to experience Everest. As a physician, it is extremely important for your career that you don't get frostbite in your hands or fingers.

As the Physician you will be allocating medical treatment to your teammates. Please note that you can only allocate assistance to one team member per round.

The following section shows how your score will be calculated.

DO NOT SHARE YOUR POINT SYSTEM DETAILS WITH YOUR TEAM MEMBERS.

Goal	**Points**
Reach summit	2
Avoid rescue	3
Avoiding getting frostbite	1
All climbers spend extra day at any camp	1
Total Points for Personal Goals	7
Bonus points (revealed during simulation)	3
Your Total Possible Points	**10**

A.3. Photographer's Role Description

You are an award-winning photographer for a top nature magazine and a world-renowned documentary film-maker. You have won several Emmy awards for your work. You have been to the summit of Everest twice, and you are very well respected for your mountaineering accomplishments in your native Chile.

This time, however, you would not be disappointed if you did not reach the summit. Your primary interest is in capturing photos and video of the Khumbu Ice Fall for a project on which you are working. To do a good job, you would like to spend one extra day at Camps 1 and 2.

Your hope is that these photographs will enable you to submit a winning entry to the very prestigious Pilsner Urquell International Photography Awards Competition.

The following section shows how your score will be calculated.

DO NOT SHARE YOUR POINT SYSTEM DETAILS WITH YOUR TEAM MEMBERS.

Goal	**Points**
Avoid rescue	3
Spend 2 consecutive days at camp 1	1
Spend 2 consecutive days at camp 2	1
Total Points for Personal Goals	**5**
Bonus points (revealed during simulation)	3
Your Total Possible Points	**8**

A.4. Marathoner's Role Description

You are a top-notch marathon runner, having won the New York, London, and Chicago marathons in the past five years. You are in top physical condition. Though you have asthma, it has never inhibited your running career.

The tallest peak that you have ascended is Mount McKinley -- North America's tallest peak at 6,194 meters. During that climb, you reached the summit without any substantial difficulty. You would now like to see if you can climb Everest. However, you have never climbed an 8,000 meter peak. You don't know that much about climbing in the Himalayas, but you are counting on being able to rely on others who have much more experience.

You also know that you are in phenomenal shape, and hoping this really helps. You are the kind of person who never quits. In your time as a long-distance runner, you have finished over 50 marathons and have never had to drop out of a race. You would like very much to get to the summit, so as to become the first world-class marathoner to reach the peak of Everest.

Your primary sponsor has promised to feature you in a major new ad campaign if you reach the summit, and will sign you to a new multimillion dollar endorsement contract as well. No marathoner has ever received such a lucrative endorsement contract. As a marathon runner, it is extremely important for your career that you don't get frostbite in your feet or toes. Therefore, you'll be sure to predict the weather at each camp before deciding to hike ahead.

The following section shows how your score will be calculated.

DO NOT SHARE YOUR POINT SYSTEM DETAILS WITH YOUR TEAM MEMBERS.

Goal	**Points**
Reach summit	2
Avoid rescue	3
Avoiding getting frostbite	1
Total Points for Personal Goals	**6**
Bonus points (revealed during simulation)	3
Your Total Possible Points	**9**

A.5. Environmentalist's Role Description

You are Italy's most accomplished mountaineer, who began your career as a teenager scaling mountains in the Alps. Your hero growing up was Reinhold Messner, a climber from South Tyrol in Italy who many view as the greatest high-altitude mountaineer in history.

You are here to clean up the mountain. You are tired of hearing about people who leave tons of junk on the mountain, including old tents, gear, and oxygen canisters. You are going to work on cleaning up the various camps. You have been to the summit twice before in your career. Your hope is to spend an extra day at camp 4, so that you can assemble all the garbage at camp and then enlist the help of your team to carry the tanks back to Base Camp on their way down the mountain.

If you accomplish an effective clean-up, you are going to receive a major grant from a large European corporation whose CEO is dedicated to promoting environmental protection. You plan to use the grant to fund your efforts to complete the clean-up of a polluted river in Italy – (this is your pet project, which you have been working on for 10 years).

In a surprising development, you experienced Acute Mountain Sickness (AMS) on your last expedition in the Himalayas. However, you know that everyone is counting on you to help many of the other climbers, given your experience on Everest and other high-altitude climbs. You do not want to disclose your concerns about your health, because you are afraid you may be asked to leave the team and because you had not had these kinds of problems earlier in your esteemed career. A part of you, though, thinks that this may be your last shot at Everest, if these health issues get worse.

The following section shows how your score will be calculated.

DO NOT SHARE YOUR POINT SYSTEM DETAILS WITH YOUR TEAM MEMBERS.

Goal	**Points**
Avoid rescue	3
Spend extra day at camp 4 during ascent	1
Total Points for Personal Goals	**4**
Bonus points (revealed during simulation)	3
Your Total Possible Points	7

A.6. Observer's Role Description

You are the team Observer and play a critical role in examining how this team interacts on its ascent up Mt. Everest. As the team moves through each round, you will need to observe team members and their communications carefully to see how the team dynamic evolves. You should pay particular attention to examples of information sharing, formal and informal leadership, conflict, and decision-making. After the simulation is complete, you'll be able to report a unique perspective on the team's experience.

