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RISK, UNCERTAINTY & DECISION-MAKING

DECISION-MAKING IN GROUPS UNDER UNCERTAINTY

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FonCSI

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Résumé

Titre	La décision en groupe en présence d'incertitude
Mots-clefs	décision, groupes, incertitude, psychologie, questionnaire
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Les auteurs ont étudié les processus quotidiens de prise de décision en présence d'incertitude, à l'aide d'une étude de terrain (*field study*) dans le secteur médical. Le travail s'inscrit dans la tradition de recherche en *naturalistic decision-making* (NDM), qui vise à comprendre comment des personnes travaillant dans un environnement critique conceptualisent et internalisent les incertitudes, comment ils les gèrent pour parvenir à prendre de bonnes décisions dans leur activité quotidienne.

L'analyse de leurs données d'enquête indique que l'incertitude est perçue en termes de l'*objet* concerné et des *sources* d'incertitude (ce qu'avait déjà identifié des recherches précédentes), mais aussi — il s'agit peut-être d'une observation limitée au secteur étudié — comme un manque de connaissance ou de compétence personnelle. L'incertitude est accompagnée de fortes émotions de peur et de honte. Elle survient lors du processus de diagnostic, pendant le traitement et à la fin du processus de prise de décision. Les **sources d'incertitude** les plus fréquemment citées sont une information incomplète et une compréhension imparfaite due à une information instable. Les descriptions des décisions prises en groupe révèlent que l'individu est vu comme une source d'incertitude lorsque est perçu un manque de connaissance, de compétences et d'expertise. Le groupe peut constituer une source d'incertitude s'il existe des opinions divergentes dans les personnes composant le groupe prenant la décision.

Trois situations de prises de décision en groupe ont été identifiées : des réunions interdisciplinaires planifiées (comme les conférences sur les tumeurs), les réunions formelles d'un service hospitalier, et des consultations *ad hoc*. Dans tous les centres de soins concernés par cette étude, les **procédures structurées de prise de décision sont très peu mises en œuvre**. Les stratégies employées pour gérer l'incertitude comprennent des tentatives de réduire l'incertitude en recueillant des informations supplémentaires, le report de l'action en attendant que davantage d'information soit disponible, ou la demande de conseil auprès d'autres médecins.

Les facteurs qui déterminent au final les décisions prises en groupe sont la hiérarchie (l'opinion de personnels ayant un niveau hiérarchique plus élevé ayant davantage de poids), l'intérêt des patients et la compétence professionnelle. Parmi les **attributs de mauvaises décisions** prises en groupe, citons l'absence de consensus et l'utilisation du poids hiérarchique comme principal critère de décision. Les décisions jugées bonnes sont caractérisées par une base d'information suffisante, une culture positive de la discussion et la présence de consensus.

Les auteurs identifient quatre **obstacles à une bonne prise de décision** : un fort gradient hiérarchique, une mauvaise culture de la discussion, un fort besoin de consensus, et une structuration insuffisante des processus de prise de décision en groupe. Quelques techniques d'intervention qui ont démontré leur capacité à lever certains de ces obstacles dans d'autres industries sont présentées.

À propos des auteurs

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Abstract

Title	Decision-making in groups under uncertainty
Keywords	decision-making, groups, uncertainty, psychology, questionnaire
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The authors have studied daily decision-making processes in groups under uncertainty, with an exploratory field study in the medical domain. The work follows the tradition of *naturalistic decision-making* (NDM) research. It aims to understand how groups in this high reliability context conceptualize and internalize uncertainties, and how they handle them in order to achieve effective decision-making in their everyday activities.

Analysis of the survey data shows that uncertainty is thought of in terms of issues and sources (as identified by previous research), but also (possibly a domain-specific observation) as a lack of personal knowledge or skill. Uncertainty is accompanied by emotions of fear and shame. It arises during the diagnostic process, the treatment process and the outcome of medical decision-making. The most frequently cited **sources of uncertainty** are partly lacking information and inadequate understanding owing to instability of information. Descriptions of typical group decisions reveal that the individual himself is a source of uncertainty when a lack of knowledge, skills and expertise is perceived. The group can serve as a source of uncertainty if divergent opinions in the decision-making group exist.

Three different situations of group decisions are identified: Interdisciplinary regular meetings (*e.g.* tumor conferences), formal ward meetings and *ad hoc* consultations. In all healthcare units concerned by the study, only **little use of structured decision-making procedures** and processes is reported. Strategies used to handle uncertainty include attempts to reduce uncertainty by collecting additional information, delaying action until more information is available or by soliciting advice from other physicians.

The factors which ultimately determine group decisions are hierarchy (the opinion of more senior medical staff carries more weight than that of junior staff), patients' interest and professional competence. Important **attributes of poor group decisions** are the absence of consensus and the use of hierarchy as the predominant decision criterion. On the other hand, decisions judged to be effective are marked by a sufficient information base, a positive discussion culture and consensus.

The authors identify four possible **obstacles to effective decision-making**: a steep hierarchy gradient, a poor discussion culture, a strong need for consensus, and insufficient structure and guidance of group decision-making processes. A number of intervention techniques which have been shown in other industries to be effective in improving some of these obstacles are presented.

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Foreword

In 2008, the FonCSI published a Call for Proposals titled *Risk, uncertainty and decision-making practice* aiming better to understand how people concerned by hazardous activities relate to and cope with uncertainty. How do people handle uncertainty? How do they manage to act despite ambiguity while studying problems, making decisions, taking stands on issues? How people create the conditions which make it possible to move forward in uncertain contexts?

Six research teams were selected for funding. They concern a range of scientific disciplines — psychology, sociology, management, industrial engineering, nuclear engineering — and a variety of case studies: risk management practices around French Seveso facilities, the preparation and management of an avian flu pandemic, group decision-making in hospitals, and the development of medicines in the pharmaceutical domain. For more information on this research programme, please consult FonCSI's web site.

The work presented in this document, concerning **decision-making in groups under uncertainty**, is that of one of the teams selected for funding, based at the department of psychology and ergonomics of the TU Berlin.

There is a long tradition of research into decision-making under risk and uncertainty which aims to identify the "optimal decision", given a model of decision-makers' preferences. This work in decision theory, which can be traced back to French mathematicians Blaise Pascal and Pierre de Fermat, assumes that possible decisions and outcomes are well delimited, that decision-makers are perfectly informed, are able to reason probabilistically without making mistakes, and are perfectly rational. This *normative*, or *prescriptive*, approach to decision-making has led to the development of decision-support tools which are used in areas such as project planning and finance.

The recommendations made to decision-makers revolve around what psychologists **[Lipshitz et Strauss 1997]** call the "RQP heuristic":

1. **R**educe uncertainty, by attempting to obtain more information;

2. **Q**uantify irreducible uncertainty, by providing a probability estimate;

3. **P**lug the result into a formula, which suggests which decision alternative is optimal given the estimated probability.

Researchers in psychology, analyzing how people perceive and react to risk and uncertainty, have shown that this theory has poor explanatory power concerning most practical, day to day decisions:

▷ people's perception of an event's probability is affected by their perception of its severity: we cannot interpret the two dimensions of risk in an objective manner;

▷ we often make mistakes when making probability calculations;

▷ people are affected by a number of *cognitive biases* **[Tversky et Kahneman 1974]** (or *heuristics* which we use to make decisions), such as anchoring effects, framing effects, availability heuristics, base rate fallacy, loss aversion and illusion of control, which lead to choices which are incompatible with the prescriptive models ("irrational behaviour");

▷ people seem to make decisions based on **hunches** or intuitions that they derive from their experience, or follow group/**cultural norms** rather than making probability calculations;

▷ decision makers are sometimes unable to act not because they *lack* information, but because they are overwhelmed by the **abundance of conflicting meanings** that it conveys.

Over the last 20 years, researchers in psychology have investigated more **descriptive**, or **behavioural**, approaches to decision-making under uncertainty, based on observing **what people actually do** when faced with uncertainty and the **strategies they use to cope** in such situations. The *Naturalistic Decision-Making* (NDM) school has focused on observing

and attempting to understand decision-making and sensemaking by experts in complex real-life situations, such as fire-fighting and military engagement. These field observations have allowed researchers to identify characteristics of situations where very **experienced individuals** deal with high stakes, strong time pressure, incomplete information and poorly defined procedures, in a **real-world context** (very different from traditional laboratory experiments). These researchers have found that decision-makers in these situations seem to use their experience to identify a *reasonable*, "good enough" course of action, and do not spend time weighing other alternatives, thus deviating strongly from normative decision-making procedures. The amount of information available and the level of expertise of the person making the decision were found to be critical to the quality of the decision.

Previous work using the NDM approach has focused on individual decision-making processes. The authors of the present document have applied these techniques to analyze **group decision-making**, which introduces additional forms of uncertainty ("what do my colleagues think?" and "how will my team-member react to a given event?") and possibilities for biases or heuristics (deviations from normative decision-theoretic models), such as group-think and false consensus effects. The research is based on the medical domain.

Eric Marsden, FonCSI
February 6th 2012

We welcome in your feedback! Please send any comments or suggestions for improving this document via email to `cahiers@FonCSI.org`.

Contents

Introduction

Context

Imagine the following situation: an emergency department receives a call from the ambulance, saying that they are on their way to the emergency ward with a middle-aged patient who was found unaccompanied, non-sentient in his flat with poor vital signs, injured from a fall to the ground and still in an unstable condition. In the hospital, physicians from different disciplines gather to take over the patient. The ambulance arrives and as soon as the patient is under care of the physicians, the group goes through diagnostic and treatment processes in which the physicians have to make effective decisions to stabilize and rescue the patient.

This everyday example from the medical domain contains typical aspects of **complex decision-making under uncertainty** which are commonly found in many high hazard environments. Firstly, the physicians have to deal with a situation where **information is incomplete** and/or imperfect. The patient is not responsive and can therefore not tell what happened, what symptoms he perceives or give information about his medical history. To deal with this uncertainty the physicians have to find the best available evidence to support or refute assumptions. Experts in high hazard environments often deal with situations under uncertainty and decisions must be made despite uncertainty.

