Managing the "Unknowns"
Exploring the Nature of Uncertainty and its Effects on Strategic Decisions

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The President:

Prof. Dr. Thomas Bieger

"There is a danger of expecting the results of the future to be predicted from the past"

Lord John Maynard Keynes, British economist (1883-1946)

Acknowledgements

With the submission of this dissertation, a two-year journey has come to an end. Writing this dissertation has been a personally and professionally rewarding challenge for me. Had anyone told me years ago that I would ever write a doctoral thesis, I would have not believed it. However, like once prominently stated in one of my favorite movies: "Life is like a box of chocolate – you never know what you're gonna get", I find myself here almost three years later holding this document in my hands.

While I discuss various approaches to cope with uncertainty in this thesis, I also experienced uncertainty firsthand being confronted with many sources of uncertainty throughout my dissertation journey. Therefore, I would like to thank some of the people that helped me in managing these challenges in the process:

First of all, I would like to thank my parents who have equipped me with the compass to find a way through when the waves were high, and the tide seemed to have turned against me. They always put my needs in front of theirs, sacrificed more than I could ever return, and I do not know how I would have managed without their continuous support and unconditional belief in me.

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Munich, July 2019 Isabel Alpers

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AIS	Automatic Identification System
AMR	Academy of Management Review
AoM	Academy of Management
CEO	Chief Executive Officer
Eds.	Editors
e.g.	example gratia (Latin: for example, example given)
GFF	Grundlagenforschungsfond (German: basic research fund)
i.e.	id est (Latin: that is to say)
OBR	Onboard Reporter
R&D	Research and Development
ROT	Real Options Theory
SMS	Strategic Management Society
TCE	Transaction Cost Economics
VOR	Volvo Ocean Race
UK	United Kingdom
U.S.	United States (of America)

Abstract

Effectively coping with uncertainty remains an imperative task for strategic decision-makers. The concept of uncertainty has received widespread attention from researchers and practitioners alike. Previous studies in the management field have pointed out that the current conceptualization of uncertainty may be too broad. Thus, scholars developed rich taxonomies of uncertainty that do not only capture the origin, (e.g., competitive, political), but also the nature (e.g., effect, response) of uncertainty.

Yet, we still know (surprisingly) little about how strategic decision-makers may effectively cope with different sources of uncertainty. Therefore, this dissertation explores the effects of a decomposed uncertainty concept on different strategic decisions as well as how strategic decision-makers may more effectively cope uncertainty. To fulfill this objective, three self-standing studies are being presented.

The first study explores how strategic decision-makers experience and cope with different sources of uncertainty and derives four distinct strategic postures. The study finds that despite being exposed to an objectively similar environment, strategic decision-makers not only perceived different sources of uncertainty, but also coped with them differently. Moreover, strategic decision-makers may become more effective at managing uncertainty when their strategic posture is aligned with their environment.

The second study represents a deep-dive into one of the uncertainty coping strategies presented in the first study: uncertainty reduction. From an organizational-level perspective, this study explores how organizations reduce different sources of uncertainty through their strategic decisions to govern and partner in technology sourcing across the technology life cycle. We find that governance and partner choice are contingent on the degree and locus of uncertainty experienced.

The third study focuses on the coping strategy of uncertainty amplification. Given this objective, this study explores how managerial cognitive capabilities influence strategic decision-makers’ decisions to follow or deviate from the general direction of competitors. It finds that the way in which strategic decision-makers perceived uncertainty and reasoned led to differences in their strategic decisions.

Besides the individual contributions to theory and practice of the respective studies, this dissertation also discusses more general implications for literature.

Zusammenfassung

Das Wall Street Journal hat 2017 als das Jahr der Unsicherheit für Manager deklariert. Daher ist ein effektiver Umgang mit Unsicherheit für strategische Entscheidungsfinder unerlässlich. Das Konzept "Unsicherheit" ist in der Vergangenheit auf breites Interesse sowohl unter Wissenschaftlern, als auch unter Praktikern gestoßen. Bisherige Studien im Managementbereich hoben hervor, dass das Konzept in seiner jetzigen Form wohlmöglich zu weitgehend gefasst ist. Daher haben Wissenschaftler umfassende Taxonomien des Konzepts entwickeln, die sowohl die Herkunft (z.B. Wettbewerb, Politik), als auch die Natur (z.B. Effekt, Antwort) der Unsicherheit reflektieren.

Dennoch wissen wir immer noch (erstaunlich) wenig darüber, wie strategische Entscheidungsfinder erfolgreich mit verschiedenen Arten von Unsicherheit umgehen. Daher erforscht diese Dissertation in drei unabhängigen, jedoch verbundenen Studien die Effekte eines zerlegten Unsicherheitskonzepts auf strategische Entscheidungen einerseits und den effektiven Umgang mit Unsicherheit andererseits.

Die erste Studie erforscht wie strategische Entscheidungsfinder verschiedene Arten von Unsicherheit wahrnehmen und mit ihnen umgehen. Es werden vier verschiedene Typen aufgezeigt. Die Ergebnisse der Studie zeigen, dass obwohl strategische Entscheidungsfinder derselben Umwelt ausgesetzt sind, sie verschiedene Arten von Unsicherheit wahrnehmen und auch unterschiedlich mit ihnen umgehen. Zudem ist der Umgang mit Unsicherheit erfolgreicher, wenn der Unsicherheitsumgangstyp auf die Umwelt angepasst ist.

Die zweite Studie vertieft eine der Haltungen aus der ersten Studie: Unsicherheitsreduktion. Die Studie erforscht wie Unternehmen verschiedene Arten von Unsicherheit durch ihre Führungsform und Partnerwahl im Einkauf von Technologien über den Technologiezyklus reduzieren. Wir zeigen, dass sowohl Führungsform, als auch Partnerwahl vom Grad und Herkunft der gefühlten Unsicherheit abhängen.

Die dritte Studie behandelt die Strategien der Unsicherheitserhöhung. Sie erforscht wie die kognitiven Fähigkeiten von Managern ihre strategischen Entscheidungen in Bezug auf Folgen und Abweichen vom Wettbewerb beeinflussen. Die Studie zeigt, dass die Art wie strategische Entscheidungsfinder Unsicherheit wahrnehmen und daraus schlussfolgern ihre strategischen Entscheidungen beeinflusst.

Daneben werden übergreifende Auswirkungen für die Literatur aufgezeigt.

1. Introduction

"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know."

Donald Rumsfeld, U.S. Secretary of Defense, 2001-2006

The importance of uncertainty ("unknowns"[1]) in strategic decision-making remains widely undisputed in literature (e.g., Duncan, 1972; Eisenhardt, 1989a; Galbraith, 1977; Knight, 1921; Lawrence & Lorsch, 1967; Michel, 2007; Miller, 1992; Milliken, 1987; Priem, Love, & Shaffer, 2002). Knight (1921: 199) once prominently stated "if we are to understand the workings of the economics system, we must examine the meaning and significance of uncertainty". According to Knight (1921: 225 emphasis in original), true uncertainty is inherent in decision situations where there is "*no valid basis of any kind* for classifying instances". Thus, uncertainty may be distinguished from risk in the sense that probabilities of future outcomes cannot be assigned. In fact, in the 1920s, Lord Keynes observed that "it is uncertainty, not risk, which is the more prevalent circumstance in economic and business environments" (cited in Teece & Leih, 2016: 5). Given this importance, understanding and coping with uncertainty becomes imperative for managers to steer their organizations through unforeseeable environments.

Major contributions to the conceptual frame of uncertainty have been achieved throughout the late 1960s to the late 1980s (see for example Conrath, 1967; Downey, Hellriegel, & Slocum, 1975; Downey & Slocum, 1975; Duncan, 1972; Lawrence & Lorsch, 1967; Milliken, 1987; Thompson, 1967). The concept of uncertainty attracted interest of early organization theorists, such as James Thompson who, in his highly influential 1967 book, called uncertainty "the fundamental problem with which top-level organizational administrators must cope" (cited in Milliken, 1987: 133). Uncertainty also became increasingly important to organizational behavior scholars. Research in this field established uncertainty as a subjective, multi-dimensional concept that does not only vary in degree, but also in the source from which it arises (Downey et al., 1975; Duncan, 1972; Milliken, 1987).

[1] The term "unknowns" was coined by U.S. Secretary of Defense Donald Rumsfeld (2001-2006), and, since then, has been picked up in literature to describe uncertainty (e.g., Teece, Peteraf, & Leih, 2016).

However, by the late 1980s, economics, organization theory, and organizational behavior scholars had largely moved away from studying antecedents and outcomes of uncertainty, because it had proved to be difficult to measure (e.g., Duncan, 1972; Downey & Slocum, 1975; Milliken, 1987). Therefore, scholars focused on the easier to measure concept of risk and studied individual and organizational decision-making assuming conditions of risk instead (e.g., Weber & Camerer, 1991).

Yet, risk-based decision-frameworks seem too simplistic and unrealistic given the complexities of today’s global economy (Teece & Leih, 2016). Therefore, more recent work moved away from these frameworks and towards contexts embracing a broader Knightian conceptualization of uncertainty (e.g., Alvarez & Barney, 2005; McMullen & Shepherd, 2006). Thereby, scholars increasingly emphasized the multidimensional nature of uncertainty. Researchers demonstrated that different sources of uncertainty have a variety of effects on strategic decisions, such as network partner selection (e.g., Beckman, Haunschild, & Phillips, 2004), technological specialization (e.g., Toh & Kim, 2013), contracting (e.g., Carson, Madhok, & Wu, 2006), and imitation (e.g., Gaba & Terlaak, 2013).

However, studies that systematically assess outcomes of different sources of uncertainty still remain dearth. Particularly, there is a lack of understanding regarding the consequences of uncertainty in organizational and management theories. More specifically, we still know little about how strategic decision-makers cope with uncertainty and how uncertainty influences strategic decisions. In this respect, Teece and Leih (2016: 6) noted that “there has been a failure to think through what [uncertainty] means for management decision making, business organization, and business strategy.” The necessity for further research in this field also becomes evident at the example of the Academy of Management Review’s (AMR) call for papers for a special topic forum that focuses the implications of uncertainty for management and organization theories in July 2018. In summary, there is a growing urgency to address this gap in extant research.

Therefore, this dissertation is positioned within this niche. I address this gap in research by exploring how strategic decision-makers cope with different sources of uncertainty and how different sources of uncertainty influence organizations’ and individuals’ strategic decisions. Thereby, I define uncertainty as a “perceived inability to predict something accurately” (Milliken, 1987: 136) stemming from a lack of

confidence in one's knowledge to resolve a decision-situation (Duncan, 1972; Lipshitz & Strauss, 1997). The source of such uncertainty can be a dynamic organizational environment (Duncan, 1972; Lengnick-Hall & Beck, 2005) or solving day-to-day problems (Michel, 2007).

Furthermore, the strategic decision-makers studied in this dissertation may be considered experts in their domain. Experts differ from novices to the extent that they perceive information in their domain of expertise more accurately and quickly and are consequently better able to respond appropriately, because they rely on skilled intuition and controlled mental processing that is less prone to heuristics and biases in judgment (Heerkens & van der Heijden, 2011; Helfat & Peteraf, 2015; Kahneman & Klein, 2009; Tetlock, 2017. Therefore, experts are likely to command a diverse and suprior set capabilities in their domain.