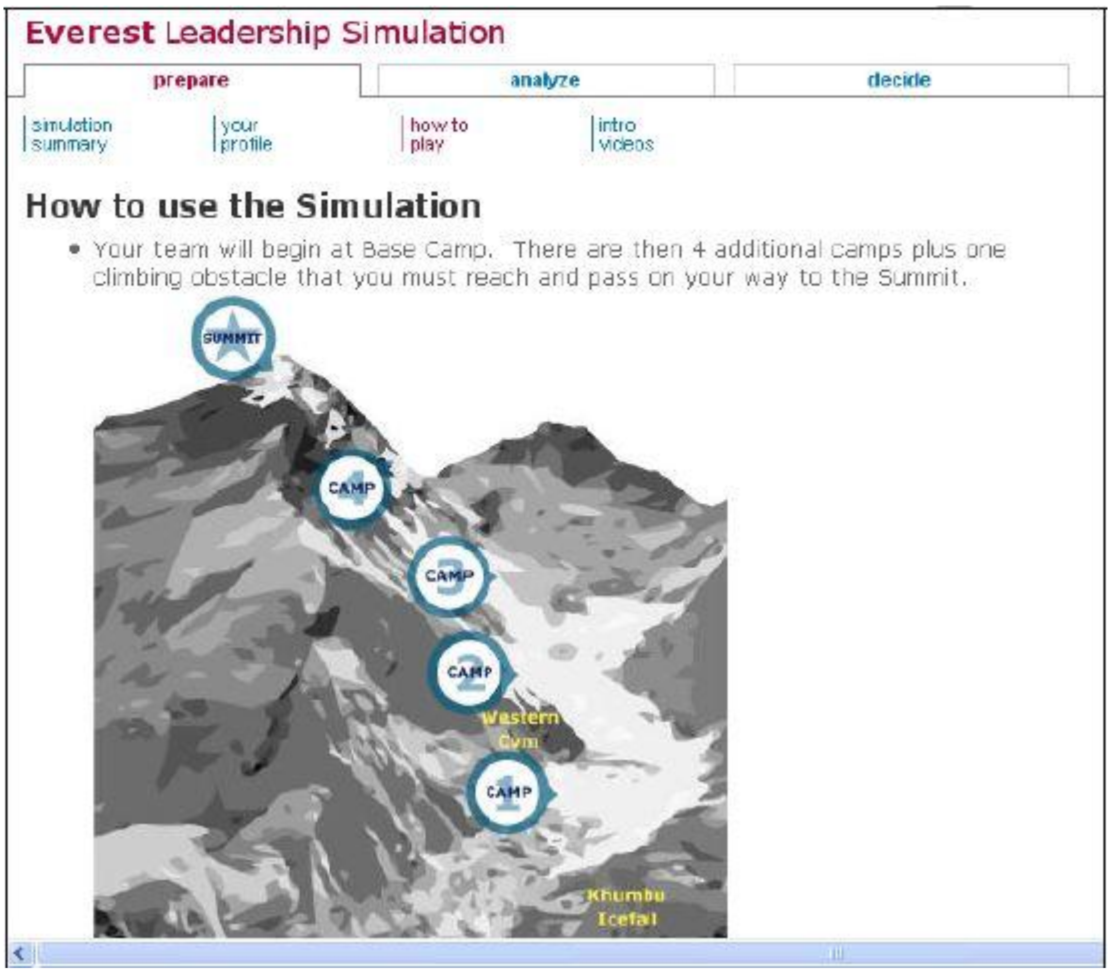
APPENDIX B: SIMULATION SNAPSHOTS

Retrieved from the Facilitator's Guide, Leadership and Team Simulation: *Everest* (Roberto & Edmondson, 2010). Reprinted with Permission from Harvard Business Publishing[9].

Figure B.1

Prepare Section - How to Play

(Roberto & Edmondson, 2010 p. 24)



[9] Please see Appendix F for the Copyright Permission to reproduce these snapshots

Figure B.2

Prepare Section – Individual Profile

(Roberto & Edmondson, 2010 p. 25)

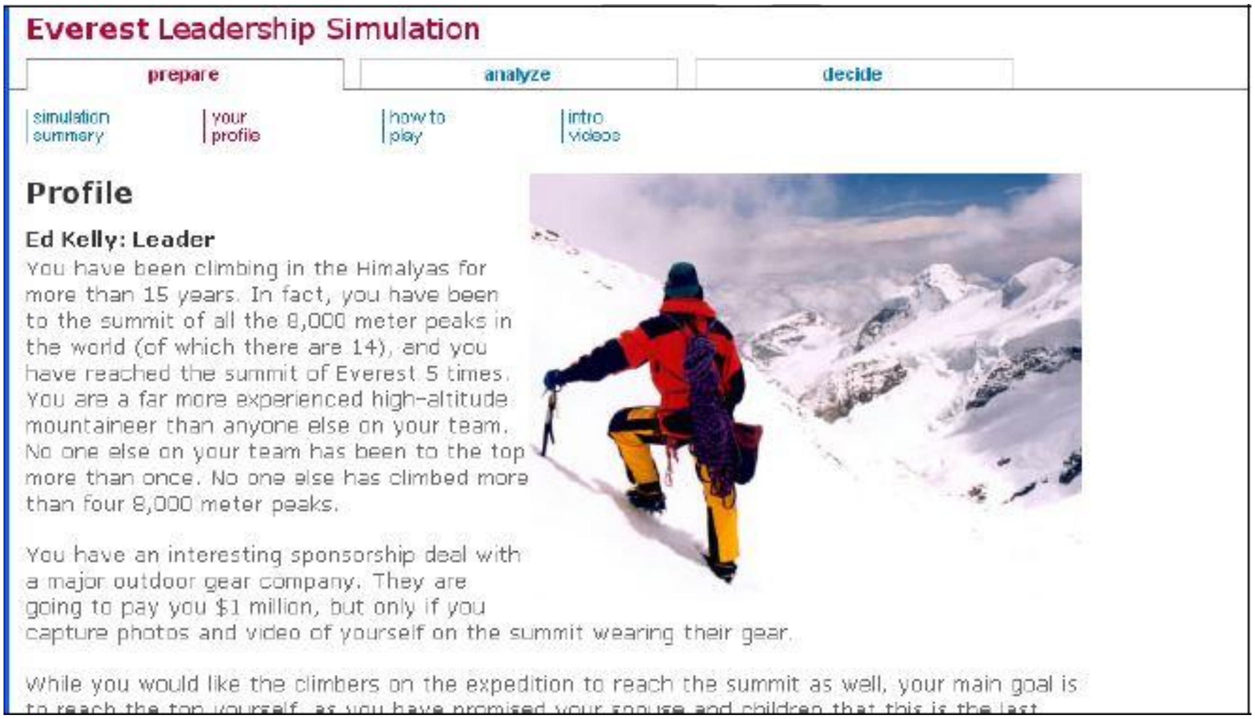


Figure B.3

Analyse Section – Dashboard Overview

(Roberto & Edmondson, 2010 p. 26)