Secondly, in the example above, a group of physicians from different medical disciplines must deal with the decision-making situation. They combine their knowledge and expertise to handle this difficult situation. Organizations in many settings use *groups* (defined as any set of two or more members who perform on the same task **[Johnson et Johnson 1975]**) to cope with system variety and to overcome possible individual shortcomings. Groups are seen as means of achieving reliable outcomes (such as productivity and safety).

Both aspects — making decisions under uncertainty and decision-making in a group context — can have fundamental influences on decisions and be major obstacles to effective decision-making. These influences have therefore been analyzed in depth by psychologists.

Psychological research approached decision-making from different directions:

▷ **Normative approaches** explore how people *should* make decisions. Starting from formal mathematical models (such as subjectively expected utility models and Bayesian probability theory), general principles and constraints on making rational decisions are derived.

▷ **Descriptive approaches** have analyzed and described different heuristics and biases in decision-making under uncertainty **[Kahneman et Tversky 1972; Tversky et Kahneman 1974, 1986]**.

As decision-makers systematically violate normative principles, **prescriptive interventions** are implemented to help decision-makers to more nearly satisfy the normative ideal **[Lipshitz et Cohen 2005]**.

Another approach can be characterized by the attempt to understand how people in real-world contexts actually make decisions that are meaningful and familiar to them **[Lipshitz et al. 2001]**. This approach is called *Naturalistic Decision Making* (NDM) **[Klein 2008]**. NDM is primarily a descriptive approach that focuses on human decision-making in terms of expert performance in demanding situations **[Klein et al. 1993]**. NDM deals with situations that are marked by time pressure, uncertainty, vague goals, high stakes, group and organizational constraints, changing conditions, and varying amounts of experience. Other essential characteristics of NDM are context-bound informal modeling (studying the information people look for and the arguments used, rather than abstract formal models), and empirical prescription (prescriptions are derived from descriptive models of expert performance) **[Lipshitz et al. 2001]**. In contrast to normative research approaches, which conduct mainly laboratory experiments, NDM research is characterized by **field studies**, focusing on techniques to **elicit expert knowledge**.

The NDM research field has resulted in a number of **decision models**. The models tend to have different viewpoints, but all of them have been generated from studies in natural settings. Two examples are:

1. **Recognition-Primed Decision Model** (RPD): [Klein et al. 1993] has studied decision-makers (such as firefighters) in operational settings, to understand how they manage to be effective under high stress and time pressure. The main conclusion is that the decision-makers seldom analytically reach a decision by comparing different alternatives. Instead, they assess the situation and select an appropriate strategy based on the recognition of the situation. At the cognitive level, the RPD model incorporates two processes: firstly **situation assessment** (to generate a course of action) and secondly, **mental simulation** (to evaluate a course of action).

2. **Search for Dominance Structure [Montgomery 1989]**: In situations where people have a number of alternatives to choose from, they tend to look for a **dominant alternative**. The decision-maker processes the information (the set of attributes) in order to find a dominant alternative. If one is found, it is chosen. Otherwise, he/she will examine a different set of attributes and alternatives. A dominant alternative is an alternative that is perceived to be at least as good as all the other alternatives on all relevant attributes and better than each of them on at least one attribute. NDM recognizes that human beings operate with cognitive limitations in **bounded rationality**. It emphasizes **experience**, **intuition**, quick assessments, and expert judgment rather than time-consuming formulas (such as decision trees). The naturalistic decision-maker primarily faces problems which are not clearly defined; he has limited knowledge of possible action alternatives and their consequences, and therefore chooses a satisfactory alternative.

Objectives of this document

In line with this tradition of field work, our project aims to understand:

▷ how actors conceptualize and internalize uncertainties;

▷ how they handle them to ensure effective group decision-making in practice;

▷ what influences these decision-making processes;

▷ how effective decision-making in groups under uncertainty can be supported.

To do so, the authors have undertaken an **exploratory field study in the medical domain**. This document presents the method used and the results of the research.

Document structure

In chapter 1, theories on decision-making under uncertainty from naturalistic decision-making research and on social influences will be presented to specify and illustrate the underlying research framework. In section § 1.3, the application domain of health care will be described.

Chapter 2 describes the methods used in this work, a field study of medical decision-making in European hospitals, based on a questionnaire. The questionnaire is designed to obtain information on **types of uncertainty encountered** by health-care practitioners in hospitals and to **illustrate their potential impact on decision-making**.

Results from the field study are presented in chapter 3. We specify sources of uncertainty, analyze how they are perceived by decision-makers, and ask for possible consequences on decision-making practice and conceptualizations of uncertainty. This chapter includes a classification of decision-making processes and of decisions and identifies characteristics of effective decisions.

Chapter 4 discusses the results obtained, with the different obstacles to effective group decision-making. It links to previous research work (focusing on literature sources with pedagogical values) which suggests methods for improving some of the obstacles encountered.

The problem treated

1.1 Uncertainty in decision-making

[Lipshitz et Strauss 1997] define uncertainty in line with their research focus on uncertainty in decision-making processes from a naturalistic decision-making perspective "as a sense of doubt that blocks or delays action". The doubts that delay or block an action can be specified in terms of categories of either *issues* or *sources*. The first dimension is on issues, it describes *what the decision-maker is uncertain about.* **[Lipshitz et Strauss 1997]** distinguish three issues on this dimension:

   ▷ the nature of the situation;

   ▷ the alternatives of the decision;

   ▷ the potential outcomes.

The second dimension specifies sources, which means *what causes the uncertainty.* The link between uncertainty and information is drawn on this dimension. Uncertainty has often been associated to the **perceived gap between the information available and the information a decision-maker would like to have**. **[Lipshitz et Strauss 1997]** categorized uncertainty regarding their sources in:

   ▷ incomplete information (most frequently cited source);

   ▷ inadequate understanding (*e.g.* conflicting meanings);

   ▷ overwhelming information or undifferentiated alternatives.

Incomplete information is when a variable in a decision or model of the given situation simply is not known. Sometimes this can be resolved (through research, inquiry, *etc.*), but not always. Uncertainty can arise from disagreement between information sources. This disagreement itself is often caused by the sources themselves having incomplete information.

Moreover, the doubt is described by **[Lipshitz et Strauss 1997]** as being *inclusive* and *subjective*:

   ▷ Inclusive means that there is no particular form of doubt.

   ▷ Subjectiveness refers to the fact that different individuals may experience different doubts. The interpretation of the person assessing uncertainty will depend on their individual perceptions. Human perception is by no means flawless due to certain bias and distortions and merely provides an approximate reflection of the reality prompting it. Such distortion falls into two groups: simplification, arising from individuals' cognitive limitations and the affective influence emerging from a variety of factors ranging from personal beliefs to the opinions of others.

Although doubts are inclusive and subjective, all kinds of individually perceived doubts have in common that they have effects on action, such as hesitancy, indecisiveness, or procrastination. And people perceiving doubts must find a way to handle the situation of uncertainty.

Three broad classes of **tactics** that individuals use to cope with uncertainty exist **[Lipshitz et Strauss 1997]**:

   ▷ **tactics of reduction**, which involve trying to retrieve information or enhance predictability. Examples are collecting additional information, solicit advice, following standard operation procedures, delaying action until more information is available, and assumption-based reasoning (constructing a mental model of the situation based on beliefs).

▷ **tactics of acknowledgement**, involving taking uncertainty into account in selecting a course of action or preparing to avoid possible risks. Examples are avoiding irreversible action, weighing pros & cons, preempting (generating specific responses to possible negative outcomes), and improving readiness (developing a general capability to respond to unanticipated negative developments).

▷ **tactics of suppression**, which are more or less a denial of uncertainty. Examples are ignoring uncertainty, relying on "intuition", or taking a gamble.

from individual to group decision-making under uncertainty

[Lipshitz et Strauss 1997] examined decision-making under uncertainty in an **individual context**. Therefore the above reported findings are limited to individual decision-making under uncertainty. One unanswered question is to what extent these findings are also valid for situations where **groups** have to make decisions under uncertainty. Social influences and group dynamics can play an important role in group decision-making under uncertainty. The work presented in this document aims better to understand their role.

1.2 The social side of uncertainty

If people do not make decision individually but in a group, the social context and social interactions can influence decision-making and uncertainty. Social influence refers to the process by which individual judgments, behavior and attitudes change as a result of the (real or implied) presence of other people.

One important category of social influence emanating from social interaction and social contextual factors reflects the need, or the tendency, for individuals to make assumptions, estimates, or **predictions about other group members**. This is especially the case if some information that is needed for decision-making is not accessible and intelligible to everyone, *e.g.* because of its dependence on technical knowledge in specialized fields. For these kinds of situations, [Hansson 1996] theoretically derived additional sources of uncertainty in group contexts. Decision-makers have to rely on **experts**, which adds extra dimensions of uncertainty. It is not clear whether information obtained from others (such as experts) can be relied on *(uncertainty of reliance)*. Hansson distinguishes three different aspects on this matter:

1. when experts are recognized but disagree;

2. when experts are not identified;

3. whether to rely at all or not on experts.

Furthermore, social issues require the evaluation of complex outcomes that differ in terms of several categories, such as money, human lives, and human well-being. Another dimension is described by *uncertainty of values* of decision-makers or of relevant others [Hansson 1996].

Another class of results of social influences on decision-making which have been intensively analyzed in social psychology is **decision-making biases**. [Jones et Roelofsma 2000] give several examples of social contextual and group decision biases:

▷ the **false consensus effect**: the tendency for people to overestimate the degree to which others agree with them;

▷ **groupthink**: a type of thought within a deeply cohesive in-group whose members try to minimize conflict and reach consensus without critically testing, analyzing, and evaluating ideas;

▷ **group polarization**: tendency of people to make decisions that are more extreme when they are in a group as opposed to a decision made alone or independently.

Past research has shown that these constraints may result in failed group decisions. Empirical evidence for most examples of social contextual and group decision biases stem from laboratory and field experiments. These constraints and biases have not been explored or documented in the context of everyday group decisions in high-reliability organizations.

There is a lack of field research on this topic in the context of high-reliability organizations regarding daily decision-making processes in groups. Our research project aims to improve understanding in this area, by addressing how decision-making groups in this context conceptualize and internalize uncertainties and how they handle them in order to guarantee effective decision-making in their everyday work activities.