Given this context, I first explore how strategic decision-makers cope with different sources of uncertainty by taking a managerial cognitive capabilities lens because managerial cognitive capabilities account for differences in strategic decision-makers' cognition and eventually behavior. Based on the uncertainty coping strategies identified in the first part of this dissertation, I then conceptually and empirically explore two uncertainty coping strategies in individual strategic decisions, uncertainty reduction and uncertainty amplification, from an organizational and individual level perspective. Overall, I find that organizations and individuals alike adapt their strategic responses to the source of uncertainty that is most salient.

I study my research questions in the context of two editions of a professional sailing race: The Volvo Ocean Race of 2014-15 and 2017-18. The Volvo Ocean Races are around-the-world sailing competitions that last approximately nine months. The races provided ideal contexts to study uncertainty perceptions and outcomes because their controlled setting allowed to explore skippers' cognition and strategic decisions at an accelerated pace. While a single strategic decision may normally take in between 2-18 months (e.g., Eisenhardt, 1989a), skippers participating in the two races have to take strategic decisions within days or weeks. Furthermore, skippers need to content multiple sources of uncertainty within short periods of time. This enabled me to explore how they coped with and responded to different sources of uncertainty and how this affected their performance.

In summary, this dissertation contributes to our understanding of how strategic decision-makers experience uncertainty and how both, organizations and individuals, manage it, and respond to it.

1.1. Motivation

Building on the above outlined definition, this dissertation explores uncertainty on the organizational and individual-level. In this respect, this thesis speaks to three limitations currently found in management literature. These limitations encompass different outcomes of uncertainty in general as well as a new theoretical lens for analyzing outcomes of uncertainty, namely (1) a shortfall in understanding of how strategic decision-makers cope with uncertainty, (2) a lack of exploration of outcomes of a decomposed view of uncertainty on strategic decisions, and (3) the underexplored nature and role of managerial cognitive capabilities in strategic decisions.

(1) Strategic decision-makers uncertainty coping behavior

Thompson (1967) already defined uncertainty as a key challenge that managers need to content. Thus, the management and decision-making literatures discussed different strategies on how to cope with uncertainty. These include reducing (e.g., Cyert & March, 1963; March & Simon, 1958; Simon, 1976), amplifying (e.g., Hayek, 1948, 1937; Kirzner, 1997; Schumpeter, 1934; or Jacobson, 1992; Roberts & Eisenhardt, 2003; Young, Smith, & Grimm, 1996 for a summary), acknowledging (e.g., Cohen, Tolcott, & McIntyre, 1987; Lipshitz & Strauss, 1997; Thompson, 1967), and suppressing (e.g., Lipshitz & Strauss, 1997; Matlin & Stang, 1978) uncertainty.

While the management literature analyzed how strategic decision-makers cope with uncertainty in individual decision situations (e.g., Beckman et al., 2004; Carson et al., 2006; Toh & Kim, 2013), it neglected to provide a more comprehensive picture: Do strategic decision-makers always cope with uncertainty in the same way? Thus, do they follow a pattern of uncertainty coping? And, how does their coping affect performance? Thus, our understanding of how strategic decision-makers manage uncertainty is still underdeveloped. Yet, learning how strategic decision-makers may more effectively cope with uncertainty is crucial given that uncertainty, despite technological advances, such as “big data” and rapid information processing, is still ubiquitous (Teece & Leih,

2016), and because it may induce negative performance effects (e.g., Michel, 2007; Miller, 1992).

Therefore, this dissertation seeks to address this gap and explores when and how strategic decision-makers make use of individual uncertainty coping strategies, how they combine different strategies into uncertainty coping postures, and how they may become more effective at confronting uncertainty. In doing so, we advance current research on uncertainty management and enable managers to cope with uncertainty more effectively (Study 1).

(2) Effects of a decomposed uncertainty concept on strategic decisions

Strategic decisions are managerial choices that set important precedents and shape a firm's general direction (Dean & Sharfman, 1996; Eisenhardt & Martin, 2000; Eisenhardt, 1989a; Fredrickson, 1984; Judge & Miller, 1991; Mintzberg, Raisinghani, & Théorêt, 1976). While strategic management scholars have demonstrated the importance of studying the effect of individual components of uncertainty on a variety of strategic decisions (e.g., Beckman et al., 2004; Carson et al., 2006), studies in this field still remain dearth[2].

Prior research on strategic decisions indirectly assumed that environmental factors play a role in strategic decisions (Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989a; Hough & White, 2003; Kaplan, 2008a). Therefore, previous scholarly work predominantly studied the nature of and changes in organizations' environment, such as industry structure (e.g., Nadkarni & Barr, 2008) and dynamism (e.g., Mitchell, Shepherd, & Sharfman, 2011). Yet, bounded rationality prevents strategic decision-makers from developing a complete understanding of their environment (Bogner & Barr, 2000; Daft & Weick, 1984). Thus, strategic decision-makers develop subjective representations of their environment that guide their strategic decisions.

[2] The importance of the role of uncertainty in strategic decisions is further highlighted by the Academy of Management Specialized Conference "From Start-up to Scale-up: Coping with Organizational Challenges in a Volatile Business Environment" taking place in Tel Aviv in December 2018, the Special Topic Forum "The Implications of Uncertainty for Management and Organizational Theories" organized by the Academy of Management Review, announced in July 2018 and taking place in May 2019, and the Strategic Management Society's Special Conference on "Strategic Decisions in an Uncertain World", taking place in Frankfurt, Germany in June 2019.

Prior research acknowledged that strategic action, not only on the individual, but also on the organizational level (e.g., Daft & Weick, 1984; Lyles & Schwenk, 1992; Prahalad & Bettis, 1986; Thomas, Clark, & Gioia, 1993), is grounded in top managements perceptions of the environment (e.g., Nadkarni & Barr, 2008), Thus, perceptions play a central role in how strategic decision-makers and organizations alike identify and understand patterns in their environment (Helfat & Peteraf, 2015).

Because uncertainty originates in strategic decision-makers’ perceptions of their environment, the concept is present in (almost) all decision scenarios (Haunschild, 1994). Therefore, shedding more light on the relation between different sources of uncertainty and strategic decisions may ameliorate our understanding of why strategic decision-makers opt for one way.

Speaking to this perspective, this dissertation analyzes and discusses the role of uncertainty in two strategic decisions that executives face: Governance and partner choice in technology sourcing (Study 2), as well as deviating from or following the general direction of competitors (Study 3).

(3) The nature and role of managerial cognitive capabilities

Managerial cognition and strategic decision-makers’ interpretative processes play a central role in the deployment of capabilities and resources, and hence in the formation of strategy (Benner & Tripsas, 2012; Eggers & Kaplan, 2009; Gavetti, 2005). All of these studies share the perspective that managerial cognition is crucial for capability development. Yet, research with regards to how they do so is fragmented (Eggers & Kaplan, 2013).

Therefore, recent conceptual work by Helfat and Peteraf (2015) attempted to provide a more comprehensive picture of the mental activities underlying capability development. Helfat and Peteraf (2015) highlighted that due to differences in their mental activities, strategic decision-makers vary in the way and in the extent to which they sense and seize opportunities. They defined the “capacity of an individual manager to perform one or more of the mental activities that comprise cognition” managerial cognitive capabilities (Helfat & Peteraf, 2015: 835). While their work contributed to our understanding of managerial cognitive capabilities, it did not provide insights with regards to the nature and role of managerial cognitive capabilities in strategic decisions.

Therefore, while we *do know* that managerial cognitive capabilities play a crucial role in strategic decisions, we do not yet know *how*. Yet, exploring how managerial cognitive capabilities influence strategic decisions is important to better understand the strategic decision-makers' mental activities, their strategic choices, and, ultimately, performance. More specifically, because managerial cognitive capabilities may be altered through repeated practice (Zollo & Winter, 2002), strategic decision-makers may further develop their cognitive capabilities to ameliorate their strategic decisions.

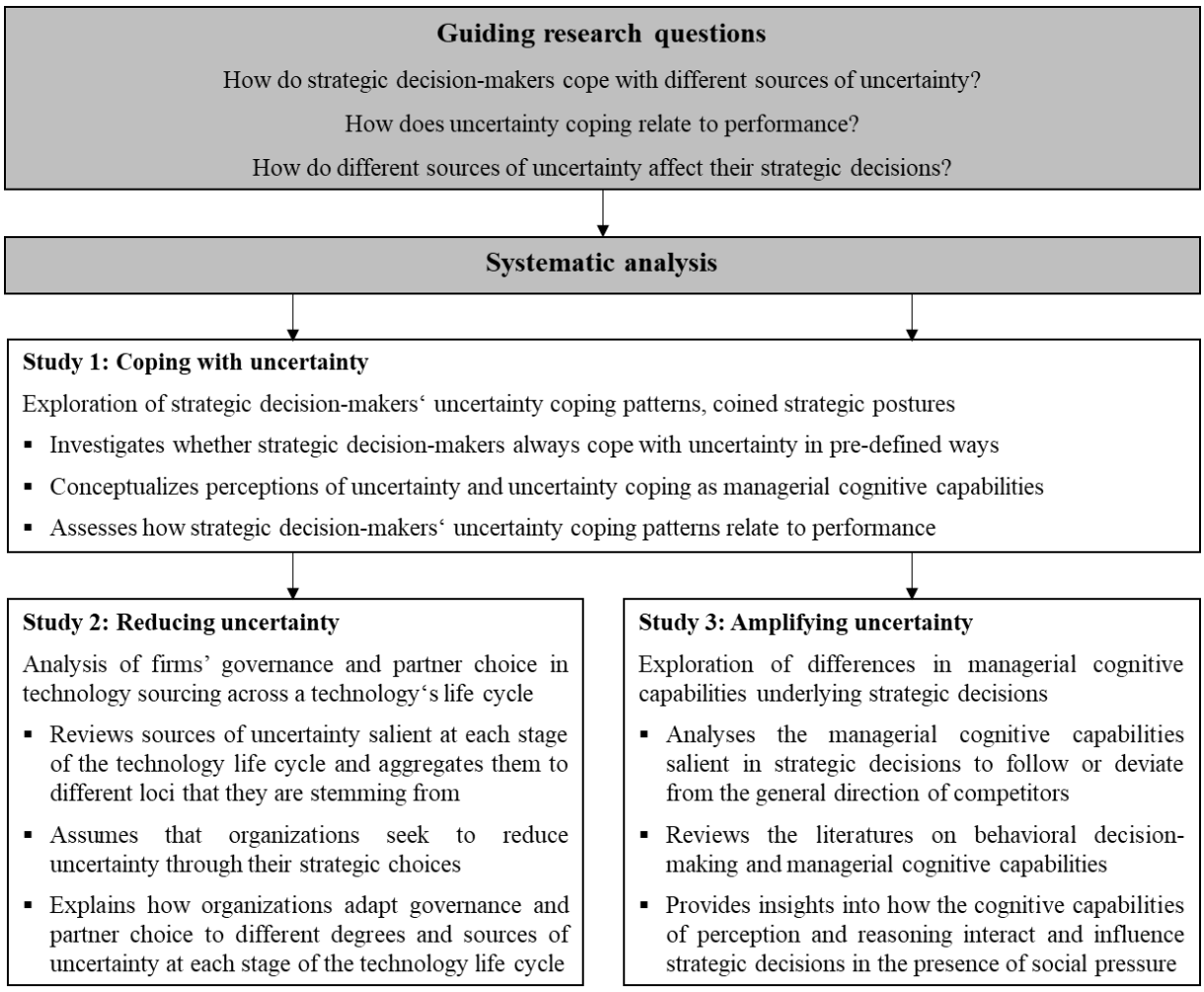
This dissertation aims to make a first step into this direction by exploring the role of managerial cognitive capabilities in strategic decision-makers' uncertainty coping behavior (Study 1), and the strategic decisions to follow or deviate from the general direction of competitors (Study 3).