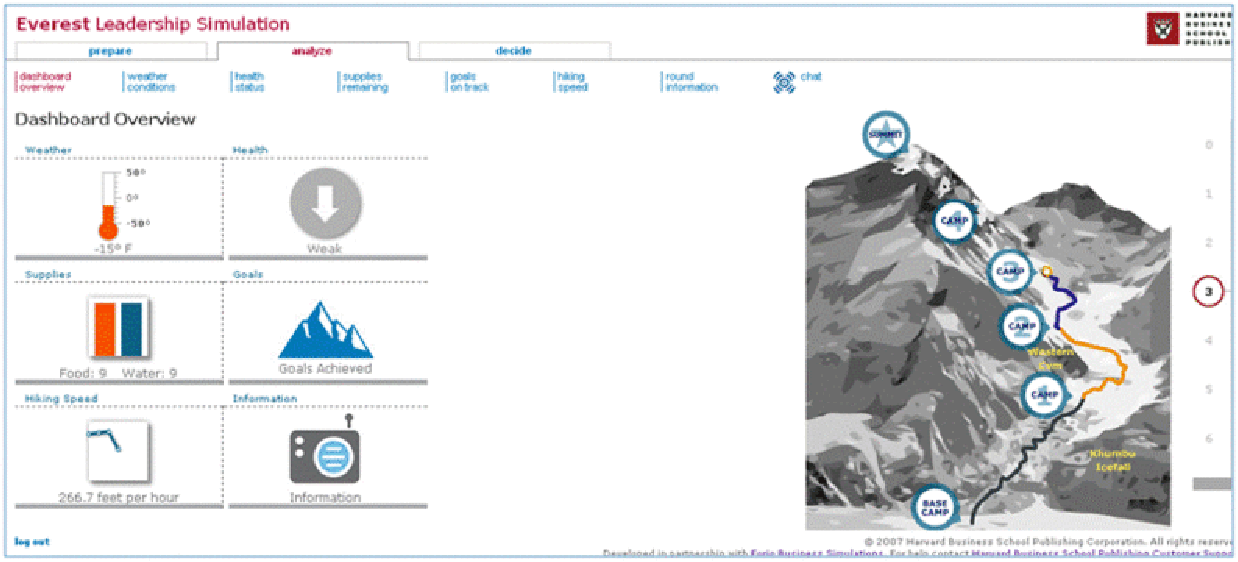


Figure B.4

Analyse Section – Weather Conditions

(Roberto & Edmondson, 2010 p. 28)

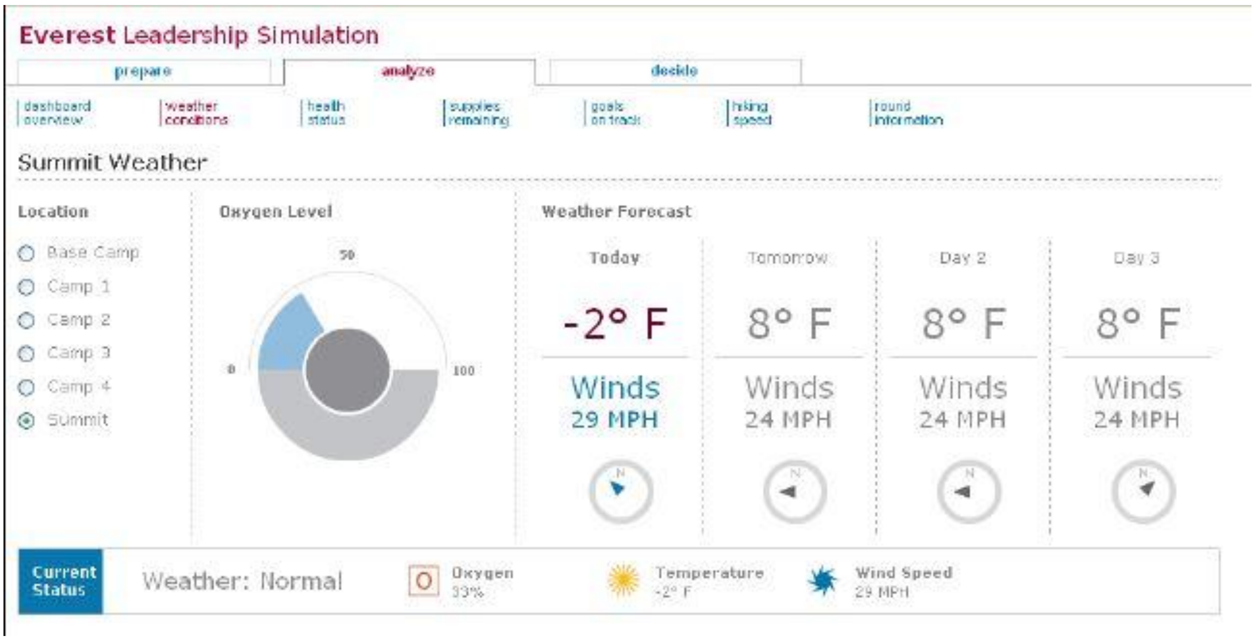


Figure B.5

Analyse Section – Health Status

(Roberto & Edmondson, 2010 p. 29)