1.3 Domain: Medical decision-making

We have chosen the health care sector as the applied research domain for studying decision-making in groups under uncertainty. This choice was made for several reasons:

▷ Health care is an adequate example of high hazard environments where highly trained professionals interact with advanced technology in risky situations. Errors can have severe consequences on life and well-being of patients. Furthermore, public trust can be influenced adversely and errors can lead to financial and legal ramifications [Kao et Thomas 2008].

▷ Decision-making is a crucial element in the field of medicine. Healthcare professionals have to take many critical decisions in a relatively short span of time during a normal working day. Lots of these decisions have substantial consequences, and involve important trade-offs. This is also recognized by the World Health Organization, which ranks decision-making among the most important human factors aspects with influence on patient safety [Flin et al. 2009].

▷ Being confronted with uncertainties belongs to the normal course of life in health care. Physicians need to deal with information from different sources that are **ill-structured, uncertain or conflicting** [Hunink et al. 2001; Kushniruk 2001]. Uncertainty can arise during all phases of the medical decision-making process: uncertainties in the diagnostic process (was the carotid artery stenosis really asymptomatic? how accurate is the available diagnostic test? would a repeated sonography bring about the same results?), the treatment process and an outcome or effect of the treatment in an individual patient (*e.g.* will a carotid endarterectomy really protect patient X from a stroke during a coronary artery bypass grafting? [Hunink et al. 2001; Tschan et al. 2009]).

▷ Many decisions are made by medical groups (*e.g.* surgical groups, emergency room groups, ward teams, cancer conferences). These groups are often multidisciplinary and established as means to improve decision-making by pooling expert knowledge and ironing out individual differences [Ho et al. 2007; Kee et al. 2004]. If a decision is made by a group, it is the group that has to go through the medical decision-making process and deal with all occurring uncertainties.

For all these reasons, it is not surprising that [Chapman et Sonnenberg 2000] designate the medical domain as an "ideal arena" to study decision-making.

Method

2.1 Field study: Medical decision-making in European hospitals

To obtain a first understanding of the work and tasks in medical wards, one researcher from the team accompanied residents in a gastroenterology ward for two days and residents in an emergency room during one night shift (a "shadowing" approach **[Vogd 2004]**).

Then the focus turned to methods more appropriate for gathering data from an expanded group of practitioners in medical decision-making. In line with our NDM framework, the aim was to design a method devoted to illuminating the roles of domain knowledge, situation, task, and information strategies and appropriate to elicit knowledge from experts in an explorative field study.

2.2 Questionnaire

A questionnaire was developed which allows for obtaining a first understanding of relevant situations and work processes, gaining insights into how decision-making groups in health care organizations conceptualize and internalize uncertainty and how they handle them in order to ensure effective decisions in their everyday work activities.

The questionnaire includes five sections. Table 2.1 summarizes the sections and contents of the questionnaire in use.

Part	Interest	Topics
1	Personal data	Sex, position, organization size, expertise level, decision group
2	Uncertainty in decision-making	Conceptualization of uncertainty, emotions in the face of, coping with uncertainty Decision issues and sources
3	Uncertainty in group decision-making	Critical incident Situational aspects, decision criteria, inhibiting/promoting factors
4	Management of uncertainty	What strategies are used
5	Decision values	Characteristics of poor and effective decisions

Table 2.1 – *The content of the questionnaire*

2.2.1 First section: Personal data

The first part of the questionnaire asked for some kind of personal data like current position, physicians' own rating on their expertise level, and some facts about the organization (*e.g.* size, kind of agency). Participants were then asked whether they usually make their decisions by themselves or within a group and how many group members usually take part in a decision.

2.2.2 Second section: Uncertainty in decision-making

The second section of the questionnaire is focused on the significance of uncertainty in decision-making. Responders should describe what they understand as uncertainty, what kind of emotions are involved for them personally and how they cope with uncertain situations. Moreover, referring to the categorization of **[Lipshitz et Strauss 1997]** which distinguishes three issues of uncertainty (*i.e.* situation, alternatives, and outcome) participants were asked to state how often (5 point rating scale) they have to deal with what kind of decision issue in their daily work practices.

To further improve our understanding of uncertainties in medical decision-making, it was necessary to find out what kind of sources cause uncertainty. The responders were asked for a rating (5 point scale) on this question. For both topics (issues and sources) the respondents had the opportunity to give examples.

2.2.3 Third section: Uncertainty in group decision-making

Group relevant aspects in group decision-making under uncertainty were examined in this section. The critical decision method **[Klein et al. 1989]** was used in this section of the questionnaire, to elicit expert knowledge on the topic of uncertainty in medical group decision-making.

_____ **The critical decision method** _____

DEFINITION

The critical decision method (CDM) is a **retrospective interview technique**, developed for eliciting expert knowledge, decision strategies and cues attended to when making decisions. The method was developed by NDM researchers, who wished to study in detail the critical information and prior knowledge used by experts in decision-making. After the description of an incident that requires decision-making, a semi-structured format is used to probe different aspects of the decision-making process **[Klein et al. 1989]**.

Compared with more conventional interview techniques, the CDM focuses on non-routine cases, is case-based, and, in attempting to probe cognitive aspects of expert behaviour, is not limited to responses which can be verified objectively.

Firstly, respondents were asked to describe a typical situation (critical incident) they face during their daily work where they have to make a decision and are confronted with uncertainty. After this part, some questions were set up which should lead to an elaboration of this critical situation (*e.g.*: what kind of sources caused the uncertainty in this situation) and a description of typical group decision-making situations (such as group size, hierarchy of group members). Participants were requested to think of typical group decisions and answer questions concerning usual decision criteria and inhibiting and promoting influences on group decisions.

2.2.4 Fourth section: Management of uncertainty

In the next part, open questions were presented which concerned the management of uncertainties, especially the strategies used in handling different sources of uncertainty.

2.2.5 Fifth section: Decision values

In the last section of the questionnaire, characteristics of good and bad decisions were addressed via two open questions.

2.3 Subjects

Responses of N=21 physicians (10 female and 11 male) were involved in the analysis. Physicians were associated with different hospitals in German-speaking countries (one hospital located in Switzerland, four in Austria, and 16 in Germany). The participants cover a variety of different medical disciplines (*cf.* table 2.2).

Physicians	Medical discipline
5	Anesthetics and intensive care
4	Internal medicine
4	Gynecology
2	Neurosurgery
1	Surgery
1	Pediatrics
1	Neurology
1	Child and adolescent psychiatry
1	Oral and maxillofacial surgery
1	Dermatology

Table 2.2 – *Distribution of medical disciplines of respondants*

Whereas 12 of them work as residents, eight are ranked as specialist doctors and one is head of department. They rated their own expertise on a high level (5-point scale from low to high), M=3.33 (SD=1.15). The size of the organization (hospital) they work for varies from 40 to 3000 beds, the ward size from 7 to 80 beds. 17 hospitals are under public, five are private and one is a charitable institution. 17 physicians and therefore the majority of physicians make decisions in a group. The group size they usually handle decisions varies from 2 up to 15 people, M=4.95 (SD=4.48).

Subjects participating in the questionnaire survey were recruited via direct contact, which was found necessary to involve experts from the medical domain in this study. Then participants with whom contact has already been made used their professional networks to refer the researcher to other people who could potentially participate (chain referral sampling).

2.4 Data analysis method

The data from the questionnaires were inserted into SPSS or Microsoft Excel, analyzed, then tables and graphical diagrams were generated to show relevant results. The critical incident data and all data stemming from open questions were analyzed via textual analysis. Therefore, the given answers were clustered with regard to their content. If more than one aspect was named, answers were divided into aspects (*e.g.* participants usually depicted more than a single emotion in the face of uncertainty). Each cluster was characterized by a key term. The key term was then used as a category label and each aspect in the answers was sorted by two independent raters into one of the identified category. The inter-rater-reliability is sufficiently high when reaching 0.70 or above [Bortz et Döring 2002]. Cohen's kappa for the conducted textual analysis ranges from 0.74 to 0.92 and can therefore be considered sufficient.

Results

In this chapter, data concerning uncertainty conceptualizations (§ 3.1) in medical decision-making processes and emotions (§ 3.2) following uncertainty will be reported. Results on issues (§ 3.3) and sources (§ 3.4) of uncertainty in day-to-day activities in hospitals are presented. Subsequently, different kinds of typical decision-making groups (§ 3.5) are described. Decision-making processes and procedures applied in health care are addressed in § 3.6. In § 3.7, results concerning strategies to handle uncertainty in groups are illustrated. § 3.8 describes perceived inhibiting and promoting influences on group decision-making processes. Decision criterion used by the practitioners interviewed are presented in § 3.9. The chapter concludes in § 3.10 with a record on decision values in form of attributes of poor and effective group decisions.

3.1 Uncertainty conceptualizations

The aim was to gain insights into how physicians — laypersons with regard to decision theories and research — define uncertainty. Therefore, participants were asked how they would describe uncertainty. The N=21 physicians stated 33 aspects which were categorized by two independent raters. Results are shown in figure 3.1.

Figure 3.1 – *Respondents' uncertainty conceptualizations (multiple responses possible)*

Almost half of the medical experts describe uncertainty as a **lack of knowledge, skills or expertise in their own competencies**. The other two most stated aspects are **unpredictable or possibly adverse outcomes** and a **perceived conflict due to undifferentiated alternatives**. The seven made up categories could be further accumulated into three broad classes of uncertainty conceptualizations: issue, source and self.

Issues and sources of uncertainty are two core aspects of the definition of uncertainty as a form of doubt offered by **[Lipshitz et Strauss 1997]**. As expected, their definition (derived from work in the military area) seems also to fit medical decision-making. But the strong emphasis on one's own shortcomings (lack of knowledge, skills, expertise) needs to be highlighted. Highly educated and trained medical decision-makers conceptualize uncertainty as something that originates not only in situational factors but in their own self. This implies that one individual perceiving uncertainty might not necessarily assume that other individuals perceive the same uncertainties or uncertainty at all. This can in turn have consequences for strategies to handle uncertainties and group decision processes, as the results presented later will illustrate.