1.2. Scope of the dissertation

The purpose of this dissertation is to explore the outcomes of strategic decision-makers' perceptions of different sources of uncertainty. Building on prior work in this field, this thesis is guided by the following research questions: First, how do strategic decision-makers cope with different sources of uncertainty? Second, how does this affect their performance? And third, how do different sources of uncertainty affect their strategic decisions?

Because this dissertation seeks to answer different research questions, I sub-divided it into three independent studies. Figure 1-1 provides an overview of the scope of the dissertation as well as the individual studies.

Figure 1-1: Scope of dissertation



The first study draws on managerial cognitive capability theory (e.g., Eggers & Kaplan, 2013; Gavetti, 2005; Helfat & Peteraf, 2015) to explore differences in strategic decision-makers' patterns to cope with uncertainty, termed strategic postures. Despite managerial cognitive capabilities being a relatively new theoretic lens, it represents an appropriate perspective to study our research questions because it offers the opportunity to study differences in managers' capability to cope with uncertainty. The central thesis of this study is that strategic decision-makers are heterogeneous in the way they cope with uncertainty because they hold different cognitive capabilities (Helfat & Peteraf, 2015). In this respect, this study does not only explore the nature of strategic postures to cope with uncertainty, but also performance implications.

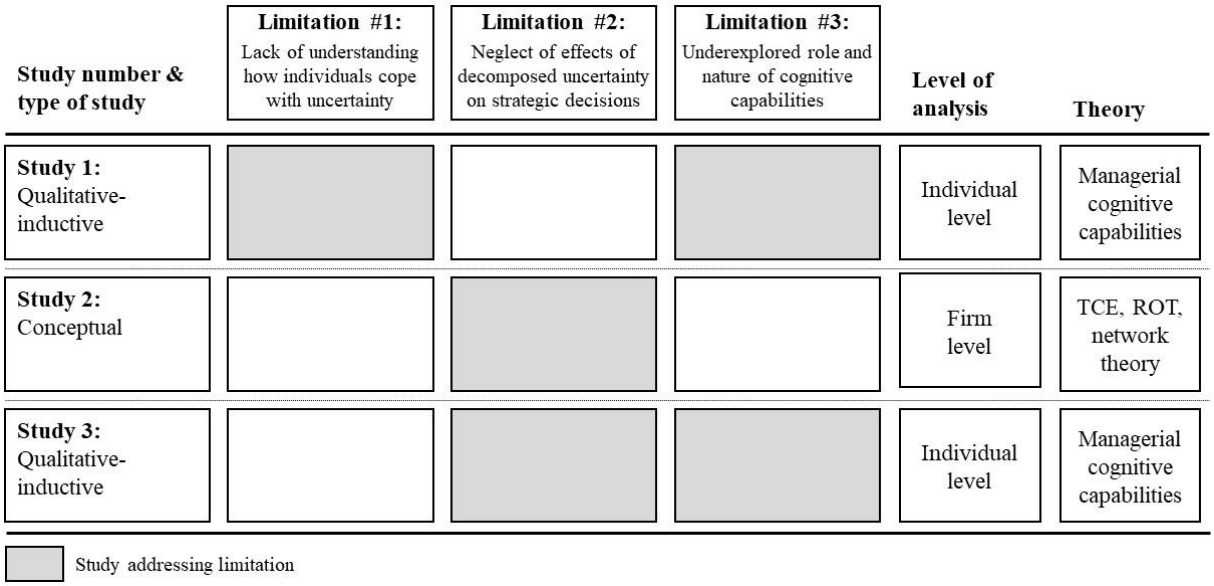
Based on the uncertainty coping strategies discussed in the first study, the second study deep-dives into ways in which strategic decision-makers reduce uncertainty from an organizational-level perspective. Thereby, this study explores the strategic decisions to govern and partner in technology sourcing across a technology's life cycle (e.g.,

Beckman et al., 2004; Dosi, 1982; Hoetker, 2005; Kaplan & Tripsas, 2008; Nelson & Winter, 1982; Suarez, 2004; Teece, 1986; Tushman & Anderson, 1986; Tushman & Rosenkopf, 1992). Drawing on transaction cost economics (TCE), real options theory (ROT), and network theory, the central thesis of this study is that organizations alter governance and partner choice for technology sourcing because they seek to reduce different sources of uncertainty across the technology life cycle. More specifically, because the source and degree of different sources of uncertainty changes as a technology progresses in terms of life cycle, organizations adapt by altering governance and partner choice.

The third study, again, draws on managerial cognitive capabilities theory (Helfat & Peteraf, 2015) to explore cognitive mechanisms underlying strategic decisions (e.g. Eisenhardt, 1989a; Mitchell et al., 2011; Nadkarni & Barr, 2008). More specifically, this study looks at why some strategic decision-makers decide to deviate from the general direction of competitors while others do not. More broadly speaking, when do strategic decision-makers amplify uncertainty and when do they seek to reduce it? The central argument of this study is that, assuming everything else equal, strategic decisions vary because underlying them are different mental activities. Hence, strategic decision-makers that possess specific cognitive capabilities will decide differently than others.

Jointly, the studies outlined above address the three limitations in existing literature (see Figure 1-2 for an overview). The first study addresses the question of how strategic decision-makers *manage uncertainty*, whereas the second and third study explore the effect of *different components of uncertainty* on strategic decisions. All three studies have in common that they decompose uncertainty. Yet, their theoretical lenses differ. In this respect, Study 1 and Study 3 draw on *managerial cognitive capabilities theory*, whereas Study 2 integrates perspectives from TCE, ROT, and network theory.

Figure 1-2: Studies addressing the three limitations in existing literature



1.3. Review and definition of the concept of uncertainty

In their review of the concept of environmental uncertainty, Downey and Slocum (1975: 562, emphasis in original) note that the term "uncertainty" is so frequently applied that "it is all too easy to *assume* that one knows what he [or she] is talking about" when applying the term. Similarly, Argote (1982: 420) criticized that "there are almost as many definitions of uncertainty as there are treatments of the subject". Thus, there have been various conceptualizations and operationalization of uncertainty in management literature. The two major debates have been formed:

From a broader perspective, researchers debated whether uncertainty should be considered a description of the state of organizational environment and consequentially may be operationalized objectively for all parties involved (Milliken, 1987) or whether it relates to how uncertain an individual perceives the environment to be – often stemming from a lack of knowledge or information that the respective person experiences to be missing (Michel, 2007; Milliken, 1987). The latter perspective implies that uncertainty lies "in the eye of the beholder" (Milliken, 1987: 134) and consequentially should be studied as a perceptual phenomenon (Aldag & Storey, 1975; Duncan, 1972; Starbuck, 1976).

In addition, researchers have defined and measured uncertainty as risk (Anderson, Deane, Hammond, & McClelland, 1981; Arrow, 1965; MacCrimmon & Wehrung, 1986), ambiguity (Carson et al., 2006; Hogarth, 1987; March & Olsen, 1976),

complexity (Duncan, 1972; Emery & Trist, 1965; Thompson, 1967), entropy (Leblebici & Salancik, 1981), turbulence (Terreberry, 1968), equivocality (Weick, 1979), and conflict (March & Simon, 1958). In addition, researchers implied uncertainty as a contextual variable (e.g., Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989a). These various conceptualizations of uncertainty have contributed to the confusion around the term as well as its effects.

Acknowledging these ongoing debates, this dissertation is positioned within the camp conceptualizing uncertainty as an inherently perceptual phenomenon that is idiosyncratic to the individual or organization who experiences it. Thereby, I follow the definition offered by Knight (1921): While risk is subject to measurement, uncertainty is ineradicable from any business decision-making process. In this sense, managers have to deal with the existence of "unknowable causes" (Knight, 1921: 41-51) and the "indeterminatedness" (Knight, 1921: 524-527) of the business world. More specifically, I define uncertainty as a "perceived inability to predict something accurately" (Milliken, 1987: 136) stemming from a lack of confidence in one's knowledge to resolve a decision-situation (Duncan, 1972; Lipshitz & Strauss, 1997). Following this definition, the source of such uncertainty can be a dynamic organizational environment (Duncan, 1972; Lengnick-Hall & Beck, 2005) or solving day-to-day problems (Michel, 2007).

1.4. Dataset and research approach

The empirical context of this study are two editions of a professional sailing race: The Volvo Ocean Race 2014-15 and 2017-18. The Volvo Ocean Race (VOR) is one of the world's longest professional sailing races taking participants around the world within approximately nine months. Seven skippers campaigned in each edition respectively. Sailing races provide ideal contexts to study my research questions for several reasons:

First, the Volvo Ocean Race is one of the world's longest professional offshore sailing competitions. This offered me two advantages: On the one hand, the duration of the race allowed for a sufficient timeframe to study skippers' perceptions, coping strategies, and strategic decisions. Sailing races are characterized by an accelerated pace of decision-situations and thus different sources of uncertainty that strategic decision-makers need to contend compared to traditional business settings (i.e., 1.5 to 18 months in Eisenhardt, 1989a), because skippers need to select and adjust the general direction of their boats (i.e., through tacks and gybes) within short periods of time, sometimes on

a daily basis, to sail towards their target destination. And, on the other hand, skippers are exposed to varying conditions throughout the race as they sail through all oceans of the world. Thus, they need to effectively cope with different sources of uncertainty in order to win. These are similar to those found in organizational settings. Environmental forces, such as the weather as well as constant competition, the need to have sufficient supplies, a healthy crew, and an intact boat make the environment unpredictable and thus give rise to perceptions of different sources of uncertainty.

Second, the context provided me with the opportunity to study highly experienced strategic decision-makers, sailing boat skippers to answer my research questions. Skippers participating in the Volvo Ocean Race are highly knowledgeable and skilled in their domain due to prolonged practice and rapid feedback to their choices (i.e., performance implications against their competitors, speed). Thus, they are likely to command skilled intuition (Kahneman & Klein, 2009). As this race is one of the most physically challenging sailing races in the world, participants require ample sailing experience and long-winded training prior to the start of the competition to be able to endure the conditions of this around-the-world race. Skippers are the ultimate decision-makers onboard and carry the responsibility for their teams. Thus, their hierarchical position is similar to that of a CEO, a strategic decision-maker, whose perceptional frames are crucial in determining the organization’s strategic choices (Gavetti, 2012; Helfat & Peteraf, 2015; Kaplan, 2008a; Knudsen, 2001).