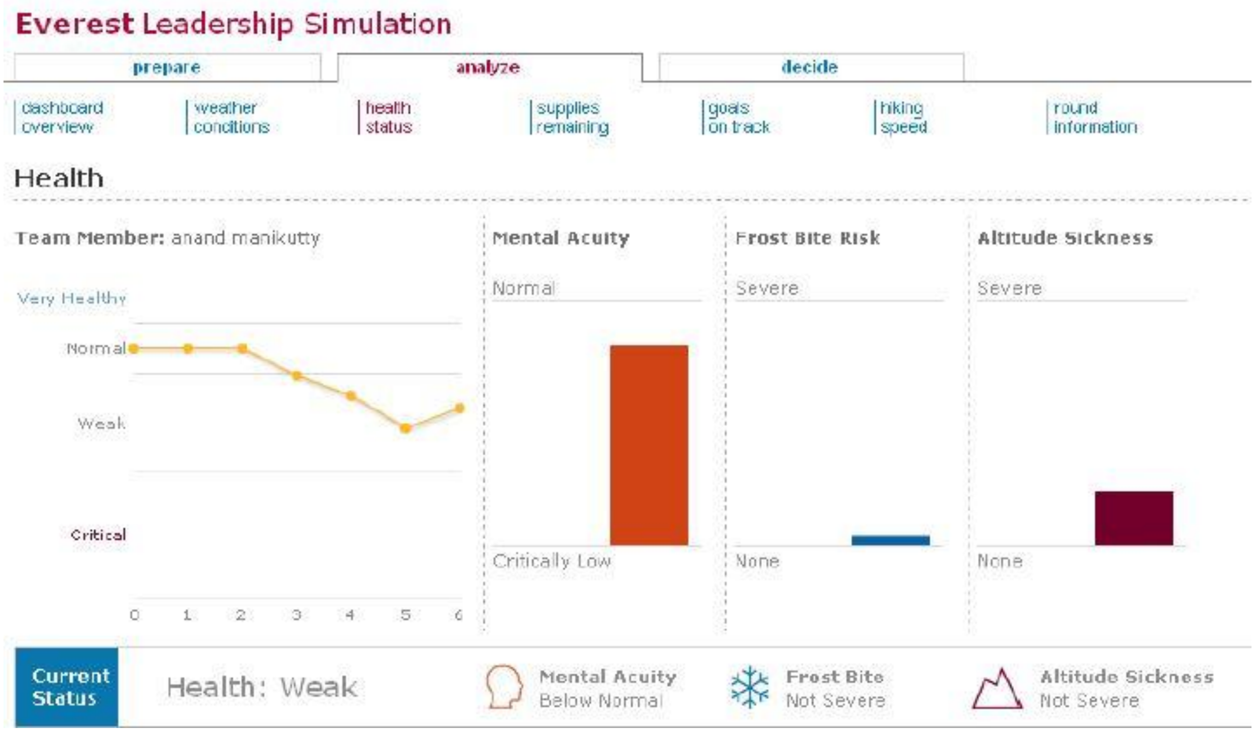


Figure B.6

Analyse Section – Supplies Remaining

(Roberto & Edmondson, 2010 p. 30)

Figure B.7

Analyse Section – Hiking Speed

(Roberto & Edmondson, 2010 p. 32)

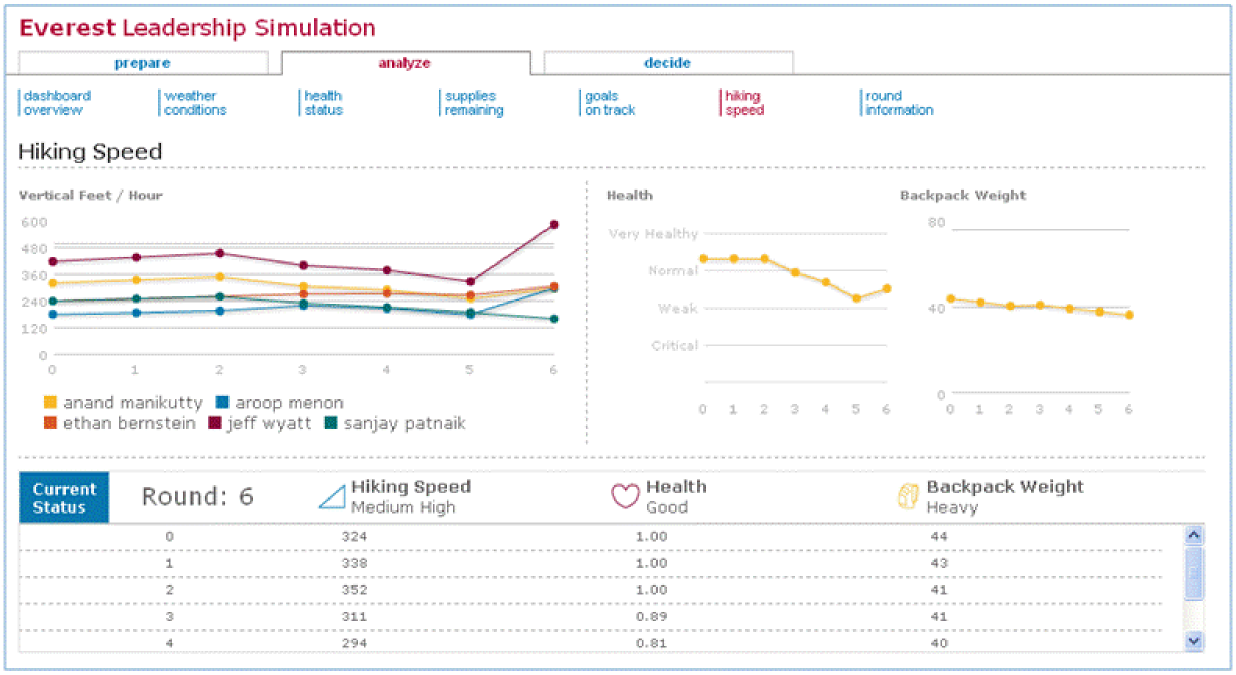


Figure B.8

Round Information Pop-Up

(Roberto & Edmondson, 2010 p. 34)