3.2 Emotions in the face of uncertainty

To figure out which effects perceived uncertainty has on the decision-maker, respondents were asked what kind of *emotions* appear in the face of uncertainty.
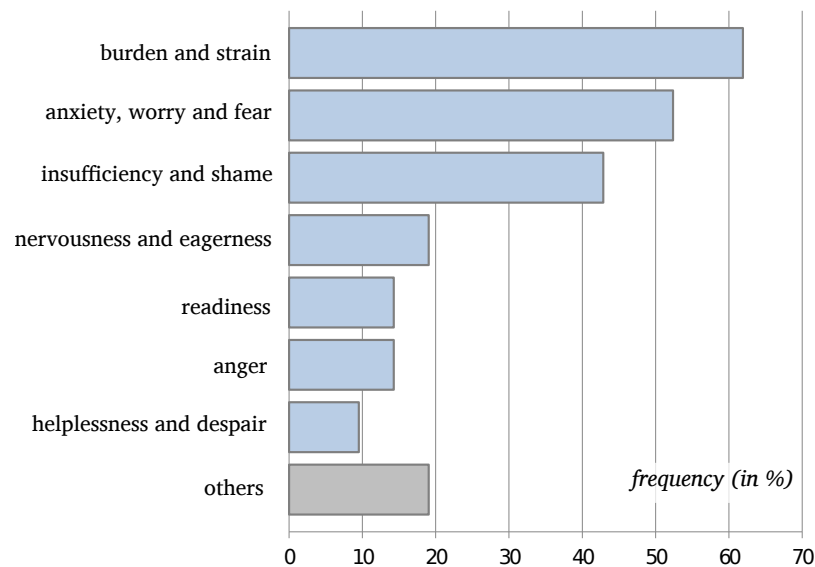

Figure 3.2 – *Emotions following uncertainty (multiple responses possible)*

The 21 physicians stated 49 emotions which were converted into eight categories (figure 3.2). The category "others" contains emotions each mentioned by just one individual.

Uncertainty causes intense negative emotions in experts such as fear, shame and despair

The most frequently stated emotions, with almost 62%, fall in the category burden and strain. The next most frequently mentioned emotions are anxiety, worry, and fear with 52% and insufficiency and shame with 43%. What stands out is that all distinguishable emotions following the realization of uncertainty in the medical domain are **adverse** and range up to **strong and intense feelings** like fear, shame, and despair. Furthermore, emotions seem to be linked to the conceptualization of uncertainty. For example, it can be supposed that the conceptualization of uncertainty as a personal lack of knowledge, skills and expertise leads to emotions of insufficiency and shame.

3.3 Issues of uncertainty

In line with Lipshitz and Strauss' categorization of uncertainty issues (*i.e.* situation, alternatives, and outcome), participants were asked **how often** they are confronted with each of these different kinds of uncertainty issues in their day-to-day work and to give an example for every kind of issue. Results of the frequency estimations (5-point scale, 1=never...5=most often) are shown in table 3.1.

Regarding the issue in decision-making it is clear that the decision situation, the different alternatives, and also the outcome are vulnerable to uncertainties in clinical daily work practices. A slide tendency in the frequency or relevance of daily events is seen in uncertainties regarding the decision outcomes.

Uncertainty issue	N	M	SD
situation	21	3.14	0.66
alternatives	21	3.14	0.85
outcome	21	3.45	1.05

Table 3.1 – *Issues of uncertainty in clinical day-to-day decisions ("how often do you encounter uncertainty related to…?")*

N is the number of respondents having answered concerning this category; M is the mean (geometric average) of their frequency estimations on a 5-point scale; SD is the standard deviation of their frequency estimations (a high value indicates a large amount of variability in answers).

The 49 given examples can easily be summarized. All examples concerning uncertainty regarding the situation include the question concerning the correct diagnosis (*e.g.* appearance of new symptoms that run contrary to the original diagnosis). All examples concerning uncertainty regarding alternatives deal with the question of the adequate therapy (*e.g.* invasive or non-invasive therapy).

Finally, all examples concerning uncertainty with regard to decision outcomes center on the **therapeutic result** (*e.g.* will the applied anticoagulant prevent the patient from getting a stroke).

These examples show that uncertainty **arises during all phases of the medical decision-making process** (diagnostic process, treatment process, outcome [Tschan et al. 2009]).

3.4 Sources of uncertainty

Participants were asked how often they are confronted with different kinds of uncertainty sources that have been suggested by [Lipshitz et Strauss 1997]. The participants estimated the frequency using a scale ranging from 1 (never) to 5 (most often). To further explore the types of sources in the field, respondents where asked to describe typical situations. Results of the frequency estimation are shown in table 3.2.

Source of uncertainty	N	M	SD
Information			
completely lacking	21	3.00	1.00
partly lacking	21	3.71	0.56
unreliable	20	2.90	0.91
Inadequate understanding			
owing to equivocality	20	2.10	0.72
owing to instability	18	3.22	1.06
owing to novelty	20	2.75	1.02

Table 3.2 – *Sources of uncertainty in clinical day-to-day work*

For the first three categories, the most frequent source of uncertainty is **partly lacking information**. Physicians often find themselves in situations where the information base is insufficient. An example for these situations stated by the physicians are situations where patient's auto anamnesis is incomplete because she or he is suffering from dementia. Another exemplary case is a situation where the physician has to deal with incomplete documentation of patient's medical history (*e.g.* medical record).

For the second type of source (inadequate understanding), participants quote inadequate understanding owing to **instability of information** as the most frequent source of uncertainty. Examples are situations where patients and affiliated give differing information (*e.g.* relating to social or health status). Another example is unstable demands from senior physicians.
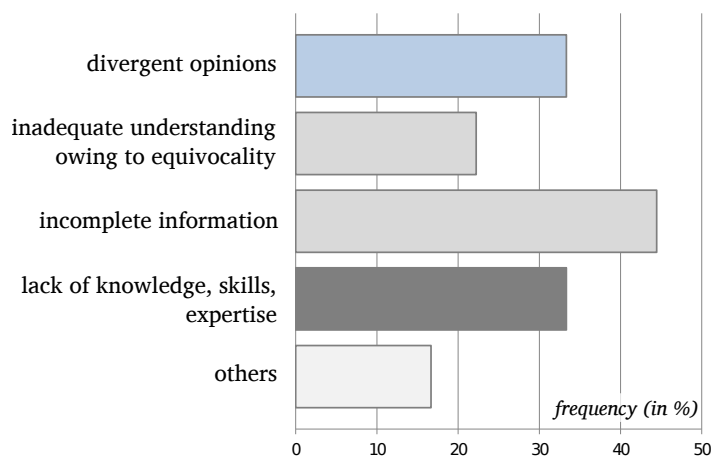
Figure 3.3 – *Sources of uncertainty in group decision-making*

Changing from ticking the box to open descriptions of prototypical situations and changing from the individual to the group, the picture depicted in figure 3.3 is found.

In the description of typical group decisions, 27 single sources of uncertainty were named that can be classified in four main categories (*i.e.* divergent opinion, inadequate understanding owing to equivocality, incomplete information, and lack of knowledge, skills, expertise). Inadequate understanding owing to equivocality and incomplete information (grey bars) are sources that are part of Lipshitz and Strauss' categories of uncertainty sources. Here again the intrapersonal factor lack of knowledge, skills, and expertise is found. This source is also an outstanding topic in physicians' conceptualization of uncertainty (see above). As it is not included in the sources of uncertainty suggested by Lipshitz and Strauss who conducted their research with a military sample, this factor might be specific for the health care domain.

Despite the two situational sources and the one intrapersonal source one finds a new source that is unique and specific for group decision-making: the perception of divergent opinions insight the group leads to uncertainty. So the group itself can be a source of uncertainty. This means that one can find in practice of day-to-day group decisions one aspect of *uncertainty of reliance* mentioned by **[Hansson 1996]** (who derived a number of issues theoretically in the context of expert group decision-making).

In summary, the types of uncertainty sources suggested by Lipshitz & Strauss seem to be generalizable for group decisions in health care and medicine when adding first the decision-maker himself as a source of uncertainty (lack of skills, knowledge, expertise) and second the group as an important source of uncertainty (divergent opinions).

3.5 Decision-making groups

The participating physicians were asked to precisely describe the group and situation within which they normally make decisions. 25 specifications of group composition and 22 specifications of decision situations were obtained.

Concerning the **group composition**, the ordinary group size ranges from two to 16 and is made up of three to seven individuals in the majority of given cases. Nine groups are interdisciplinary and nine groups include all hierarchical levels with residents[1] up to head of department. In twelve of the described decision-making groups, allied health personnel[2] is incorporated. The lowest common denominator in all the 25 groups is that they consist at least of two expertise levels, a physician and a senior physician.

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[1]   Residency is a stage of graduate medical training. A resident is a person who has received a medical degree and who practices medicine under the supervision of fully licensed physicians.

[2]   Health care workers (paramedical personnel) such as medical records technicians, occupational therapists, physicians' assistants and practical nurses who are specially trained and licensed to assist and support the work of health professionals.

Descriptions of **decision situations** could be grouped in three clusters. In four cases, participants reported interdisciplinary meetings on a regular basis (cancer conferences, X-ray conferences). The second cluster is formal ward meetings (morning round, shift change meeting), which contains six descriptions. The majority of decision situations (mentioned twelve times) are *ad hoc* consultation, for example grouping of different disciplines in an emergency department when a multiple trauma patient is brought in or consultations of a senior ward physician when difficulties with patient's status arise.

3.6 Decision-making processes and procedures

To obtain a first understanding of how the decision groups work together and whether/how they use procedures, participants were asked for the information base at the beginning of the decision-making process and how the exchange of and discussion about information takes place.

In the majority of the situations described (17 statements), members do not have the same basis of information at the beginning of the decision-making process. Therefore, information exchange is needed. The exchange of information is only in part systematic.

Most groups do not follow any predefined systematic course of action. Meeting procedures depend on the type of decision situation characterized above.

▷ **Interdisciplinary regular meetings** are led by the chief of the board (*e.g.* head of department, most senior physician). Initial information exchange is done by a physician who presents the case and its details which need to be discussed. The information presentation is conducted in a predefined and systematic structure. The subsequent group discussion is at most semi-structured.

▷ **Formal ward meeting** are similar to interdisciplinary meetings as one physician, usually a resident, presents a patient case which is then discussed by the group. The discussion process is more or less unstructured. It is often guided by "Who knows what?" questions. Head and moderator of these meetings are senior physicians. For larger groups it is reported that the less senior physician is presenting but not integrated in analysis and discussion processes as the more senior physicians are discussing and deciding. This point should be stressed as residents have less expert knowledge than senior physicians but they are the ones with richest information concerning important patient aspects (social status, patient preferences, social support), because residents are the ones who interact with patients on a daily basis. These aspects often need to be included in therapy decisions.