Third, as with other sports, sailing races have pre-defined boundary conditions and rules that are enforced as soon as an incident occurs. Sports offer the advantage of a controlled setting where participants are not being made aware of the context of study. Sport settings allow to eliminate noise created by differences in institutional settings as influencing factors (Holcomb, Holmes, & Connelly, 2009). Hence, the race enabled me to focus on the cognitive capabilities of the skippers. Boats are made of one design and equipped with the same technology. Crew sizes are fixed with a pre-defined age range of participants and maximum crew weight (resource similarity). In addition, skippers are restricted in their information supply and only receive information at pre-defined points in time (information symmetry). In this respect, they are not allowed to search for information online, interact with others outside the race, and only receive position reports on their competitors from Race Control every six hours.

And fourth, as the race enjoys public attention around the world through diverse channels, such as live-broadcasting, TV documentaries, and press reports, skippers have an interest in performing well. Not only is winning the Volvo Ocean Race considered highly prestigious among sailors, it may also help skippers obtain future sponsorship for campaigns. These are often based on performance in past races. Thus, all skippers share similar aspirations to obtain a podium position.

Overall, the dataset derived from the Volvo Ocean Races comprises three major elements: First, daily log book entries written by skippers themselves or 'neutral' observers, called onboard reporters (OBRs), describing skippers' perceptions, their thought processes, and actions. Second, strategic reviews of each stage of the race written by race experts that are part of the Volvo Ocean Race administrative staff. And third, visual data from the official Volvo Ocean Race tracker that allowed viewers to derive the exact position of the boats and their rankings, partly as live coverage when close to shore, or updated during six hourly intervals when boats were too far offshore. I drew on qualitative research methods to analyze and code the data using *ATLAS.ti*™. Chapters 2 and 4 provide more details on the content of the individual data sources used in the respective studies.

1.5. Structure of the dissertation

The structure of the dissertation reflects the three independent studies conducted to answer the overarching research questions. Thus, while the first chapter includes an introduction to the dissertation, outlines of the motivation for the thesis as well as purpose, choice of theory, key terminology, and research approach, Chapters 2 to 4 present the three studies directed at answering the initial research questions outlined. The final Chapter 5 provides an overarching discussion of the findings of this dissertation, particularly with respect to implications for theory and practice (summarized in Table 1-1).

Table 1-1: Structure of the dissertation

<table>
<tr><td colspan="2">Chapter 1: Introduction
Motivation, purpose of dissertation, choice of theory, definitions, research approach, structure</td></tr>
<tr><td colspan="2">Chapter 2: Managing uncertainty (Study 1)
Exploring strategic postures to cope with different sources of uncertainty</td></tr>
<tr><td>Authors
Alpers, I., Ambos, B.

Research grants
GFF (basic research fund)

Publication status
Ready for submission

Publication outlet
Administrative Science Quarterly</td><td>Abstract
Do strategic decision-makers' follow distinct pattern(s) in coping with different sources of uncertainty? We explore this question through an inductive study of seven skippers participating in the Volvo Ocean [Sailing] Race 2014-15. Drawing on managerial cognitive capabilities theory, our research identifies four distinct patterns of how strategic decision-makers perceive and cope with uncertainty, which we coin strategic postures: Explorer, Commander, Repressor, and Hedger. As expected by managerial cognitive capabilities theory, strategic decision-makers varied in the way they coped with uncertainty when their perception of it differed. Yet, even when they perceived similar sources of uncertainty, their coping strategy differed. This suggests that the way in which strategic decision-makers perceive and cope with uncertainty may be rooted more deeply in strategic decision-makers' cognitive underpinnings than previously assumed. Our study also discusses important performance implications suggesting a strategic posture-context fit.</td></tr>
<tr><td colspan="2">Chapter 3: Reducing uncertainty (Study 2)
Uncertainty, governance, and partner choice in technology sourcing over a technology's life cycle</td></tr>
<tr><td>Authors
Alpers, I., Ambos, B.

Conferences
AoM 2018; SMS 2017; SMS Costa Rica 2017</td><td>Abstract
This study explores the effect of uncertainty on governance and partner choice in technology sourcing over the course of a technology's life cycle. We draw on rationales from transactions cost economics, real options theory, and network theory to explain how organizations govern technology sourcing and choose transaction partners as the sourced technology moves through its life cycle. We argue that these choices are contingent on the degrees and sources of uncertainty that organizations face. While early phases of a technology's life cycle are characterized by numerous exogenous sources of uncertainty, which lead to hybrid forms of governance in partnerships formed with suppliers already familiar to the organization, hierarchical governance emerges in later phases due to higher degrees of endogenous sources of uncertainty. After exogenous shocks, organizations will seek market-based forms of governance and source from new suppliers because doing so helps mitigate firm specific sources of uncertainty.</td></tr>
<tr><td colspan="2">Chapter 3: Amplifying uncertainty (Study 3)
Perception and reasoning capabilities in strategic decisions to follow or deviate from competitors</td></tr>
<tr><td>Authors
Alpers, I.

Publication status
Ready for submission

Publication outlet
Strategic Management Journal</td><td>Abstract
When do strategic decision-makers follow their competitors and when do they deviate? While prior work in this the management and psychology literature has focused on social and cognitive pressures as well as framing of the decision situation, we analyze the nature and relation of managers' underlying mental activities that affect their uncertain strategic choices. Building on prior work in managerial cognitive capabilities theory, we argue that strategic decisions are contingent on how strategic decision-makers perceive uncertainty and on the way in which they reason. Thereby, our analysis suggests that when strategic decision-makers perceive less controllable sources of uncertainty and when the reason sensibly, it increases the likelihood of them taking the strategic decision to deviate from the direction of their competitors. By contrast, when strategic decision-makers perceive more controllable sources of uncertainty and reason protectively, it increases the likelihood for strategic decisions to follow competitors.</td></tr>
<tr><td colspan="2">Chapter 5: Discussion and conclusion
Summary, contributions to research and practice, outlook, conclusion</td></tr>
</table>

2. Managing uncertainty: Navigating the "unknowns" – Exploring strategic postures to cope with different sources of uncertainty[3]

Abstract:
Do strategic decision-makers' follow distinct pattern(s) in coping with different sources of uncertainty? We explore this question through an inductive study of multiple case studies in the context of the Volvo Ocean [Sailing] Race 2014-15. Drawing on managerial cognitive capabilities theory, our research identifies four distinct patterns of how strategic decision-makers perceive and cope with uncertainty, which we coin strategic postures: *Explorer*, *Commander*, *Repressor*, and *Hedger.* As expected by managerial cognitive capabilities theory, strategic decision-makers differed in the way they coped with uncertainty when their perception of it differed. Yet, even when they perceived similar sources of uncertainty, their coping strategy differed. This suggests that the way in which strategic decision-makers perceive and cope with uncertainty may be rooted more deeply in strategic decision-makers' cognitive underpinnings than previously assumed. Our study also discusses important performance implications suggesting a strategic posture-context fit.

Key words: Uncertainty, uncertainty coping strategies, strategic postures, managerial cognitive capabilities, performance, adaptive fit

[3] Acknowledgements: This study is co-authored with Björn Ambos. Further, I am grateful to Steven Floyd, Dietmar Grichnik, Sven Kunisch, Felipe L. Monteiro, Thorsten Schmid, and Thomas Zellweger for insightful discussions and helpful comments on earlier versions of this paper.

2.1. Introduction

Uncertainty is considered one of the key challenges that managers need to contend (Ashill & Jobber, 2010; Duncan, 1972; Miller, 1992; Milliken, 1987; Packard, Clark, & Klein, 2017; Thompson, 1967). Following Knight (1921), we define uncertainty as “an individual’s perceived inability to predict something accurately” (Milliken, 1987: 136) stemming from a lack of confidence in one’s knowledge to resolve a decision-situation (Duncan, 1972; Lipshitz & Strauss, 1997). The source of such uncertainty can be a dynamic organizational environment (Duncan, 1972; Lengnick-Hall & Beck, 2005) or strategic decision-maker’s day-to-day problems (Michel, 2007). Because uncertainty can induce negative emotions, such as stress, doubt, and anxiety (Kiefer, 2005; Lipshitz & Strauss, 1997; McKenzie, Woolf, van Winkelen, & Morgan, 2009), as well as adverse performance effects (Michel, 2007; Miller, 1992), effectively coping with uncertainty becomes a crucial managerial task.

Conventional wisdom suggests that individuals strive to reduce uncertainty. Grounded in the Carnegie School (e.g., March & Simon, 1958; Simon, 1976), uncertainty reduction was termed a “fundamental need” (Hogg & Mullin, 1999: 253), and a form of control (Case, Fitness, Cairns & Stevenson, 2004; deCharms, 1968; White, 1959), and therefore the primary guiding principal of human behavior. This idea appears to be aligned with practical life examples: CEOs of U.S. companies hesitating to invest as they waited for uncertainty to reduce following the 2008 financial crisis (Berman, 2015), or Danone CEO’s “beyond budget” initiative applying flexible budgets to lower uncertainty in strategic planning (Lublin, 2016).

However, such conventional wisdom stands at odds with the Austrian School (e.g., Jacobson, 1992; Kirzner, 1997; Michel, 2007; Roberts & Eisenhardt, 2003; Schumpeter, 1934) suggesting that strategic decision-makers should amplify uncertainty. Practical examples include Elon Musk’s approach to experiment with new technologies in Tesla’s production lines (Sage, 2017), Google managers’ minimum viable product approach to innovation market testing, and the CEO of Deutsche Post pioneering mass-production of small electric trucks despite it being a logistics company.

In addition, studies on naturalistic decision-making found that strategic decision-makers may also suppress or acknowledge uncertainty as coping mechanisms (Lipshitz & Strauss, 1997). This indicates that uncertainty reduction may, in fact, not be a “fundamental need”, but that the way in which strategic decision-makers cope with

uncertainty may be rooted more deeply in strategic decision-makers mental processes (e.g., Michel, 2007).

Thus, one possibility to reconcile these different lines of thought lies in managerial cognitive capabilities theory. Cognition researchers have long suspected that differences in mental processes play a central role in how strategic decision-makers respond to changes in their environment (e.g., Adner & Helfat, 2003; Eggers & Kaplan, 2009; Gavetti, 2012; Helfat & Peteraf, 2015). Managerial cognitive capabilities scholars suggest that differences in how strategic decision-makers manage organizational resources may arise from the way in which they perceive their environment (Adner & Helfat, 2003; Dong, Garbuio & Lovallo, 2016; Gavetti, 2005; Teece, 2007). Therefore, strategic decision-makers deviate in the way they cope with uncertainty because of differences in their perception of it. Perceptions of uncertainty may be distinguished in terms of the source from which it arises (e.g., suppliers, competitors) and the nature (e.g., how to respond to environmental change) of uncertainty strategic decision-makers perceive (Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984).