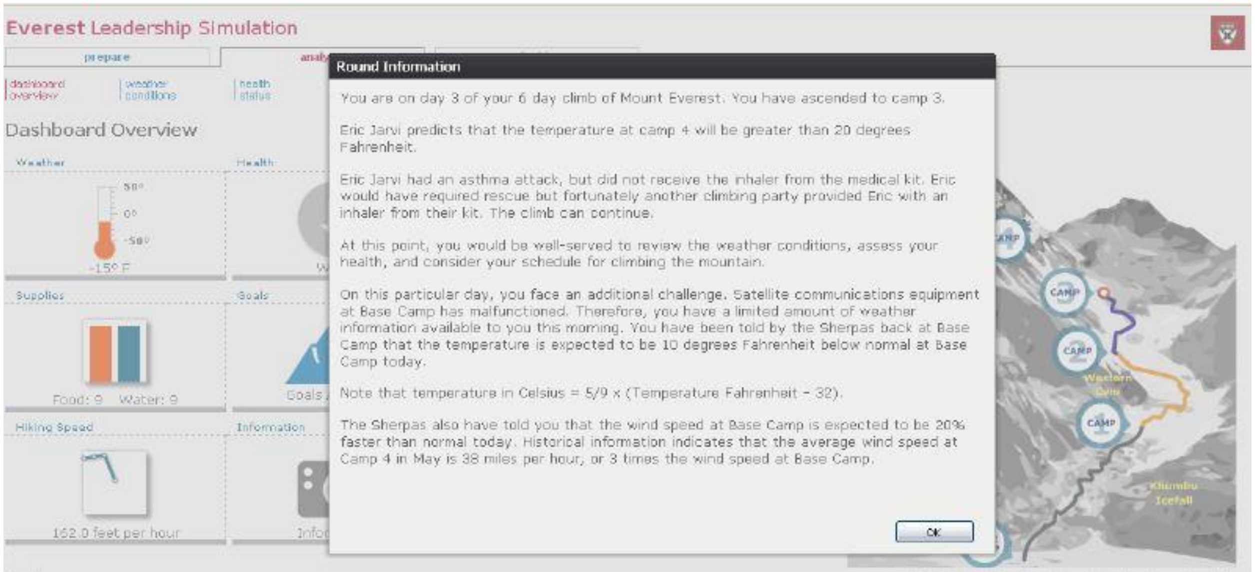
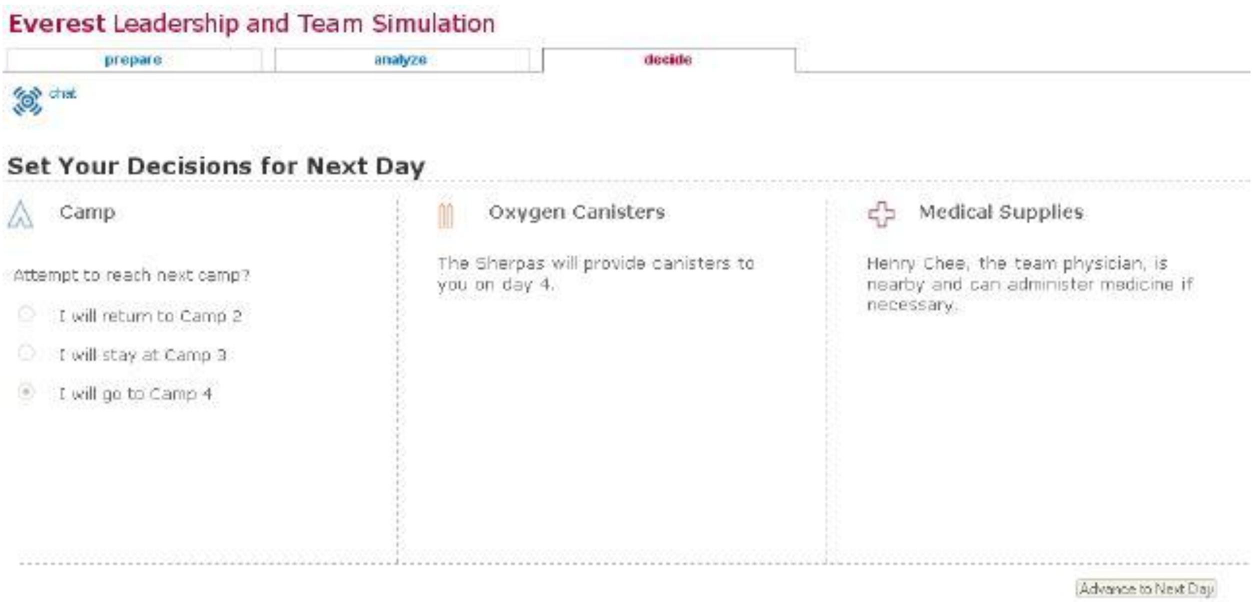


Figure B.9

Decide Section

(Roberto & Edmondson, 2010 p. 35)



APPENDIX C: WEIGHTED GOAL OVERVIEW BY PLAYER

(Roberto & Edmondson, 2010 p. 57)

Goals and Challenges	Leader	Physician	Photographer	Marathoner	Environmentalist	Total Potential Points Per Team
Avoid rescue	3	3	3	3	3	15
Reach the summit	2	2		2		6
Other members reach the summit	5					5
Other members avoid rescue	5					5
All members stay together through Camp 4	1					1
All members reach summit together	1					1
Avoid frostbite		1		1		2
Extra day at any camp		1				1
Extra day at Camp 1			1			1
Extra day at Camp 2			1			1
Extra day at Camp 4					1	1
Pass medical challenge (Round 2)	1	1	1	1	1	5
Pass weather challenge (Round 3)	1	1	1	1	1	5
Pass oxygen challenge (Round 4)	1	1	1	1	1	5
Total potential points by role	20	10	8	9	7	54

APPENDIX D: CODING SCHEME

Information-Oriented Behaviours

Voluntary Information Provision

- Unsolicited fact or status sharing, i.e. does not follow a request
- Also any statement providing information regarding the structure/functioning of the simulation
- Sometimes when they are reviewing their profile, they read some parts aloud. These utterances should be coded as <u>residual</u> and not VIP (because these utterances are not usually communicated with the rest of the team).

Request Information

- Request for information (not for action), questions seeking information regarding facts or status
- Also any question seeking information regarding the structure/functioning of the simulation.
    - For example, when someone asks the physician what he has in his medical kit or whether he can give away only one thing per day.

Answer

- Supplying information in response to a question
- If the answer is not provided immediately and is delayed by one or two utterances, still code it as answer.
- Also any statements regarding the structure/functioning of the simulation.
- In rare cases, they answer a yes/no question with head nod/shake. If that is the only answer the person gets, then code it as if it was an utterance.
- If the person attempts an answer but does not provide the information (e.g. I don't know), we still code it as answer and assign the NIP code under info code.

Information Code

- Whenever you choose a code from VIP, ReqInfo, or Answer, the appropriate info code should be selected as well.
    - **System** code is selected when they share/ask information about the structure/functioning of the simulation. Also any information related to the videos.
    - **NIP** code is selected when they discuss lack of knowledge about the simulation. For example, "I don't know how...". or "I don't know".

- **Gen Know** If they are giving information from elsewhere, for example their personal experience or general knowledge.