▷ ***Ad hoc* consultations** are not at all structured. They are conducted in a question-and-answer-game manner.

To summarize, group decisions range from large, quite structured rounds to unstructured *ad hoc* decision situations. Information is always unequally distributed within the group. For all three types of decision situation, the decision-making process is not very systematic. There are no clearly separated phases of situation assessment, search for alternatives, and evaluation of these options with their risks and benefits as recommended in decision-making literature.

Little use of structured decision-making procedures is made in the healthcare units concerned by our study

3.7 Strategies to handle uncertainty

To find out which strategies decision-making groups in health care use to handle uncertainties, each participant was asked to imagine that they would have to make a decision in a group and to describe how the group would manage uncertainties from different sources.

Each source of uncertainty suggested by **[Lipshitz et Strauss 1997]** (*i.e.* information complete lacking, partly lacking or unreliable, and inadequate understanding owing to equivocality, owing to instability, or owing to novelty) made up a distinct open question. A textual analysis was run and the depicted strategies were categorized according to Lipschitz & Strauss' classification of strategies to handle uncertainty.

Results with respect to uncertainty sources that originate in lacking information are presented in table 3.3. Results with regard to uncertainty sources that originate in inadequate understanding are presented in table 3.4. Unlike the other frequency calculations in this report,

percentages are calculated based on the number of stated tactics instead of the number of participants.

Strategy	Source of uncertainty: information is...					
	...completely lacking N=20; 25 tactics		...partly lacking N=21; 22 tactics		...unreliable N=21; 23 tactics	
	fre-quency	%	fre-quency	%	fre-quency	%
Tactics of reduction						
collect additional information	12	48.00	17	73.91	10	41.67
delay action	5	20.00	4	17.39	2	8.33
solicit advice		4.00	1	4.35	3	12.50
assumption based reasoning	1	-	-	-	4	16.67
others	-	-	-	-	-	-
Total	**19**	**76.00**	**21**	**95.65**	**18**	**79.17**
Tactics of acknowledgement						
weighting pros and cons	1	4.00	-	-	1	4.17
others	3	12.00	-	-	2	8.33
Total	**4**	**16.00**	**-**	**-**	**3**	**12.50**
Tactics of suppression						
Ignore uncertainty	2	8.00	1	4.35	2	8.33
Total	**2**	**8.00**	**1**	**4.35**	**2**	**8.33**

Table 3.3 – *Strategies to handle uncertainty due to lack of information*

As can be seen in table 3.3, medical groups in decision situations that are characterized by a lack of information primarily use tactics of **reduction of uncertainty**. Across all three types of uncertainty sources, the preferred tactic to reduce uncertainty is **collection of additional information**. The delay of action until more information is available and soliciting advice from colleagues and seniors are other common tactics of reduction.

Interestingly, **acknowledgement of uncertainty** is only used as a strategy in situations where information is either completely lacking or unreliable. For example, one physician stated: "When information is completely lacking we discuss in a group what most likely fits the patient's interest." In other situations where at least some information is given and reliable, strategies of reduction predominate. Group specific tactics of suppression of uncertainty were also described, such as: "We declare that uncertainty is not important enough to spend energy on information search".

A similar pattern of strategies to reduce uncertainty is found for uncertainty due to inadequate understanding (*cf.* table 3.4). Here, tactics to reduce uncertainty are preferred, too, although collecting additional information isn't used as frequently as in cases of lacking information. Both examples and frequencies illustrate that soliciting advice by asking other group members whether they can make sense of the information or trying to improve understanding by group discussion is a more important strategy if uncertainty arises from inadequate understanding than from lacking information.

Tactics of acknowledgement and tactics of suppression are also in use, though less frequently.

Taken together, the results indicate that tactics to handle uncertainty examined by [Lipshitz et Strauss 1997] in an individual context are also used in a modified manner in group decision-making processes when it comes to handling uncertainties.

A tactic of reduction that is not found in our sample is to follow norms and procedures, maybe because standard operating procedures are not applied in health care. Also preempting,

improvement of readiness and avoidance of irreversible actions are tactics to acknowledge uncertainty that are not used in medical decision groups. Furthermore, nobody described a situation in which a group would suppress uncertainty by taking a gamble or relying on intuition.

| Strategy | Source of uncertainty: inadequate understanding due to… | | | | | |
| | …equivocality N=20; 26 tactics | | …instability N=17; 18 tactics | | …novelty N=13; 13 tactics | |
	fre-quency	%	fre-quency	%	fre-quency	%
Tactics of reduction						
collect additional information	14	53.85	5	29.41	6	46.15
delay action	-	-	2	11.76	-	-
solicit advice	7	26.92	1	5.88	5	38.46
assumption based reasoning	2	7.69	3	17.65	-	-
others	-	-	-	-	1	7.69
Total	**23**	**88.46**	**11**	**64.71**	**12**	**92.31**
Tactics of acknowledgement						
weighting pros and cons	-	-	-	-	-	-
others	-	-	4	23.53	1	7.69
Total	**-**	**-**	**4**	**23.53**	**1**	**7.69**
Tactics of suppression						
Ignore uncertainty	3	11.54	2	11.76	-	-
Total	**3**	**11.54**	**2**	**11.76**	**-**	**-**

Table 3.4 – *Strategies to handle uncertainty due to inadequate understanding*

In summary, groups in a clinical context mostly try to reduce uncertainty by different tactics and partly also use strategies of acknowledging uncertainty and suppressing uncertainty by ignoring it. The last fact indicates that sometimes **uncertainty is perceived but consciously not communicated or acted upon**.

3.8 Inhibiting and promoting influences

In line with our naturalistic decision-making framework, we have tried to find out what factors are inhibiting and what factors are promoting group decision-making processes, from the physicians' point of view. 29 promoting and 34 inhibiting statements were stated. Though promoting and inhibiting influences were asked for separately, textual analysis revealed that influencing factors are not completely different for inhibiting and promoting influences.

Rather, we can identify underlying themes that can have either a promoting or inhibiting influence on group decision-making under uncertainty, depending on their value. Figure 3.4 depicts these factors and their type of influence.

As shown in figure 3.4, the inhibiting influences on group decision-making processes stated most often are high workload and time pressure, high hierarchy and dominance behavior displayed by individual group members and a process that is only structured and organized at a low level.

The top promoting influences are high respect and appraisal of different opinions, low workload and time pressure, a good basis of information, and a high courage to speak up.

The influence of high respect and appraisal of different opinions can be best understood by looking at the statement of one of our participants:

Factors such as respect and hierarchy are important influences on decision-making, which appear only in group contexts
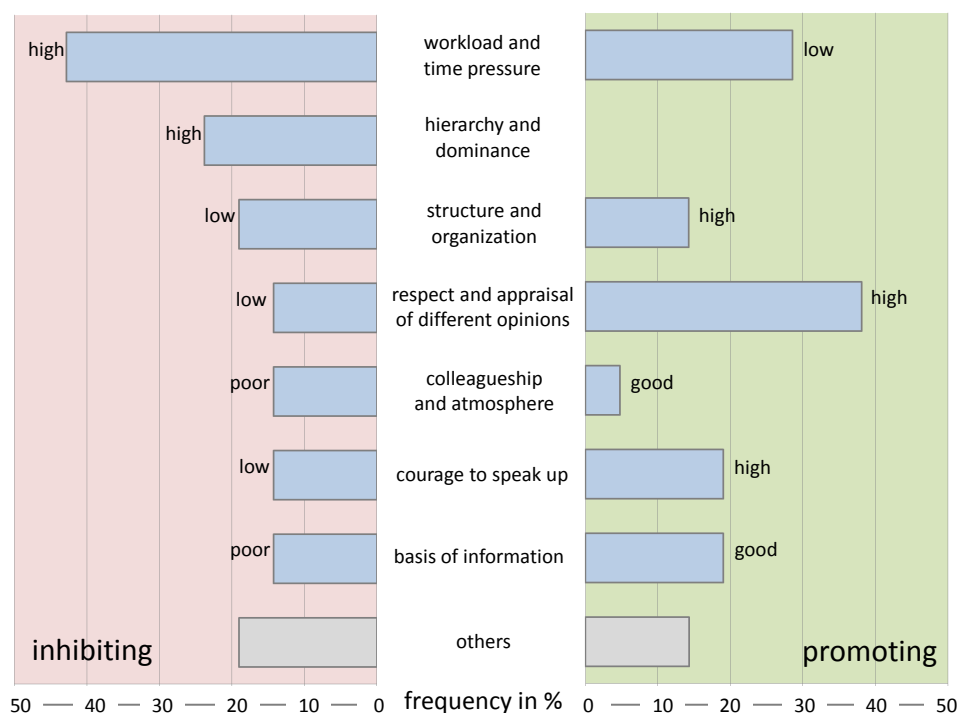
Figure 3.4 – *Inhibiting and promoting influences on the group decision-making process*

Factors are shown in the middle. On the left side blue bars on a red ground indicate the percentage of physicians that stated a factor in its negative specificity as being inhibiting. Adjectives at the end of bars concretize the negative specificity. For example, 43% perceive high workload and time pressure as an inhibiting influence. On the right hand side, blue bars on green ground show the percentage of physicians that stated the factor in its positive value as being promoting. For example, 5% stated that good colleagueship and atmosphere promotes group decision-making.

> *It is crucial that every discussant has the feeling that he can speak openly. This is the only way that the group can gain the maximum amount of information.*

In summary, group decision-making processes are influenced firstly by situational factors like workload and time pressure or information basis. Secondly, the way the process itself is organized and structured seems to be important. Thirdly, crucial influences like respect or hierarchy are intragroup factors. This point is specific for group decision-making and therefore it is worthy of special attention.

The chance to handle uncertainty and to reach an adequate decision in a group process depends on the atmosphere, mutual respect and openness to divergent opinions within the group. **Dominant behavior of single group members may lead to suboptimal decisions**, as it may hinder the group in gathering all relevant information and constrict collecting, discussing and evaluating possible risks and benefits.