Yet, we still know (surprisingly) little about how strategic decision-makers cope with different sources of uncertainty. Therefore, taking a managerial cognitive capabilities lens, two opportunities arise: First, prior studies on uncertainty coping focused either on one source of uncertainty or one way to manage uncertainty (e.g., Engau & Hoffmann, 2011; Michel, 2007; Toh & Kim, 2013). While these studies contributed to our understanding how strategic decision-makers may cope with specific sources of uncertainty, they did not provide insights into whether strategic decision-makers always cope with uncertainty in the same way. Hence, we know little about whether strategic decision-makers follow (mentally) pre-defined pattern(s) of coping with uncertainty. Yet, exploring potential uncertainty coping pattern(s) is important because they may hold performance implications.

And second, managerial cognitive capabilities theory suggests that strategic decision-makers with superior cognitive capabilities are better able to sense and seize opportunities before they materialize (Denrell, Fang, & Winter, 2003). As a result, these individuals may seize first-mover advantages and contribute to long-term organizational performance prior to other strategic decision-makers (e.g., Helfat & Peteraf, 2015). In this respect, Gavetti (2012) also argued that strategic decision-makers with superior cognitive capabilities may be less likely to fall trap to detrimental intuition and hunches

and thus have greater success in identifying promising strategic opportunities (Helfat & Peteraf, 2015). This implies that some individuals may possess more effective cognitive capabilities than others (Gavetti, 2012, 2005; Helfat & Peteraf, 2015). Therefore, strategic decision-makers that cope with different sources of uncertainty in a specific way may experience superior performance effects as a result.

Based on these opportunities, our study seek to answer the following questions: First, do strategic decision-makers follow (a) distinct pattern(s) in the way they cope with different sources of uncertainty? Second, if yes, what do these pattern(s) look like? And third, are there uncertainty perception and coping pattern(s) that are superior to others?

Thus, the purpose of this study is to explore potential pattern(s) of how strategic decision-makers’ cope with different sources of uncertainty and how this/ these pattern(s) relate(s) to performance. Through within and cross case study analysis, we study uncertainty perceptions and uncertainty coping strategies used by strategic decision-makers over a period of nine month in the context of a professional sailing race, the Volvo Ocean Race 2014-15.

Professional sailing races represent ideal settings because skippers of sailing boats have to manage different sources of uncertainty on a daily basis. Therefore, pattern(s) that we can link to performance may emerge more quickly than in traditional business settings. We define a distinct pattern of uncertainty perceptions and coping strategies a strategic posture – a term borrowed from the literature on strategic groups and adaptation (e.g., DeSarbo & Grewal, 2008; Lengnick-Hall & Beck, 2005; Porter, 1979).

The central idea behind this study is that strategic decision-makers differ in the way they perceive and cope with uncertainty due to their mental predispositions (e.g., Helfat & Peteraf, 2015). Thus, when observed over time, distinct pattern(s), or strategic postures, of how strategic decision-makers perceive and cope with uncertainty may emerge. Furthermore, some strategic decision-makers that perceive and cope with uncertainty in specific ways may be more effective than others.

In summary, our work attempts to contribute to our understanding of how strategic decision-makers cope with different sources of uncertainty, and how they may become more effective in doing so. To our knowledge, few scholars examined both different sources of uncertainty and several uncertainty coping strategies in a single

study, although a great deal of studies were conducted on each (e.g., Beckman, et al., 2004; Engau & Hoffmann, 2011; Michel, 2007). Yet, examining both different sources of uncertainty and uncertainty coping strategies allows us to identify underlying pattern(s) and dependencies in strategic decision-makers mental activities of perceptions and coping to more confidently talk about the relation between sources of uncertainty, uncertainty coping strategies, and how they impact performance. More broadly, our study also contributes to our understanding of how managers align their organizations to changes in their environment to build competitive advantage (e.g., Chakravarthy, 1982; Dutton & Dukerich, 1991; Ginsberg, 1988; Jennings & Seaman, 1994; Miles & Snow, 1978; Tripsas & Gavetti, 2000).

2.2. Background

There are currently two generic forms of uncertainty coping strategies discussed in literature: active and passive uncertainty coping strategies. Whereas active strategies (uncertainty *reduction* and *amplification*) draw on organizational and social resources to lower the degree of uncertainty (e.g., uncertainty reduction through collecting additional information), passive strategies (uncertainty *acknowledgement* and *suppression*) encompass purely mental actions to address the degree of uncertainty (e.g., uncertainty suppression through ignorance of uncertainty) (Lipshitz & Strauss, 1997).

More specifically, one stream of research emphasizes the idea that uncertainty should be *reduced* (e.g., March & Simon, 1958; Simon, 1976). The basic idea behind this hypothesis is that "certainty renders existence meaningful and confers confidence in how to behave and what to expect from the physical and social environment" (Hogg & Terry 2000: 124). Moreover, the psychology literature finds that reducing uncertainty is a way "to simplify cognitive demands on [their] employees" (Michel, 2007: 508). Thereby, the central unit of analysis is an individual's mental representation (Michel, 2007). As uncertainty is grounded in a perceived lack of confidence in one's knowledge (Duncan, 1972; Lipshitz & Strauss, 1997), it may be reduced by acquiring information to fill a knowledge gap, re-establish confidence, and thereby regain control (Case et al., 2004; Greve, 1998; Stinchcombe, 1990). According to this perspective, uncertainty amplification does not represent a viable option to cope with uncertainty as "it would overwhelm and thereby impede the effectiveness of boundedly rational decision makers" (Michel, 2007: 508).

Yet, a second stream of research emphasizes the need to *amplify uncertainty* (e.g., Hayek, 1948, 1937; Kirzner, 1997; Schumpeter, 1934; or Jacobson, 1992; Roberts & Eisenhardt, 2003; Young, Smith, & Grimm, 1996 for a summary). By amplifying uncertainty, organizations are exposed to opportunities that may generate new sources of profit (Kirzner, 1997). While they may find themselves in dynamic environments when seeking out uncertainty, it is the turbulence that enables opportunities for growth (Hayek, 1948). Thereby, this perspective argues that uncertainty reduction may even block profit potential and that organizations may rather act upon simple rules that serve as guidelines if expected outcomes do not match actual outcomes following assumption-based actions (Eisenhardt & Martin, 2000; Eisenhardt & Sull, 2001). This, in turn, allows for experimental learning, such as learning by doing, improvisation, and probing (Miner, Bassoff, & Moorman, 2001).

On an individual level, cognition scholars take a similar stance on uncertainty creation through a distributed cognition approach that reunites organizational and individual cognition processes, “because cognition is distributed across a cognitive system with higher capacity than an individual has” (Michel, 2007: 508). In other words, through interaction with their environment, individuals expand their mental representations and maintain the effectiveness of their decisions. Thus, particularly turbulent environments call for new uncertainty coping strategies directed at amplifying uncertainty instead of reducing it (Eisenhardt & Sull, 2001; Michel, 2007; Roberts & Eisenhardt, 2003).

A third, yet smaller, stream of research builds on the idea that strategic decision-makers cope with uncertainty by *acknowledging* its presence (Lipshitz & Strauss, 1997). This strategy is typically applied by managers when uncertainty reduction or amplification is not feasible or too costly to undertake. Uncertainty is being acknowledged when managers consciously take note of its presence. For example, they may acknowledge uncertainty by weighing pros and cons (Lipshitz & Strauss, 1997), or extrapolating information from existing resources (Cohen, Tolcott, & McIntyre, 1987).

And fourth, research on decision-making demonstrated that strategic decision-makers manage uncertainty by *suppressing* it (Lipshitz & Strauss, 1997). In contrast to the other streams, suppressing uncertainty encompasses ignorance (Smithson, 1989) and denial (Matlin & Stang, 1978) of uncertainty. Thereby, decision-makers try to avoid having to consciously deal with the uncertainty perceived. Thus, through uncertainty

suppression strategic decision-makers may overcome inertia or paralysis by shifting away the focus from uncertainty (Brunsson, 1985; Lipshitz, 1995; Montgomery, 1988). Table 2-1 summarizes our findings of uncertainty coping strategies currently discussed in literature:

Table 2-1: Uncertainty coping strategies in literature

No.	Uncertainty coping strategy	Underlying assumption	Examples	Type of strategy
1	*Uncertainty reduction*	Uncertainty may be regulated by one or several decision-makers	- Imitating (Miller, 1992) - Forecasting (Mascarenhas, 1982) - Collecting information/soliciting advice (Greve, 1998; Jauch & Kraft, 1986; Lipshitz & Strauss, 1997) - Cooperating/exchanging (Beckman et al., 2004; Miller, 1992) - Reducing number of factors considered (Eisenhardt & Sull, 2001; Levinthal & March, 1993)	**Active** *Involves strategic decision to regulate uncertainty*
2	*Uncertainty amplification*	Uncertainty may be regulated by one or several decision-makers	- Focusing (Toh & Kim, 2013; Wernerfelt & Karnani, 1987) - Proactive moves (Jauch & Kraft, 1986) - Applying no-regret moves (Courtney et al., 1997)	
3	*Uncertainty acknowledgement*	Uncertainty cannot/is not intended be (further) regulated	- Weighing pros and cons (Lipshitz & Strauss, 1997) - Assumption-based reasoning (Cohen, Tolcott, & McIntyre, 1987)	**Passive** *Only involves mental action as uncertainty remains at same level*
4	*Uncertainty suppression*	Uncertainty cannot/is not intended be (further) regulated	- Ignoring undesirable information (Smithson, 1989) - Waiting (Miller, 1992; Wernerfelt & Karnani, 1987) - Denying (Matlin & Stang, 1978) - Taking a gamble (Lipshitz & Strauss, 1997)	

Perceptions as managerial cognitive capabilities driving uncertainty coping

Managerial cognitive capability theory offers a possible explanation of why strategic decision-makers may favor one strategy to cope with uncertainty or the other. Studies in this field argue that strategic decision-makers differ in the way they perceive their environment (Gavetti, 2005; Helfat & Peteraf, 2015). Perception is a mental activity that guide selection and management of meaningful information about a particular environment (Gazzaniga, Heatherton, & Halpern, 2010). They involve a range of functions, such as pattern recognition, and interpretation of data (Helfat & Peteraf, 2015). Therefore, strategic decision-makers may choose different strategies to cope with uncertainty depending on how they perceive uncertainty.

Early research on uncertainty unveiled that the concept of uncertainty is, in fact, multidimensional and that its effect may therefore only be fully understood when decomposed into its individual components (Duncan, 1972; Downey, Hellriegel, & Slocum, 1975). Therefore, scholars developed rich taxonomies on different sources of

uncertainty to distinguish the internal and external environmental origins from which it arises, such as internal research and development capabilities, and external suppliers and competitors (Duncan, 1972; Miller, 1992; Tosi & Slocum, 1984) as well as the nature of information that strategic decision-makers perceive to be missing. This may include an inability to derive potential courses of actions and/or assessing which one will yield the highest utility to the organization (Ashill & Jobber, 2010; Milliken, 1987; Packard et al., 2017). In other words, while the former strategy reflects environmental sources of uncertainty, the latter perspective may be conceptualized as a source of strategic uncertainty, because strategic decision-makers perceive uncertainty regarding how to allocate important strategic resources and setting the general direction of the firm (Dean & Sharfman, 1996; Mintzberg et al., 1976).