General Note: When they are going back and forth exchanging round information to understand whether they have similar information or not, I code it as information exchange with System code.

- When they help other members to find something on the system; for example, it's under round information
- When they are checking whether everyone has received the new round information; it's coded under information category.
- When they talk about whether they can all stay or go; it is system information.

Solution-Oriented Behaviours

a) **Propose Solution:** Statements that propose/suggest solutions.
   - Any concrete, particular, specific proposal for action;
   - Includes any proposed bargain, whether new or if added to another person's proposal.
   - Note that the proposal is not necessarily clearly framed as a proposal. Examples of indirect proposal for action:
   - "He is wheezing so I guess he needs an inhaler".
   - "Do you want to wait for another day here?"

b) **Elaborate Solution:** Any statement that modifies (make partial or minor changes), elaborates (presents and describes in more details), qualifies (describes by enumerating the characteristics or qualities of the solution), clarifies or provides details on proposed solution.

c) **Evaluate Solution:** Statements that offer reasoning to support, reject, or evaluate the proposed solution
   - NOTE THAT REASONING AND JUSTIFICATION IS KEY HERE.
   - All statements that describe possible benefits of a solution, draw analogies between the solution and other solutions or situations, or indicate aspects of the problem that the solution will overcome
   - All statements that offer reason for rejecting a solution or details of a solution
   - All statement that are evaluating solution, providing reasoning, even if they do not have a clear positive or negative evaluation.

d) **Solution-Oriented Questions**
   Any solution related question (ask for <u>clarification of the solution dimensions</u>, <u>ask for elaboration on different dimensions</u>, <u>asking for more details</u>, <u>asking critically</u>).
   - Basically, whenever they ask a question related to the solution at hand, it should be categorized under this item. Examples:

- Questions designed to have the person who proposed the solution describe it in more detail
- All interrogatory statements asking for clarification of the statements of a previous speaker

e) Ask for Confirmation: When someone explicitly asks for confirmation or vote; The person asks the group (or individual members) whether they agree with the final decision.

f) Confirm Solution: when team members offer final confirmation of the decision, either verbally or by head nod.

- Note: In most teams, they do not explicitly ask for confirmation. It is in the form of going around and pointing at different people whether they've submitted.

Simple Agreement: Simple Agreement with immediately preceding act

- Statements expressing agreement with immediately preceding act, but which do not give reasons or justification. Statements which agree and also give reasons are coded as 'Evaluate Solution'.

Simple Disagreement: Simple disagreement with immediately preceding act

- Statements expressing disagreement with immediately preceding act, but which do not give reasons or justifications. Statements which disagree and also give reasons are coded as 'Evaluate Solution'.

Individual Decision Activity: When team members express (or are asked about) their decision regarding staying or going in isolation from the team.

- **Ask for Individual Decision:** When someone asks about a team member's decision as if they are deciding as independent decision makers. For example: "What are you going to do?"
- **Express Individual Decision:** When someone expresses individual decision in forms such as: "I am going to stay here today"

Executive Activities

Statements that direct the group's process or help the group do its work; It can be in form of statement, question, or answer to question; Statement representing executive activities include:

- Statements that summarize previous discussion
- Statements on how the group should organize its discussion. E.g. "we are going to go around and share information".
- Pacing or timekeeping statements.
- Comments on internet speed or connectivity. E.g. "my internet is very slow"
- Comments on taking notes or storing information somewhere
- All requests for **repetition** and answer to such requests.

    - Note that if the person repeats a previous statement without anyone asking for repetition, we code it based on the function of the statement; in other words, we ignore that it is being repeated.
- All **clarification** questions and answer to these questions. For example, when someone asks a question to clarify course of team discussion, it is coded as Executive Activities. Example:
    - "But he has done it twice"
    - "What? Clean up the garbage?" [clarification question]
    - "NO, reach the summit" [clarifying statement]
- **Correction** of a team member's comment.
- **Exclamation** (e.g. someone says something and another person repeats with slight surprise)
- When someone repeats something that another person said, we code it here. Even though it seems more reasonable to categorize it as residual, we code it here to make the coding easier.
- I am waiting
- Oh, we have to read.

Ask/Give Opinion, Evaluation, and Analysis

- Giving opinion, evaluation and analysis
- Asking someone's opinion
- When they summarize the key points of the reading, it should be coded here instead of executive activity.

Residual

- Anything that does not fit other categories
- Incomplete or inaudible sentences
- Sometimes, they use phrases as emphasis, something like tag questions. For example, in response to "my health is critical" someone asks "is it?". This question and its answer should be categorized as 'residual'.
- Nontask statements: comments not related to the task
- Joking
- The expression "yeah" unless it is an answer to a question.
- "wait", "hold on", etc.
- Blaming
- Reflection on previous decision

Coding Guidelines:

1. If an utterance is incomplete (by intention or interrupted) but the function is communicated and clear, then we code that utterance as if it were completed.

2. When an utterance is cooperatively completed by another, code the completion as serving the same function(s) as the utterance is completed. In other words, ignore that it was a cooperative act and code it as if the first speaker completed his/her sentence.
    a. The statement of the next person who completed the first one, and also the first speaker's continuation of his statement should go into residual. For example:
        i. Mar. The weather tomorrow is... [treat as complete sentence]
        ii. Phot. Minus 16 [residual]
        iii. Mar. Minus 16 [residual]
3. If someone is interrupted and then repeats the statement later on, we code the first one as residual and the second one based on the function of the statement.
4. When Golchehreh enters the room, two cases could happen:
    - Case 1: I come in to give instruction regarding the use of advance button. These comments should be coded as 'residual'
    - Case 2: They ask me in to answer their questions. In this case, it could be coded as information-oriented activities. Of course, if I come in to give instructions and then they start asking question, we should choose the right code for the information seeking statements.

Note about Time:

If they are making a pacing comment such as "hurry up guys", it should be executive activity.

If they are just checking how much time they have left or how much time they have used, then it's a simple fact checking, with system info code.

Summary of Rules for Repetition:

If the same person repeats his/her statement, it is coded as if it were the first time.

If another team member just repeats something said by another member, we code it as executive activity. In essence, this should be residual. However, to keep our coding simple, we decided to put it as executive activity.