3.9   Decision criteria

The last step in a group decision-making process is to actually decide. Participating physicians were asked which criteria are in the end decisive. Results of the textual analysis of 29 stated criteria are depicted in figure 3.5.

Over forty percent of the physicians name **hierarchy** as the crucial decision criterion. Many of them use a German saying regarding card games to illustrate their point, literally quoted as "queen trumps jack". This indicates the hierarchy criterion being in use in situations where dissent between group members is present.

As the question about decision criteria didn't ask for a judgment, we are not able to interpret a hierarchical decision criterion as being judged in a positive or negative manner.

The other two most frequently cited decision criteria are the **patient's interest** and **professional competence**. The latter means that the decision is based upon the opinion of group members with highest medical expertise and skills.
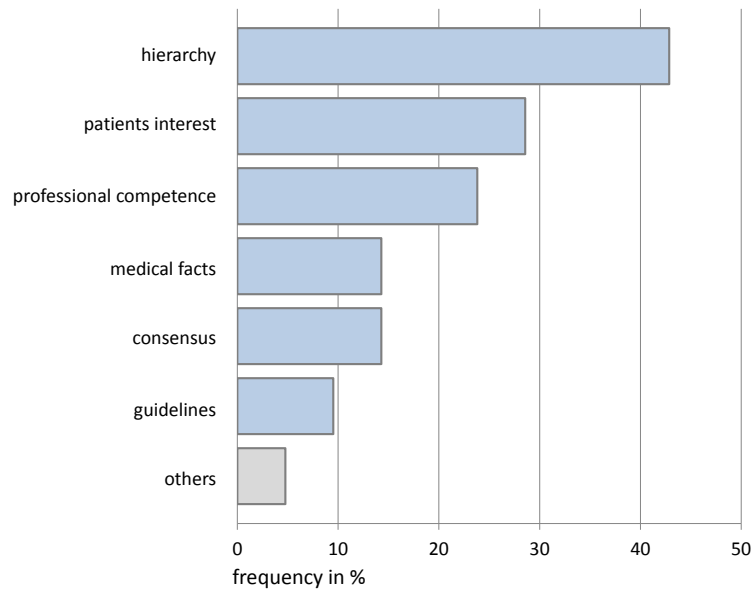
Figure 3.5 – *Decision criteria: which factors determine the final decision? (Multiple responses possible)*

Medical facts, consensus and guidelines play only a minor role as decision criteria compared to the top three. One reason might be that medical facts are not always clear in situations including uncertainty. In addition, guidelines do not exist for many medical diagnoses.

3.10 Attributes of poor and effective group decisions

The decision-making process ends with an actual decision. Looking back at a given decision (as well as the process by which it was reached), group members can evaluate the decision. This evaluation mirrors decision values. Participants were asked what, in their opinion, are attributes of poor decisions and attributes of effective decisions. 44 attributes of effective decisions and 34 attributes of poor decisions were stated.

Similarly to the results of inhibiting and promoting influences on the decision-making process described above, textual analysis revealed a number of underlying evaluation dimensions, rather than single discrete attributes for poor and effective decisions. Results are shown in figure 3.6.

The most important attributes of poor group decisions are a decision without consensus and decisions that are made with hierarchy as the predominant decision criterion. This result is interesting with regard to the fact that hierarchy, as our data shows, is the most often used decision criterion. Moreover, hierarchy and dominance are the second most frequent stated inhibiting influences on decision-making processes. Therefore it can be assumed that **medical decision-making groups feature an abrupt hierarchy gradient, that has a negative impact on the quality and evaluation of group decision-making**.

Medical decision-making groups are strongly hierarchical, which has a negative impact on the quality and evaluation of group decisions

On the other hand, three facts seem to be important with regard to **effective group decisions**:

▷ a good decision is one which is founded on **sufficient information**;

▷ the decision-making process is influenced by the group's **discussion culture**, and a good decision is reached by a process where every group member is treated with respect, where group members are free to speak up and where different opinions are appreciated;

▷ **consensus** is perceived as a strong attribute of effective group decisions: a good decision can be agreed on by all group members.
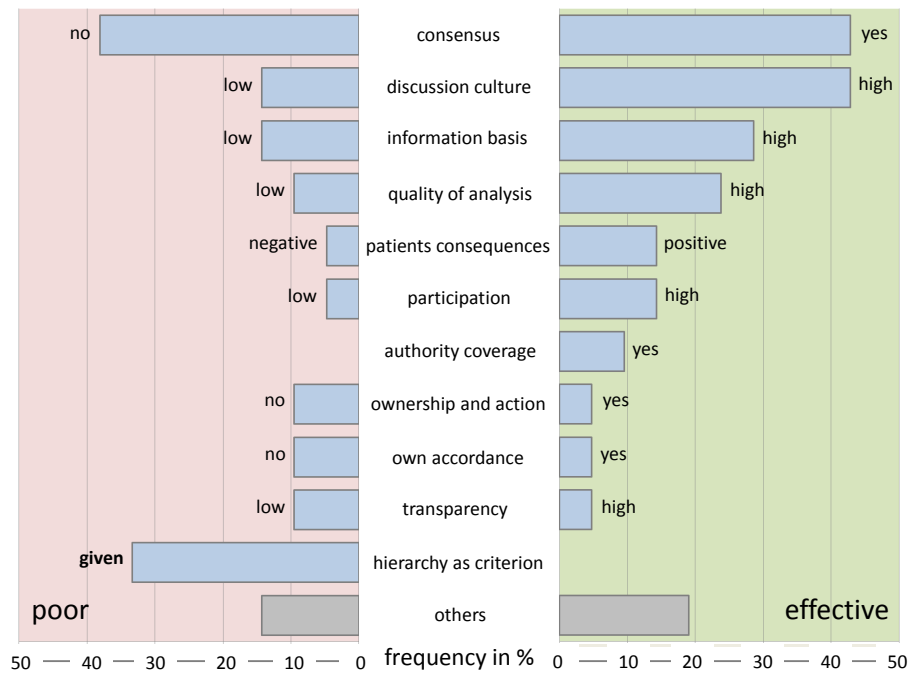
Figure 3.6 – *Attributes of poor and effective decisions*

In the middle of the figure, evaluation dimensions are depicted. On the left side, blue bars on a red ground indicate the percentage of physicians who stated a dimension in its negative specificity as being an attribute of poor group decisions. Adjectives at the end of bars concretize the negative specificity. On the right hand side, blue bars on a green background show the percentage of physicians who stated the dimension in its positive value as being an attribute for effective group decisions.

These results are interesting because consensus and a strong discussion culture where divergent opinions are appreciated seem to be contradictory on a first glance. This antagonism may be resolved when assuming that a positive discussion culture is promoting during the process and consensus is positive as a criterion when actually making the decision at the end of the process. The two attributes concern different points in time in a decision-making process. Nevertheless, **speaking up** and looking at a situation with uncertainty from **many different perspectives** may lead to decisions that most group members can agree with, as all available information, arguments and concerns are brought to light.

The next chapter provides a discussion of these results and of possible implications for improving medical decision-making in hospitals.

Discussion

Uncertainty that is caused by a lack of understanding or a knowledge gap is a natural experience also in the health care work context. Results from this study have highlighted the relevance of this topic as part of the medical decision-making process. As physicians make decisions most of the time in groups, the group is an important means to deal with decisions under uncertainty. The present chapter identifies possible obstacles for effective group decisions under uncertainty. Results concerning group decision processes and procedures, decision criteria, inhibiting and promoting influences, and attributes of poor and effective decisions stemming from participating physicians are summarized and interpreted from a psychological perspective.

The four main possible obstacles to effective group decision-making identified are discussed in the following sections: steep hierarchy gradients (§ 4.1), discussion culture (§ 4.2), need for consensus (§ 4.3), and structure and guidance of decision processes (§ 4.4). Each topic will be described bearing in mind the scientific literature. A number of recommendations for improvement are provided.

4.1 Hierarchy gradient

Our data shows that hierarchy is an important factor in medical group decision-making under uncertainty, for several reasons:

▷ hierarchy and dominance behavior displayed by individual group members are the second most often stated inhibiting influence on group decision-making;

▷ hierarchy is perceived as a strong attribute of poor group decisions;

▷ hierarchy is the dominating decision criterion. It is adequate to the results to conclude status differences to be perceived discerning.

It is uncontroversial to state that an extreme hierarchical differentiation exists in most medical groups. Hierarchy differentiation is defined as an organizational structure in which levels and roles are clearly discriminated [Baker et al. 2006; Edmondson 2003]. Hierarchy is a necessity as it comes along not only with power but also responsibility and accountability. Furthermore, a directive style of decision-making allows for very quick response to decision-making problems and is often present in hospitals [Faller et Lang 2006]. Moreover, it can be assumed that higher ranked physicians possess more experience and expertise than less senior physicians. Therefore, differences in status should not be judged to be dysfunctional *per se*. Steep authority gradients are an attribute of almost all high reliability organizations, which show extraordinary performance with regard to reliability and safety [Baker et al. 2006]. The critical point about steep hierarchy gradients is that they can impact lower status physicians' behavior adversely [Flin et al. 2009]. Such negative behavior changes in junior staff members with consequences for group decision-making are:

▷ decreased information exchange;

▷ decreased willingness to speak up;

▷ decreased courage to challenge higher status group members when they may be making an error [Flin et al. 2009; Leonard et al. 2004].

All these changes can in the end lead to poor group decision-making. There is strong evidence from the aviation industry that the way of dealing with hierarchy issues affects performance in settings where two or more people are engaged in dynamic decision-making [Bowers et al. 1998]. For medical decision-making this link may become even more problematic, keeping in mind that an information gradient also exists.

In aviation, both pilots have the same access to information, whereas in hospitals, people at the bottom of hierarchy spend more time at patients' bedside and therefore possess richer data than most superiors [Weick et Sutcliffe 2003].

Moreover, in the aviation domain, special efforts are made to reduce the status 'gradient' on the flight deck [Flin et al. 2009]. Antidotes for inhibiting influences of steep hierarchy gradients on effective group decision-making under uncertainty can have two foci: leadership behavior and assertiveness.