To summarize, depending on which source of uncertainty strategic decision-makers perceive, they may differ in terms of uncertainty coping strategy they apply. This rationale also implies that strategic decision-makers may alter the way in which they cope with uncertainty depending on which source of uncertainty they perceive. Furthermore, managerial cognitive capabilities theory suggests that cognitive capabilities may improve through experience (Helfat & Peteraf, 2015). This means that through repeated practice, particularly in a specific domain of application (Ericsson & Lehmann, 1996), strategic decision-makers can improve the way in which they perceive their environment. This may explain why some strategic decision-makers are more effective at coping with uncertainty than others.

Yet, while managerial cognitive capabilities theory offers indications regarding the underlying mechanism behind strategic decision-makers’ choice of uncertainty coping strategy, it only provides limited insights with regards to potential pattern(s) of this mechanism. Hence, the theory does not explain whether strategic decision-makers always perceive the same source(s) of uncertainty and therefore also cope with uncertainty in (a) similar way(s). Furthermore, although the theory suggests that experience may play a role in the effectiveness of managerial cognitive capabilities (Helfat & Peteraf, 2015), we still do not yet fully understand why and how it may be involved, and which other factors potentially also contribute to some ways of perceiving and coping with uncertainty being more effective than others.

These extant gaps suggest that the current perspective does not yet fully reflect when strategic decision-makers use one strategy to cope with uncertainty or another, and how they may cope with uncertainty most effectively.

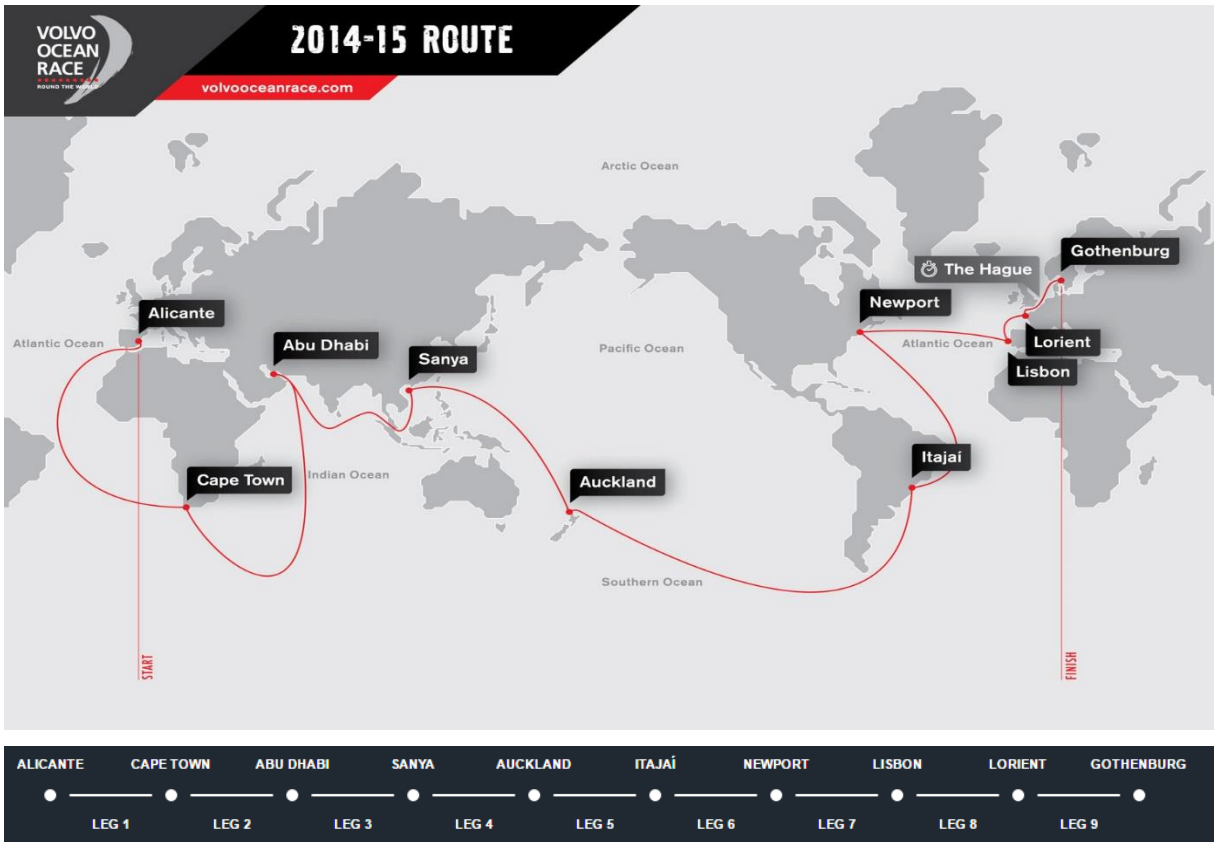
2.3. Methods & data

Because uncertainty is a subjective phenomenon that differs per individual despite them being exposed to the same objective environment, uncertainty coping behavior is difficult to observe in isolation from other influencing factors. Thus, prior studies predominantly drew on experiments (e.g., Lovallo & Kahneman, 2000; Tversky & Kahneman, 1974) or on extensive qualitative data sources, such as case studies and interviews (e.g., Engau & Hoffmann, 2011) to assess individuals' and organizations' uncertainty coping behavior. Our context of study provided a unique opportunity to analyze how strategic decision-makers cope with uncertainty over an extended period of time and how their perceptions and coping behaviors influence their strategic decisions.

Our dataset stems from a head-to-head professional sailing competition, the Volvo Ocean Race (VOR) 2014-15. The Volvo Ocean Race is one of the world's longest sailing competitions taking sailors around the world in nine months. The race started on 4 October 2014 in Alicante, Spain, and lasted until 22 June 2015 terminating in Gothenburg, Sweden. Thereby, the race is divided into nine legs with breaks in between the individual legs[4]. Figure 2-1 provides an overview of the route and legs:

[4] Legs equal stages of the race sailed continuously without breaks in between.

Figure 2-1: VOR 2014-15 route and legs (Volvo Ocean Race, 2017)



Study context

Sailing contexts are already well-established in empirical research and have rendered valuable theoretical contributions to management literature (e.g., Boumgarden, Nickerson, & Zenger, 2012; Bouty & Drucker-Godard, 2018; McGrath, Ferrier, & Mendelow, 2004; Ross & Sharapov, 2015). Hence, there are several reasons why a sailing race also represents an ideal context to develop our theory around strategic postures:

First, the Volvo Ocean Race is one of the world's longest professional offshore sailing competitions. This offered us two advantages: On the one hand, the duration of the race allowed for a sufficient timeframe to study skippers’ uncertainty perceptions and subsequent coping strategies to explore the existence of pattern(s), which we refer to as strategic posture(s). Sailing races are characterized by an accelerated pace of decision-situations and thus different sources of uncertainty that strategic decision-makers need to contend compared to traditional business settings (i.e., 1.5 to 18 months in Eisenhardt, 1989a), because skippers need to select and

adjust the general direction of their boats (i.e., through tacks and gybes) within short periods of time, sometimes on a daily basis, to sail towards their target destination. And, on the other hand, skippers are exposed to varying conditions throughout the race as they sail through all oceans of the world. Thus, they need to effectively cope with different sources of uncertainty in order to win. These are similar to those found in organizational settings. Environmental forces, such as the weather as well as constant competition, the need to have sufficient supplies, a healthy crew, and an intact boat make the environment unpredictable and thus give rise to perceptions of different sources of uncertainty.

Second, the context provided us with the opportunity to study uncertainty perceptions and coping strategies used by highly experienced strategic decision-makers, sailing boat skippers, to develop our theory of strategic postures. Skippers participating in the Volvo Ocean Race are highly knowledgeable and skilled in their domain due to prolonged practice and rapid feedback to their judgments (i.e., performance implications against their competitors, speed). Thus, they are likely to command skilled intuition (Kahneman & Klein, 2009). As this race is one of the most physically challenging sailing races in the world, participants require ample sailing experience and long-winded training prior to the start of the competition to be able to endure the conditions of this around-the-world race. Skippers are the ultimate decision-makers onboard and carry the responsibility for their teams. Thus, their hierarchical position is similar to that of a CEO, a strategic decision-maker, whose perceptional frames are crucial in determining the organization's strategic choices (Gavetti, 2012; Helfat & Peteraf, 2015; Kaplan, 2008b; Knudsen, 2001).

And third, as with other sports, sailing races have pre-defined boundary conditions and rules that are enforced as soon as an incident occurs. Sports offer the advantage of a controlled setting where participants are not being made aware of the context of study. Sport settings allow to eliminate noise created by differences in institutional settings as influencing factors (Holcomb et al., 2009). Hence, the race enabled us to focus on the perceptions of skippers and their coping strategies onboard to explore strategic postures. Boats are made of one design and equipped with the same technology. Crew sizes are fixed with a pre-defined age range of participants and maximum crew weight (resource similarity). In addition, skippers are restricted in their information acquisition and only supplied with the same information at pre-defined points in time (information symmetry). In this respect, they are not allowed

to search for information online or interact with others outside the race. Skippers only receive position reports on their competitors from Race Control every six hours. Hence, the context of a professional sailing race eliminated noise created from heterogeneous information and resources.

Furthermore, as the race enjoys public attention around the world through diverse channels, such as live-broadcasting, TV documentaries, and press reports, skippers have an interest in performing well. Not only is winning the Volvo Ocean Race considered highly prestigious among sailors, it may also help skippers obtain future sponsorship for campaigns. These are often based on performance in past races. Thus, all skippers share similar aspirations to obtain a podium position.

Study design

We used log book entries of onboard reporters on a total of seven boats taking part in the Volvo Ocean Race 2014-15[5]. Onboard reporters are part of the crews and day-to-day observe skippers’ perceptions, their actions, and strategies, which they reflect in log book entries. This allowed an up-close perspective on what happened onboard. Furthermore, while onboard reporters sail with the crews, they are not allowed to interfere with the racing. They may only support daily life onboard in terms of cooking, cleaning, pumping water for the sailors and themselves, and preparing meals. Therefore, they may be considered neutral observers of daily life onboard.

[5] One team, Team Vestas Wind, in addition to the six boats mentioned, was forced to terminate the race early after the second leg (stage of the race) as their boat was destroyed when hitting a reef due to a navigating error. They re-entered the race in leg 8. Therefore, our dataset for this skipper and his team only comprises legs 1 and 2 as well as 8 and 9.