Summary of Rules About 'Yeah'

- It cannot be simple agreement
- It can be a response in executive activity
- It can be a response to a request for info
- It can be solution elaboration in response to a solution-oriented question.

IMPORTANT NOTE
If they ask a question about the solution and the person responds with bringing up information,

we code the response in information-oriented section as answer and choose the right info code. If they answer with “I don’t know” or “it doesn’t say anything”, it should be answer and NIP.

Note about Misunderstood Questions

If someone asks a question that is misunderstood and the person repeats the question:

- Obs: “What are you giving to him?” [code based on the main function; sol-oriented question]
- Phys: “Yeah” [residual]
- Obs: “what are you GIVING to him?” [residual]

Note about Distinction between Executive Activity And Confirmation

If they use words such as “Submit” or “entered their solution”, then it is executive activity and not confirmation.

Note about Statements Ending in ‘Right?’

Sometimes statements ending in ‘,Right?’ are VIP and sometimes they are Request for Info. We decided that we will look at the next statement to understand how the team members interpreted the statement.

Note about Reflection on Data

If they summarize or emphasize a piece of information, as long as it’s clear which piece they are referring to, I code it as VIP. If it’s a comprehensive summary of what they read, I code it as Opinion.

Note about Detection of Asthma

If they say “it must be asthma” or “you have asthma” or anything along that line, I code it as Opinion and not proposing solution because it doesn’t say how they are going to treat it.

Note on Propose Solution

When someone is advocating a solution without any argument, I am coding it as propose solution. For example, if they talk a while and then someone says, “Yeah, I think we should stay”. So, it’s not a new proposal but the best fit for it is propose solution.

APPENDIX E: DETAILS ON DEVELOPMENT OF PHASE MAPS

In the first step, using four phase indicators (i.e. I, S, C, and E), I made the following replacements in the existing code:

1. All 'residual' codes were removed.
2. Information-oriented codes (i.e. voluntary information provision, request information, and answer) were replaced with letter **I**.
3. Because 'ask/give opinion, evaluation, and analysis' is more similar to information block than solution block, I replaced this code with letter **I**.
4. Solution-oriented codes (i.e. propose solution, elaborate solution, evaluate solution, solution-oriented question, express individual decision, and ask for individual decision) except for 'ask for confirmation' and 'confirm' were replaced with **S**.
5. 'Ask for confirmation' and 'confirm' were replaced with **C**.
6. 'Executive activities' were replaced with **E**.
7. According to the coding scheme guideline, 'simple agreement/disagreement' codes are agreement/disagreement with previous statement. Therefore, the nature of each of these codes is similar to the previous code. I replaced each of these codes with **I** if the previous code was in the list of information-oriented activities, **S** if the previous statement was in solution-oriented activities and so on.

After these replacements, I created a string of coded behaviours for each team. For example, the following string shows coded interactions of team 12:

IIIIIIIIIIEEIIIIIIIIIIIIEIIIIEISIIEIIIIIIEEEIIIISIISIIIIISSISSSSIIIIIEEEEEIISIIIIIIESIIISSSI
ISSSSSSIIISEESIIIIIIESSIISIISSSSISSIIIEISSSSIIIISSSIIISSSSSSIIISIIIISSSEESSSSSSEI
IIIIISSSSIIIIIIIISCEIEECCIIEIIICEIIIIICIIIIISSEEEESSIIISSSSSSIIISSSSEESEISSSISIIS
IESSSSEEEESSSSSSSSSSSSSSSEESSSSSSSSSISSSSSSISSSSSIISSIIEIISSSSIESSSSSSSI
SSSSSSSSSSSEEEIIEISISISIISSSSSSSSSSSIIIEIEIIIIIIISSSSSSSISSSSSSSESSSSSSSSSISS
SISSSSSSIIESSSSSIISISSSSSSSSISSSISSISSSICCSCSSSCCCEEEEEEEC

Once I created these initial strings, I realized that the E phase indicator would not provide useful information about team processes. This is mainly due to the definition of this code. According to the coding scheme, a wide range of behaviours such as asking for repetition, asking for clarification, repeating, clarifying, and exclamation are coded as executive behaviour.

Therefore, in order to simplify the existing strings, I removed all E indicators from the strings. In other words, I treated executive code as residual.

Identifying Phases

In the next step, I needed to set some rules for identifying a phase. Holmes and Poole (1991) who developed the flexible phase mapping method, indicate the following steps as their guideline for phase mapping:

1. "A phase is minimally defined as three consecutive codes that share the same phase marker value. The initial boundary of a phase is the first phase maker of the set of three.
2. A phase continues until it is terminated by the occurrence of three consecutive phase markers not of the same phase value. The terminal boundary of a phase is the last phase marker prior to the three non-matching codes.
3. If three codes from three different classifications occur consecutively, the period is designated a non-organized period, one in which no distinctive or coherent behaviour can be detected with this coding system.
4. Combination phases may be defined when theoretically appropriate. In this case, combinations of several different phase markers are used to identify the complex phase" (Holmes & Poole, 1991, p. 296).

According to these rules, if for example I am marking an information phase, the following string would qualify as a phase: IIIISISICI. Therefore, pure information-oriented phases would be mixed with non-pure phases that involve alternation between information-oriented and solution-oriented activities. Hence, while building on Holmes and Poole's guidelines, I made some adjustments to these guidelines to make them more suitable for my research question.