Intervention on the high end of hierarchy gradients should impact **leadership styles** and behavior of superiors. Leaders should be made aware of possible negative effects and be taught ways to reach more effective group decisions. This can be achieved by flattening hierarchy, creating familiarity and encouraging lower status group members to speak up [Smith-Jentsch et al. 1996; Lyndon 2006]. When leaders are authoritarian and reinforcing large authority gradients, they may run into unnecessary risks [Lyndon 2006].

The other intervention strategy concentrates on building the **competence to speak up** in group members at the lower end of the hierarchy gradient. Given our data, this strategy should fall on fertile ground, especially within the group of less senior physicians. Nearly 20% of participating physicians in our study perceive courage to speak up as promoting factor in group decision-making processes. 15% stated a lack of courage to speak up as an inhibiting factor in group decisions.

The key target to promote adequate speaking up is **assertiveness**.

Assertiveness

DEFINITION

Assertiveness occurs when an individual **declares her or his opinion through questions and statements** and does so with **appropriate persistence** until it is reacted upon. It involves clearly and directly communicating one's own feelings, ideas, and concerns [Smith-Jentsch et al. 1996]. Assertiveness should not be confused with aggressive behavior. Assertive statements are expressed in a manner which is **constructive** and which gives others the opportunity to express their own. Assertiveness is neither passive nor aggressive but a happy medium between the two.

Assertiveness can be improved by training, and has been the subject of training in the aviation domain for over 25 years. The need for training assertiveness is also acknowledged in the health care community (*e.g.* [Baker et al. 2006; Lyndon 2006]). For example, [Smith-Jentsch et al. 1996; Baker et al. 2006] designed assertiveness training that does not only aim at changing trainees' attitudes towards assertive behavior. It also uses behavioral modeling techniques to demonstrate assertive and non-assertive behavior and provides multiple practice and feedback loops.

CRM training in civil aviation

Crew Resource Management (CRM) training teaches pilots, air traffic management and ground staff cognitive and interpersonal skills needed to manage flight within the complex civil aviation system. CRM aims to foster a climate or culture where the freedom respectfully to question authority is encouraged. Key elements of the training concern leadership, assertiveness, decision-making and communication.

4.2 Discussion culture

DEFINITION

_____ **Discussion culture** _____

An organization with a discussion culture features a positive atmosphere during group discussions and a taken-for-granted open discussion of suggestions and concerns within a group of people. This notion is closely related to speak up behavior and high respect and appraisal of different opinions within a group.

A high discussion culture is, together with consensus, the most often stated attribute of effective group decisions in our study. If similar features like respect and appraisal of different opinions and courage to speak up are included under the label discussion culture, discussion culture in both its high and low form of appearance is perceived to have an eminent influence on the quality of decision-making processes under uncertainty. A poor discussion culture can be a strong obstacle for decision-making under uncertainty and is therefore worth thinking about.

Poor discussion culture has something in common with steep hierarchy gradients: it may lead to sub-optimal decisions as it hinders a group to gather and exchange all relevant information and constricts collecting, discussing and evaluating possible risks and benefits in an open manner. But there are differences: hierarchy gradients influence especially communication between individuals of different status, whereas discussion culture has a broader scope, influencing communication not only between seniors and residents but between all group members with the same or different roles, training, expertise and perspectives. But this communication is needed for safe and effective decisions in health care [Flin et al. 2009]. In other domains dealing with high risk like aviation or nuclear power plants, the need for and value of a mutual understanding, that all group members actively solicit and consider input, concerns and recommendations from other group members is acknowledged [Rochlin 1999]. However, how can this be achieved?

One possible way is to take advantage of the concept of **psychological safety**. This describes

> " *… individuals' perceptions about the consequences of interpersonal risks in their work environment. It consists of taken-for-granted beliefs about how others will respond when one puts oneself on the line, such as by asking questions, seeking feedback, reporting a mistake, or proposing a new idea.* [Edmondson 2004, p. 241]

When an individual is not worrying about being embarrassed, criticized or punished, psychological safety is in place.

It is convincing to assume that in a group within which members feel psychologically safe, a positive and strong discussion culture in group decision-making processes exists. Indeed, high psychological safety in work teams is correlated with components of discussion culture like feedback seeking, help seeking or speaking up about concerns [Edmondson 2004].

Research has shown that groups differ in their level of psychological safety. Previous research has identified antecedents of psychological safety that can lead the way to establish a positive discussion culture. Of the antecedents introduced by Edmondson, the following promoting factors are especially valuable for our purpose as they can be actually managed:

▷ **coaching behavior of team leaders** (modeling openness, being accessible, inviting input, non-defensive responds to challenges and questions);

▷ **use of "practice fields"** (off-line situations where problems and errors have no real consequences and therefore question, uncertainties and concern can be discussed openly, *e.g.* medical simulations, simulated tumor conferences);

▷ **organizational context support** (providing timely information and resources, allowing to concentrate on the core task).

If groups are struggling with their discussion culture, antecedent conditions should be checked and where required acted upon. For example, senior physicians can be enabled by **behavioral training** to display **coaching behavior**. Whole groups can conduct guided case studies in simulated tumor conferences where they build a positive discussion culture, which carries over to real conferences. In addition, assertiveness training, even though especially designed for

hierarchical communication, tends to cultivate competences that are of value for every kind of group. [Graber et al. 2005] give an overview of organizational factors that can be addressed in order to support medical diagnostic decision-making, such as rapid communication of abnormal test results and efficient standardized procedures.

Moreover, the achievement of psychological safety may have another positive effect. It may not only improve the *way in which* groups talk about uncertainty, but also increase the chance to make groups talk about it at all. The data revealed that in some cases uncertainty is ignored. Nobody brings uncertainty up and one physician explained that it is not accepted not to be sure. If psychological safety increases, the willingness to lower one's guard should increase.

4.3 Need for consensus

The absolutely valued strong discussion culture seems to be contradictory to the fact that the presence or absence of consensus is the predominating attribute affecting evaluations of group decisions. In the results chapter, this antagonism was resolved by bringing forward the argument that a positive discussion culture — including looking at a situation with uncertainty from many different perspectives — may lead to decisions that most group members can agree with as all available information, arguments and concerns are brought to light.

But there is also the reverse side of the coin. With regard to literature on social influences in group decision-making, striving for consensus can be a warning signal for the appearance of **decision biases** which might lead to faulty decisions. Social influence in general refers to the process by which individual judgments, behavior and attitudes change as a result of the real or implied presence of other people. Several phenomena and effects of social influences have been described; the one especially connected to a strong need for consensus is called group think.

─────── **Group think** ───────

DEFINITION

Group think has been described as: "a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when members' striving for unanimity overrides their motivation to realistically appraise alternative courses of action." [Janis 1972, p. 9]

─────── **The Bay of Pigs invasion, in 1961** ───────

Janis came to this description by studying faulty political decisions, such as the Bay of Pigs invasion in Cuba, supported by the US government in 1961, that turned out a political fiasco. The invading combatants were defeated in three days. Purportedly, President Kennedy afterwards asked his advisory group: "How could we have been so stupid?". Janis would have replied: due to group think.

Group think arises out of typical antecedent conditions and leads to prototypical symptoms and practices in use [Janis 1972, 1982; Janis et Mann 1977]. Antecedent conditions are:

▷ high group cohesiveness;

▷ insulation of the group;

▷ lack of impartial leadership;

▷ homogeneity of members' social backgrounds;

▷ high stress;

▷ difficult decision-making task.

The risk of their presence in medical group decision-making under uncertainty can be judged to be high at least for high stress, homogeneity of members' social background and difficult decision-making tasks. The **symptoms of group think** are:

▷ illusions of invulnerability creating excessive optimism and encouraging risk taking;

▷ rationalizing warnings that might challenge the group's assumptions;

▷ stereotyping those who are opposed to the group as weak, spiteful, or stupid;

▷ pressure to conform placed on any member who questions the group, couched in terms of "disloyalty";

▷ self-censorship of ideas that deviate from the apparent group consensus.

In the end, sub-optimal practices are used and the decision-making process leads to faulty decisions. Examples of these sub-optimal practices are:

▷ incomplete survey of alternatives and objectives;

▷ failure to examine risks of preferred choice;

▷ poor information search;

▷ failure to work out contingency plans.

In summary, for groups vulnerable to group think, reaching consensus is more than the quality of the process by which it is formed **[Jones et Roelofsma 2000]**.

To minimize the risk of running into the group think phenomenon, several tactics can be implemented. Firstly, increasing awareness of problematic group and situational constellations can have beneficial effects. Secondly, structuring the group decision-making process with implementation of clear phases dedicated to information search, to survey of alternatives and evaluation of their risks and benefits, and to setting up contingency plans, prevent harmful practices from determining the decision-making process. Thirdly, Janis himself devised ways of preventing group think of which the following seem to be especially practicable and easy to implement for medical decision-making groups, at least without severe time pressure **[Janis 1982]**:

▷ higher-ups should not express an opinion when assigning a task to a group;

▷ leaders should assign each member the role of "critical evaluator";

▷ at least one group member should be assigned the role of *devil's advocate*[3]. This should be a different person for each meeting.

We earlier proposed two possible interpretations of the strong need for consensus. The available data does not allow for deciding which interpretation is valid. All the more, the way in which consensus is reached in medical decision-making groups needs to be studied in more detail to rule out possible vulnerability to group think and its adverse consequences as an explanation – or to increase awareness of problematic constellations and to establish remedies.

4.4 Structure and guidance of group decision-making processes

The insufficient level of structure and guidance of group decision-making constitutes another obstacle, which is easier to interpret. *Ad hoc* consultations are not at all structured and for all types of depicted group decision situation the decision-making process does not follow any systematic way that leads through the process. But physicians stated that a low level of structure and organization is an inhibiting factor for group decisions. Moreover, a high quality of analysis is valued as an attribute of effective decisions. The quality of analysis is not only correlated with the quality of decisions but also with the level of structure of the decision process **[Croskerry 2002; Hunink et al. 2001]**. To improve group decision-making, the group can be guided through a more systematic decision process.

The literature offers a number of strategies to structure decision-making processes. They can be broadly classified in two categories: strategies stemming from prescriptive or normative decision theories and strategies stemming from the naturalistic decision-making approach.

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[3] A devil's advocate is someone who takes a position he or she disagrees with, for the sake of argument. This process can be used to test the quality of the original argument and identify weaknesses in its structure.