Table 2-2: Overview of boats and description of case data

Boat	Abu Dhabi Ocean Racing	Alvimedica	Brunel	Dongfeng Race Team	Mapfre	SCA	Vestas****
Boat abbreviation	ADOR	AVIM	BRUN	DFRT	MAPF	TSCA	VEST
Skipper	**Ian Walker**	**Charlie Enright**	**Bouwe Bekking**	**Charles Caudrelier**	**Iker Martínez*** **	**Sam Davies**	**Chris Nicholson**
Age	44	30	51	40	37	40	45
Experience*	6	0	6	1	5	0	4
Color	Yellow	Orange	Green	Red	White	Magenta	Blue
Crew size (incl. OBR)**	9	9	9	9	9	12	9
Gender	Male	Male	Male	Male	Male	Female	Male
Number of legs won	2	1	2	2	1	1	0
Rank at end of race	1	4	2	3	4	6	7
Informants	Ian Walker (skipper) Matt Knighton (OBR)	Charlie Enright (skipper) Mark Towill (navigator) Nick Dana (sailor) Stu Bannatyne (sailor) Amory Ross (OBR)	Bouwe Bekking (skipper) Stefan Coppers (OBR)	Charles Caudrelier (skipper) Black (sailor) Horace (sailor) Eric Peron (sailor) Damian Foxall (sailor) Jack Bouttell (sailor) Kevin Escoffier (sailor) Martin Strömberg (sailor) Wolf (sailor) Sam Greenfield (OBR) Yann Rio (OBR)	Iker Martínez (skipper) Francisco Vignale (OBR)	Sam Davies (skipper) Libby Greenhalgh (navigator) Annie Lush (sailor) Abby Ehler (sailor) Dee Caffari (sailor) Liz Wardley (sailor) Stacey Jackson (sailor) Anna-Lena Elled (OBR) Corinna Halloran (OBR)	Chris Nicholson (skipper) Rob Salthouse (sailor) Brian Carlin (OBR)
Number of log book entries	165	168	110	182	150	152	43
Other data	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases	Newspaper articles Official race rankings Press releases

** Number of prior participation in comparable races, including America's Cup and the Olympics*

*** OBR = Onboard Reporter*

**** Iker Martínez skippered during legs 1, 2, 5, 7, 9 and his friend Xabi Fernández with similar age/experience during legs 3, 4, 6, 8*

***** Grounded shore during leg 2 and re-entered the race for legs 8 and 9*

Onboard reporters’ accounts were created on the day of observation. Therefore, ex-post reasoning and biases are limited. The sailors spent approximately 160 days at sea creating a total of 970 accounts for study where informants described various perceptions of skippers, including perceived uncertainty and subsequent coping. Additionally, some log book entries were also written by crew members, including skipper themselves.

We coded these log book entries to explore uncertainty sources as well as uncertainty coping strategies used on a day-to-day basis. Thereby, our unit of analysis was the daily log book entry per skipper participating in the race. Consistent with our interpretative research approach, we relied on how onboard reporters (and other informants from the sailing crew, if available) described how skippers perceived different sources of uncertainty and how they coped with them. Interpretative research of these rare accounts provided us with the opportunity to further structure and construe the information of the informants considering the context and contingencies in which they happened (Corbin & Strauss, 1990; Langley, 1999). An overview of the skippers, their boats, and a description of the case data can be found in Table 2-2.

Analytic approach

Having collected the data and drawing on Miles & Huberman’s (1984) suggestions for data analysis, we first analyzed log book entries from each onboard reporter in detail. Within case study analysis helped us in detecting consistent patterns in the data to explore whether strategic postures exist (Eisenhardt, 1989b; Eisenhardt & Graebner, 2007). We coded the data using *Atlas.ti™* and analyzed in an inductive, iterative manner circling between data, literature, and theory to substantiate our findings (Arora, Gittelman, Kaplan, Lynch, Mitchell, & Siggelkow, 2016). Thus, for each boat, we coded log book entries for perceptions of uncertainty and uncertainty coping strategies used by each skipper on the basis of in-vivo terms or phrases used by the informants. Thereby, we relied on constant comparison across multiple informants (whenever possible) and over time to detect concept patterns (Glaser & Strauss, 1967). We then conducted a cross-case analysis to assess whether distinct pattern(s) and thus strategic postures emerge and how they differ.

First order, *in vivo* codes reflecting perceptions of uncertainty were derived by analyzing how the key informants described their inability to predict change in their

environment and which strategies they applied to cope with uncertainty. Thereby, we further informed our data analysis through theoretical concepts reflected in the data. When identifying codes that are similar and recurring, we aggregated them into second-order categories (Gioia, Corley, & Hamilton, 2012). We iterated between data analysis and literature until a strong match between the case studies and the theory emerged. The results are presented in a theoretical framework below.

Tables 2-3 and 2-4 depict the progression of the analysis in terms of coding and data aggregation:

Table 2-3: Progression of analysis in identifying sources of uncertainty

First-order (informant) concepts	Second-order themes	Aggregate (theoretical) dimension	Evidence ADOR	AVIM	BRUN	DFRT	MAPF	TSCA	VEST
Inability to predict whether one will be able to obtain a podium Inability to predict the impact of an environmental condition on the ranking Inability to predict utility of competitors' move Inability to predict whether one will be able to catch up	*Uncertainty relating to the ranking*	**Competitive uncertainty**	**	**	**	***	***	***	**
Inability to predict where the competitors are Inability to assess whether one is able to compete effectively	*Uncertainty relating to controllability of the competition*		***	**	**	**	**	*	***
Inability to predict change in and impact of weather conditions Inability to predict direction of the current Inability to assess a pattern to the waves	*Uncertaint regarding environmental forces*	**Environmental uncertainty**	*	***	*	*	**	***	**
Inability to assess the impact of obstacles on their course Inability to assess the identity of obstacles on their course	*Uncertainty regarding obstacles*		*	**	**	***	**	*	
Inability to predict whether the intactness of the boat will remain in place Inability to assess the cause of a boat-related issue (e.g., water streaming into the boat) Inability to assess whether one is able to repair important, but broken equipment Inability to assess whether a problem has been finally resolved (e.g., provisionary repair)	*Uncertainty relating to the boat*	**Internal uncertainty**	**	*	**	**	**	**	**
Inability to predict how strainuous conditions will affect team members' ability to stay healthy Inability to predict when a crew member will recover to full strength from illness Inability to predict the safety of the crew	*Uncertainty relating to the crew*		*	**	**	**	*	*	*
Inability to identify or decide between several/conflicting strategic options Inability to predict the utility of the different options	*Uncertainty relating to a strategic decision*	**Strategic uncertainty**	**	**	**	***	*	***	**
Inability to predict duration of a leg Inability to assess whether supplies will last for this leg	*Uncertainty relating to the availability of supplies for duratrion of the*	**Supply uncertainty**	*	*	*	*	*		

*Note: "***" means that the teams was expressed frequently by the respondents, "*" means that the theme was expressed infrequently by the informants, and " " means that the theme was not expressed by the informants*

Table 2-4: Progression of analysis in identifying uncertainty coping strategies

First-order (informant) concepts	Second-order themes	Aggregate (theoretical) dimension	Evidence						
			ADOR	AVIM	BRUN	DFRT	MAPF	TSCA	VEST
Taking uncertainty into account in selecting a course of action Learning, considering uncertainty an opportunity to improve	*Embracing uncertainty in selecting a course of action*	**Accept**	*	***	***	*	**	***	**
Weighing pros and cons Extrapolate from available information (assumption-based reasoning, filling gaps in firm knowledge through assumptions)	*Dealing with the given amount of information*	**Acknowledge**	**	**	*	**	*	***	
Creating new uncertainties in selecting a course of action	*Creating uncertainty for oneself in selecting a course of action*	**Amplify**	*	**	**	*	*	*	*
Rationing (rearranging priorities) Buffering (building slack) Preempting	*Allocating resources to lower the impact of uncertainty*	**Anticipate**	*	**	*	*	*	*	
Preparing to avoid or confront potential risk Improving readiness	*Making the team ready for dealing with uncertainty*		**	*	*	*	**	*	
Collecting additional information, examining competitors' moves Soliciting advice/opinion, discussing with experts, friends, and colleagues Mental simulation or scenario building	*Increasing the amount of infornation used in decision-making*	**Reduce**	***	**	**	**	**	***	***
Simplification: Shortening time horizon, preferring short-term to long-term goals Evoking past memories, experiences or successes Selecting one of the many possible interpretations of equivocal information	*Lowering the amount of information used in decision-making*		*	*	*	*	*		**
Selling risks to other parties Control of the sources of variability which reduce predictability (shaping and controlling external events)	*Taking control of the outcome of uncertainty*		**	*	*	*	**	**	***
Act according to formal and informal rules of conduct, standard operating procedures Imitation (copy actions of competitors) Flexibility (enlarge range of strategic options to increase adaptability)	*Lowering cognitive effort in decision-making*		***	**	**	**	***	*	***
Wishful thinking (hoping for a favorable outcome of a selected option or state of nature) Denial Ignore uncertainty	*Ignoring or distorting undesirable information*	**Suppress**	*	*	*	**	***	**	*
Deferring decisions until additional information is available Rationalization (coping with uncertainty symbolically)	*Delaying decisions*		*	*	*	***	**	*	*
Relying on inutition Taking a gamble	*Not rationionalizing decision-making process*		*	*	*	*	*	*	

*Note: "***" means that the teams was expressed frequently by the respondents, "*" means that the theme was expressed infrequently by the informants, and " " means that the theme was not expressed by the informants*

2.4. Results

Our research explored the existence and nature of strategic postures and asked (1) whether strategic decision-makers follow (a) distinct pattern(s) when they are confronted with different sources of uncertainty, and (2) what this/ these pattern(s) may look like.

Our findings demonstrate that strategic decision-makers differed in the way they coped with uncertainty. Thereby, they drew on different strategies depending on the source of uncertainty they perceived. Yet, even when perceiving similar sources of uncertainty, they differed in their uncertainty coping behavior. For example, due to the competitive character of the race, all strategic posture frequently perceived competitive uncertainty. Yet, they varied in the uncertainty coping strategy they applied in response and in terms of the extent they experienced competitive uncertainty as salient.

Moreover, our analysis also uncovered that there are more uncertainty coping strategies than previously assumed from by uncertainty coping researchers. Besides the strategies of uncertainty reduction, amplification, acknowledgment, and suppression, we also identified acceptance and anticipation as strategies to cope with uncertainty. In summary, four strategic postures emerged from our case analysis: *Explorer*, *Commander*, *Repressors*, and *Hedger* (see Table 2-5). The labels emerged to reflect the nature of the different strategic postures, i.e., their management of uncertainty depending on the sources of uncertainty they perceived. Thus, the labels reflect the general attitude of a skipper holding a particular strategic posture towards how to cope with the specific sources of uncertainty they perceived. More details on the differences are described in the individual sections of the respective strategic posture.

Table 2-5: Overview of the different strategic postures

Strategic posture	Skippers of boats	Sources of uncertainty	Uncertainty coping strategies
Explorer	AVIM BRUN	Competitive Environmental	Uncertainty acceptance Uncertainty amplification
Commander	ADOR VEST	Competitive	Uncertainty reduction
Repressor	DFRT MAPF	Competitive Environmental Strategic	Uncertainty reduction Uncertainty suppression
Hedger	SCA	Competitive Environmental Strategic	Uncertainty acceptance Uncertainty acknowledgement Uncertainty suppression Uncertainty reduction

Explorer

Our case studies yielded two skippers adopting an *Explorer* posture: Bouwe Bekking of team Brunel (BRUN) and Charlie Enright of team Alvimedica (AVIM). Both skippers vary in their experience profiles. While Bouwe Bekking already participated in the Volvo Ocean Race for the sixth time, Charlie Enright was the youngest and least experienced skipper in the race. In both cases, skippers held more balanced perceptions of different sources of uncertainty. Although, similar to others, the skippers of Brunel and Alvimedica often perceived competitive uncertainty, they also perceived environmental and internal uncertainty to similar levels throughout the race. Thus, while other postures focused only on competitive uncertainties, *Explorers'* mental representation of their general environment was broader and more varied.