At the first pass, I picked six colours to mark different phases according to the following colour code:

- Pink: Pure information phase
- Green: Pure solution phase
- Gray: Pure confirmation phase
- Yellow: Mixed information and solution phase ;
- Turquoise: Mixed solution and confirmation phase

- Bright Green: Mixed information and confirmation phase

First, I marked all pure phases, meaning that the phase starts with three characters of the same phase marker and ends when a different phase marker is observed. Therefore, a phase cannot have any interruption. Then, I highlighted any mixed information and solution phase. Next, if there were three events left that fit the next two categories, I marked them. Here is the phase map for team 12 after this step:

IIIIIIIIIIIIIIIIIIIIIIIIIISIIIIIIIIIIISIISIIIIISSISSSSIIIIIISIIIIISIIISSSIISSSSSSIIISSIIIIIS
SIISIISSSSISSIIIISSSSIIIISSSIIISSSSSSIIISIIIISSSSSSSSSIIIIIISSSSIIIIIIISCICCIIIIICII
IIICIIIIISSSSIIISSSSSSIIISSSSSISSSISIISISSSSSSSSSSSSSSSSSSSSSSSSSSSSISSSSSSSIS
SSSSIISSIIIISSSSISSSSSSSISSSSSSSSSSSIIISISISIISSSSSSSSSSIIIIIIIIIISSSSSSSISSSS
SSSSSSSSSSSISSSISSSSSSIISSSSSIISISSSSSSSISSSISSISSSICCSCSSSCCCC

Smoothing

The next step is what Poole and Dobosh (2010) call smoothing. Poole and Dobosh (2010) smoothed their phase data in two respects. “First, short phases of two or fewer units that were surrounded by a single type of phase were merged into that phase. Second, where relatively short phases alternated, they were merged into a phase that was identified as the combination of the two units” (Poole & Dobosh, 2010, p. 416). I followed Poole and Dobosh’s first rule and if one or two phase markers were in the middle of two phases of the same kind, I merged these two phases. For each team, I recorded two numbers. The first number indicated the number of times that S or C indicators where merged into two information phases. Similarly, the second number indicated the number of times that I or C indicators were merged into two solution phases. For example, in team 12 the first recorded number is 7 and the second one is 11. Here is the new phase map for team 12:

IIIIIIIIIIIIIIIIIIIIIIIIIISIIIIIIIIIIISIISIIIIISSISSSSIIIIIISIIIIISIIISSSIISSSSSSIIISSIIIIISSIISIISSSSISSIIIISSSSIII
ISSSIIISSSSSSIIISIIIISSSSSSSSSIIIIIISSSSIIIIIIISCICCIIIIICIIIIICIIIIISSSSIIISSSSSSIIISSSSSISSSISIISISSS
SSSSSSSSSSSSSSSSSSSSSSSSSSSISSSSSSSISSSSSIISSIIIISSSSISSSSSSSISSSSSSSSSSSIIISISISIISSSSSSSSSSII
IIIIIIIISSSSSSSISSSSSSSSSSSSSSSSSISSSISSSSSSIISSSSSIISISSSSSSSISSSISSISSSICCSCSSSCCCC

Once the previous step was completed, there were few scattered codes in each team that were not assigned to any phase. For example, you can see one “S” and one “I” in team 12 that are not highlighted. I deleted all of these unassigned codes and recorded number of their occurrences for each team.

Normalizing

Since different teams do not have the same number of units of analysis (utterances in this case), phase maps should be normalized so that teams can be compared with each other. In a normalized map, length of each phase represents "the percentage of the total discussion it occupied" (Poole & Roth, 1989a, p. 338). I counted the number of units for each phase and calculated the percentage of total units that it occupied; this number was recorded with two decimal points accuracy.

In order to be able to create maps with the same visual length, I needed to change the letters that I used for each phase. After reviewing the size of different characters in Microsof Word, I found few characters that have the same size. I chose the following characters as new phase indicators:

- G: Information phase
- H: Solution phase
- X: Confirmation phase
- U: Solution and Information mixed phase
- N: Solution and Confirmation mixed phase
- K: Confirmation and Information mixed phase

I used font size 10 to draw the maps. When the percentage was not a whole number, I changed the font size for the last character. For example, the first phase in team 12 is an information phase with length of 10.25. To illustrate this phase, I inserted 10 "G"s with font size 10 and one "G" with font size 2. Here is the final normalized map for team 12:

GGGGGGGGGGGUGGUHGGGGGHHHGGGUUHUGHGHGHHGGHHHGGHGGKGGGGGHGHHGHHHUUHHHHHHHHHHUGHHHHH

HGUUHHHGGGHHHHHHHHHHHUHHHUHNHX

APPENDIX F: COPYRIGHT PERMISSION TO REPRODUCE THE ROLE PROFILES AND SNAPSHOTS OF THE SIMULATION

On January 07, 2014 I contacted the Copyright office of the Harvard Business Publishing (HBP) to request permission to reproduce the role profiles and simulation snapshots in the dissertation. Tim Cannon, the Permission Coordinator at HBP granted the permission. Details of the communication are provided below.

F.1. My First Email to permissions@hbsp.harvard.edu

Hello,

I am a PhD candidate at the Schulich School of Business, York University (Toronto, Canada). Back in 2010, I used the "Leadership and Team Simulation: Everest" to collect my dissertation data. Right now, I am finalizing the dissertation. My examining committee would like to see role profiles and some simulation snap shots to better understand the context of my data collection. I have attached the two appendices in which I have provided role profiles and simulation snap shots.

I am writing to you to inquire whether I would have permission to include this information in my dissertation.

I look forward to hearing from you,

Sincerely,
Golchehreh Sohrab

F.2. The First Response from Tim Cannon, the Permission Coordinator at HBP

Dear Golchehreh Sohrab,

Thank you for your email. As long as the requested HBP material is only being used to fulfill the class assignment in the pursuit of your degree, permission to use the material in your dissertation would be granted at no charge as long as the material is fully cited.

Regards,

Tim Cannon
Permissions Coordinator
HARVARD BUSINESS PUBLISHING
300 North Beacon Street | 4E | Watertown, MA 02472
voice: 617.783.7587
fax: 617.783.7556
web: www.harvardbusiness.org

F.3. My Follow up Email to Tim Cannon, the Permission Coordinator at HBP

Dear Tim Cannon,

Thank you for getting back to me so quickly. Dissertations are usually made available on different research databases within five years after student's graduation. Do you think that would be a concern?

Thanks,
Golchehreh

F.4. The Second Response from Tim Cannon, the Permission Coordinator at HBP

Hi Golchehreh,

Thank you for your follow up. No, this permission request below will be absolutely fine.

There would be an issue with the requested material for use in training or a textbook, but academic use of the material in your dissertation (which would be made available on different research databases within five years after your graduation) is approved at no charge provided you cite the material.

Good luck with your dissertation.

Regards,

Tim Cannon
Permissions Coordinator
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