4.4.1 Strategies originating in normative decision theory

Strategies stemming from a normative or prescriptive approach try to improve rational decision-making by techniques that encourage a systematic approach to decision-making that should be less affected by human nature, decision biases and heuristics (such as looking only for information that supports an hypothesis, rather than trying to falsify it, base rate neglect) [Kee et al. 2004; Li et Harris 2008; O'Hare 2002]. These tactics are often embodied in mnemonics or acronyms that break the process down to several distinct steps. These steps should be accomplished one by one and organize the process in clear phases of situation assessment, searching for alternative options, evaluating options and choosing an option. The prescriptive models differ in their complexity, time requirement and use of mathematical calculation. Therefore, they do not fit equally well different decision-making situations.

A prescriptive model that was invented for medical purpose in particular is the PROACTIVE model [Hunink et al. 2001]. In this proposed decision analysis technique, decision-makers should divide the logical structure of a problem into single components, then analyze them separately and in the end recombine the components to suggest a decision. The PROACTIVE approach is illustrated in table 4.1.

Step	Description
Problem	Define the problem. What are your principal concerns?
Reframe	Does the problem look different from different perspectives?
Objectives	Focus on objectives. What are mean objectives and what is fundamental?
Alternatives	Consider all relevant alternatives
Consequences and chances	Think through consequences of each decision option and chances of each event
Trade-offs	Identify and estimate value trade-offs
Integrate	Integrate the evidence and values. Where are important differences between options?
Value	Optimize the expected value
Explore and evaluate	Explore the assumptions and evaluate uncertainties

Table 4.1 – *PROACTIVE model, after* [Hunink et al. 2001]

Several steps in the PROACTIVE model include quantitative calculations. The process is complex, requires significant effort and is time consuming. Therefore, it doesn't seem to be suitable if a group is short of time and resources [Croskerry 2002]. Moreover, one can doubt that this model is really an antidote to heuristics and biases. Nevertheless, if the steps are interpreted as reminders of what to do in which order, it might be helpful, at least in situations where time constraints are low and data available, *e.g.* tumor conferences. Another disadvantage is that the model does not explicitly include ways to facilitate open communication between group members.

Easier to accomplish are prescriptive models form the aviation domain. They are an important part of crew resource management training in aviation and taught to pilots since the 1990s [O'Hare 2002]. But they can be applied in almost all domains and have already made their way into nuclear power plants. One common and approved model is FOR-DEC [Hörmann 1995]. As depicted in table 4.2, the model clearly separates the first three steps of analyzing from the later steps of deciding and putting a plan into action. The advantage of having a last step of checking whether the decision was effective makes this approach particularly interesting in situations where action effects can be perceived and checked in a timely manner, *e.g.* emergency departments, acute wards.

As the model is quite simple and easy to remember, it might be an appropriate way to guide and structure group decision-making processes, also in healthcare. Although it was invented for cockpit teams, it has a disadvantage in common with the PROACTIVE model as it does not clarify how to integrate a group in the process.

Step	Description
Facts	What is going on? Collect facts, analyze situation, define objectives
Options	What options do we have? Gather options, don't evaluate them
Risks and benefits	What risks and benefits incorporate single option? Are there prospects of success? Are there uncertainties?
-	
Decision	What to do? Chose option with least risks and most prospect of success, create backup option
Execution	Who does what and when? Coordination and action using all available resources
Check	Is everything OK? Monitor execution and check whether actions work; if not go back to "facts"

Table 4.2 – *FOR-DEC model, after* [Hörmann 1995]

4.4.2 Strategies originating in NDM research

Naturalistic decision-making strategies do not preferentially try to control intuitive tendencies in decision-making. In line with the NDM focus on expert decision-makers, [Klein 2003] developed the acronym STICC (table 4.3). This strategy was derived from interviews with successful experienced fire fighters on how they communicate and make decisions in a team context.

Step	Description
Situation	Here is what I think we face
Task	Here is what I think we should do
Intent	Here is why I think we should do this
Concern	Here is what we should keep our eyes on since, if that changes, we are in a new ballgame
Calibrate	Now talk to me

Table 4.3 – *STICC model, after* [Klein 2003]

STICC is less analytical in a rational sense than the two strategies introduced above. But it has some important advantages with regard to the other derived obstacles in medical group decision-making under uncertainties. If somebody is saying "here is what *I think* we face", then she or he acknowledges some degree of uncertainty [Weick 2011]. So the STICC model suggests that uncertainties should be brought up when introducing a decision problem or case to the group.

This makes tactics of suppression difficult to implement and, especially if a senior physician starts STICC after case presentation, builds trust within the group [?]. The last step actively invites all group members to speak up, to raise concern or to state additional information. Using the STICC model can facilitate a positive discussion culture and make sure that the group is able to use all its resources in the decision-making process to reach an effective decision.

All three examples of strategies to structure and guide group decision-making have their advantages and disadvantages. But all allow for the necessary structuredness of group decision-making under uncertainty. For purposes of training development one could think of combining the different approaches to concentrate their positive properties.

5

Conclusion

5.1 Summary

In line with the NDM tradition of field work, an exploratory field study in the medical domain has been conducted regarding daily decision-making processes in groups under uncertainty. The aim was to obtain an understanding of how decision-making groups in this high reliability context conceptualize and internalize uncertainties and how they handle them in order to achieve effective decision-making in their everyday work activities. Furthermore, we were interested in influences on these decision-making processes and how effective decision-making in groups under uncertainty can be supported. The main results concerning the survey data can be summarized as follows:

▷ With regard to **conceptualizations of uncertainty**, our data reveals that in the medical domain (as in other domains explored by previous research), issues and sources of uncertainty are two core aspects of uncertainty conceptualizations. We have also identified another — possibly domain specific — aspect of uncertainty conceptualizations: almost half of the medical experts describe uncertainty as a lack of knowledge, skills or expertise in their own competencies.

▷ In all cases the realization of uncertainty is accompanied by intense **negative emotions** such as burden, fear and shame.

▷ **Issues of uncertainty** (what is the decision-maker unsure about) pertain to situation, alternatives and outcomes, with outcomes rated as the most frequent issue of uncertainty. This shows that uncertainty arises during the diagnostic process, the treatment process and the outcome of medical decision-making.

▷ The **sources of uncertainty** (what causes uncertainty) rated to appear most frequently are partly lacking information and inadequate understanding owing to instability of information. Furthermore, descriptions of typical group decisions reveal that the individual himself is a source of uncertainty when a lack of knowledge, skills and expertise is perceived. Moreover, the group can serve as a source of uncertainty if divergent opinions in the decision-making group exist.

▷ Three different situations of group decisions are identified: interdisciplinary regular meetings (*e.g.* tumor conferences), formal ward meetings and *ad hoc* consultations. In all healthcare units concerned by the study, only **little use of structured decision-making procedures** and processes is reported.

▷ **Strategies to handle uncertainty** mainly include attempts to reduce uncertainty by collecting additional information, delaying action until more information is available or by soliciting advice from other physicians.

▷ **Group decision-making processes** are influenced by situational factors such as workload and time pressure or the amount of available information. Moreover, the way the process is organized and structured seems to be important. Last but not least, group-specific aspects like respect and appraisal of different opinions or dealing with hierarchy have crucial influences on decision-making processes.

▷ Looking at the ultimate **decision criteria** in group decisions, the crucial factors are hierarchy, patients' interest and professional competence.

▷ Important **attributes of poor group decisions** are the absence of consensus and the use of hierarchy as the predominant decision criterion. On the other hand, decisions

judged to be effective are marked by a sufficient information base, a positive discussion culture and consensus.

Based on our results, we have identified and discussed four possible **obstacles for effective decision-making**:

▷ A steep hierarchy gradient;

▷ A poor discussion culture;

▷ A strong need for consensus;

▷ Insufficient structure and guidance of group decision-making processes.

For each obstacle, we have suggested a number of possible remedies. Ways to decrease negative effects of hierarchical differentiation focus on leadership behavior and assertiveness. Discussion culture can be improved by establishing psychological safety. Need for consensus can lead to **group think**, which in turn can be reduced by distinct strategies (*e.g.* devil's advocate, critical evaluators). Several prescriptive models exist to improve the structure of group decisions.

5.2 Limitations

Our study is exploratory, and comprises some limitations regarding the generality of the conclusions.

Firstly, one weakness is the sample size of 21 physicians. Although the sample fits the exploratory purpose, especially when keeping in mind time and effort to answer the open questions, a higher response rate would have served generalizability.

Secondly, only German speaking physicians were included in the study. Therefore, it is not possible to conclude to which degree the findings are culture dependent. Individual and group behavior is always shaped and influenced by organizational culture [Schein 1990] and national culture [Hofstede et Peterson 2000]. As the sample includes physicians from many different hospitals, influences of a specific organizational culture can be disregarded. This is not the case for influences stemming from national culture.

Besides, the deduction and description of possible obstacles and their remedies are based on studies with international background which describe phenomena similar to those we have observed in our study (*e.g.* hospitals being hierarchical environments) for hospitals in the UK, USA and Canada. So far, we do not expect our findings to be only valid and relevant for German speaking areas.

Thirdly, although our respondants were guaranteed anonymity, it is possible that a selection bias of voluntarily reported decision cases occurred. Therefore it is important to complement the research of group decision-making under uncertainty with research methods and studies that have a lower dependency on subjective information.

5.3 Future prospects

The next steps in our project aim firstly at gaining an even deeper understanding on concrete group decision-making situations and also on strategies used in the field by people involved in the decision-making process for **coping with uncertainty**, and secondly on improvement methods.

Study 2 on strategies and decision situations is in preparation. Field observations for describing different situations and strategies (*e.g.* no *ad hoc* decision, decision judged as an appropriate or inappropriate, group members with different areas of expertise) will be conducted. For this purpose, we have video recorded tumor conferences in cooperation with a university medical center in Germany. During these conferences, multidisciplinary cancer teams discuss diagnostic and treatment aspects of patient care. The emphasis is on group decision-making through **sharing information**.

Study 3 is also in preparation and focuses on developing improvement methods and their evaluation. This field study will be conducted at an anesthesia and intensive care unit. After initial observations of group decision-making processes which are used during patient simulator training, improvement methods in order to structure the whole decision-making process, and also strengthen the awareness of common biases in perception and judgment, will be developed and tested.

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