Explorer conceptualized their role in shaping the environment as an active, influencing one. This implies that, on the one hand, *Explorers* demonstrated high acceptance of uncertainty resulting from environmental change, and, on the other hand, they took an active role to shape factors of the environment that they could influence. For example, the *Explorer* skippers did not hesitate to amplify uncertainty for themselves and others.

Thus, *Explorer's* coping strategies were characterized by high acceptance as well as opportunity and change orientation. Different from the other skippers, they depicted

a higher acceptance of competitive and environmental uncertainty, while they sought to reduce or anticipate internal uncertainty. This positive attitude towards uncertainty was often accompanied by an “okay” and “can-do” attitude as the onboard reporter of Brunel described the attitude of the skipper of Brunel when rivalling boats were closing in on them:

> *“What are Bekking's (skipper) criteria to select the individual crewmembers of Team Brunel? First: you must be an excellent sailor! But shortly after that criteria, "be an ice man." For it is striking me how positively Bouwe (skipper) and co handle setbacks (…) "If I start getting frustrated about this situation, then I risk a heart attack," laughs Bekking. He laughs, but he is sincere. "Wrong place wrong time: we're just going to start all over again." (BRUN, 13 Jan 2015)*

This log book entry also reflects how *Explorers* made use of emotional management to cope with uncertainty. They tried to maintain a level of restrained emotions, continually lifting negative feelings and suppressing outwardly positive emotions.

Unpredictable changes in the weather were often accepted as not being able to be controlled by *Explorers*. *Explorers* applied simplification strategies to focus on strategic picture instead of the immediate future as reflected in this log book entry by the onboard reporter of Alvimedica:

> *“Even without storms and loud extremities, I am in awe of weather at a time like this: it is a living thing free of rules and regulations and you have to take it as it comes. It cannot be controlled and it cannot be predicted, much as we like to think it can. Fortunately it makes the game plan fairly simple: keep the big sails in the air and make them happy; no specific heading or marching orders other than to go north-ish as fast possible, while we can!” (AVIM, 24 Nov 2014)*

Explorers also, more frequently than other strategic postures, amplified uncertainty for themselves by deviating from the general direction of competitors, particularly when perceiving environmental uncertainty. They experienced these

occasions as *"exciting"*, *"interesting"*, and *"nothing ventured, nothing gained"*. Similarly, during occasions of competitive uncertainty, *Explorers* constantly looked for opportunities and seemed to process and recover from setback-related uncertainty quickly.

However, this constant looking for and amplification of uncertainty often made it difficult for *Explorer* skippers to find routines, particularly in the unsteady conditions they actively sought out. Once settled into a routine lowering uncertainty, *Explorers* longed for something new as noted by the onboard reporter of team Alvimedica in his log book entry:

> *"New strategies and new modes are not far away. You can already see more interest in what Will (navigator) and Charlie (skipper) are looking at and everyone's spending more time at the Nav station. It's good to be informed and healthy to understand what's happening outside, and for what reasons. But man, are we hard to please. Soon as things seem to settle in, the numbing simplicity of open-ocean sailing locking you into a routine, we crave something new. And when it turns busy, interesting, and varied, we'll again long for the settled, repetitive schedules, and a decent night's sleep." (AVIM, 17 Feb 2015)*

Table 2-6 presents further illustrative evidence and representative quotes for the *Explorer* posture:

Table 2-6: Illustrative evidence of the *Explorer* posture

Strategic posture	Illustrative evidence	Informant
"Explorer"	*"Who knows, if we had some luck with the clouds we may even have led ourselves. But we didn’t, and we had to endure a long few hours of knowing it. But it never affected the effort. It never impacted the commitment. The question was always—how do we capitalize on the next opportunity?"*	*Amory Ross, OBR AVIM, 24 February 2015, leg 4*
	"The ice exclusion zone has once again compressed the fleet, very similar to Leg 5 in the Southern Ocean. The breeze has been streaky and it’s important to constantly be on top of changing gears with the boat set up. And with two legs still to go we have so much potential, so much we can continue to improve upon."	*Amory Ross, OBR AVIM, 23 May 2015, leg 7*
	"All is going well here, even though it looks a bit stressful. As Pablo said this morning: “Now we are getting good smacks from all angles but we are convinced will soon give a few slaps back.” The atmosphere is more than good! We are still fighting for the last Haribo candy, so not much has changed (haha!). And Bouwe is incredible - even if he quaffs the bitter cup, the man remains positive and keeps his smile. That's important for the young crew because a good atmosphere is very contagious when you are at sea for so long."	*Stefan Coppers, OBR BRUN, 19 January 2015, leg 3*
	"No chance of a top ranking doesn’t kill this skipper's mood. “Grumbling now isn't gonna do anybody any good. It’s important to remain positive at all times, and keep motivating each other. If one hangs his head, two and three will follow and soon everybody’s gone."" Slowly I move away from the edge. “Right”, says Arrarte, “This one we lose together, and the next time we’ll win again, together!” “Wait a minute,” Bekking says, ""Are we done? It ain’t over till it’s over and we finish. We fight till the end!”"	*Stefan Coppers, OBR BRUN, 26 January 2015, leg 3*
	"We'll be more than 100 miles behind the rest of the fleet, but there is a reasonable explanation. So if you just calm down then I put it to you plainly. All the boats sailed three days from China to the Philippines. But after the Philippines there is a whole area without wind and with a current at almost 4 knots in the wrong direction! All the men of the team, however, stand firmly behind the decision! "This makes it interesting,"" says Rokas Milevicius. "Nothing ventured, nothing gained." And skipper Bekking? He is convinced that the investment of 300 miles will pay out before we reach the Equator."	*Stefan Coppers, OBR BRUN, 11 February 2015, leg 4*

Commander

Two skippers included in our sample depicted what we call a *Commander* posture: Ian Walker of team Abu Dhabi Ocean Racing (ADOR) and Chris Nicholson of team Vestas Wind (VEST). Skippers of both of these teams were highly experienced. *Commanders* were characterized by a strong competitive orientation. Thus, these two skippers mainly experienced competitive uncertainty throughout the race. These encompassed the inability to predict where competitors are located and to a lesser extend the inability to predict whether one will be able to obtain a podium position.

Commanders only perceived environmental and internal uncertainty when changes in the environment had the potential to become survival threatening. For example, Ian Walker of Abu Dhabi Ocean Racing slowed down during leg 5, when the boats were racing through the Southern Ocean, one of the most secluded areas in the world that is characterized by unpredictable weather, high waves, and strong winds, when they heard about their rival, Dongfeng Race Team, breaking their mast during the passage. Thus, an incident by another team led the skipper of Abu Dhabi Ocean Racing to perceive internal uncertainty and consequentially to slow down to reduce the uncertainty that this fate may also strike them as illustrated by the following quote:

> *“"We were pushing it near the edge. After digesting the Race Control notification there was a slight pull back on the boat. The first real boat integrity issue had risen and proved these Volvo Ocean 65’s aren’t indestructible. One thing is clear – it’s definitely causing us to reevaluate how we sail the boat."” (ADOR, 31 March 2015)*

Consequentially, *Commanders* seek to keep uncertainty under control and reduce it as far as possible at all times, while remaining competitive. This coping behavior was independent of the source of uncertainty they were confronted with. They conceptualized their role as one of an adaptor that quickly adjusts to remain competitively flexible. For example, the skipper of Abu Dhabi Ocean Racing frequently positioned his boat flexibly to the fleet to be able to observe conditions that other boats enjoyed and to follow accordingly if conditions turn out to be more favorable. This is described in a log book entry by Abu Dhabi Ocean Race’s onboard reporter from April 2015:

> *"We've strategically set up to windward of the fleet to cover the two diverging weather forecasts towards Newport. There's a difference of hundreds of miles between the two and we're waiting to see which one Dongfeng decides to tackle tomorrow." (ADOR, 29 April 2015)*

On the one hand, this led *Commanders* to focus on factors that they can control to enhance predictability of events or improve boat readiness. For example, they frequently mentioned that they *"maintain the intensity"* or *"push hard"*, even when they sailed in the Southern Ocean, characterized by strong winds and high waves that have the potential to damage the boat, where other skippers followed a more cautious approach, not sailing their boats to 100 percent.

On the other hand, this implies that *Commanders* felt more comfortable when having the fleet sail together. This provides them with the ability to assess their performance against other boats immediately and to *"control"* the other boats. However, as soon as one skipper decided to break away from the fleet, the move induced competitive uncertainty for *Commanders*. Consequentially, *Commander* skippers sought to cover the deviating rival, if possible, as described in this log book entry from Abu Dhabi Ocean Racing:

> *"Mid afternoon, SiFi (navigator) abruptly whipped around in the nav station and shook Ian (skipper) awake in his bunk. Brunel had just turned down course and was headed for the western shore. Ian jumped into the seat and quickly talked through options with SiFi. Are we sure of the coastal winds? What would we do if there were no other boats around? Is this the time for a split? The decision didn't take long. At this stage in the race – tied for points overall with Brunel and with Dongfeng on a breakaway - we needed to cover the black and yellow boat (Brunel). And cover we did." (ADOR, 20 January 2015)*

Moreover, the skippers of Abu Dhabi Ocean Racing and Vestas Wind put strong emphasis on routines onboard to reduce sources of uncertainty that they could control.

In one of the log book entries from leg 2, the onboard reporter describes several routines of his skippers Ian Walker and what they mean for the team:

> *"C'mon wind…", Ian muttered while patiently but intently stared at the red numbers on the mast for the slightest change. His eyes are squinted, not because of the fading sunlight on the horizon but because he's looking ahead for signs on the water. It's been a battle all day; seemingly bleeding miles to the two teams to windward. Finally, on the latest sked before sunset, the first signs of optimism: we sailed 10 miles further. Ian did his familiar six-or-so trips up and back from the nav station reporting all the details from the position report to all us on deck. This was a good sign in itself; usually if a sked was bad he goes down below and doesn't come up. We're on the mend.*"

However, not only do *Commanders* evoke routines more strongly than the other skippers, they are also happy to adjust and re-learn routines as Abu Dhabi Ocean Racing's onboard describes on during leg 3:

> *"We're still learning these boats. As the winds eased in the lee of Sri Lanka and the fleet compressed to within a few miles of one another, the battle to be king of the AIS[6] was ensuing once again. The watches rotated quickly and everyone was eager to dial in Azzam (name of Abu Dhabi Ocean Racing's boat) to maximize performance, even if it meant re-learning things we thought we knew. "There is lots of tweaking, lots of modes to play with, conditions change. We had a few little lessons to learn today and it's much more interesting being a part of it than reading about it at the end of the leg."" (ADOR, 14 January 2015)*

[6] AIS refers to Automatic Identification System, an onboard software that is installed for safety reasons, but that is frequently used by sailors to detect and follow surrounding competitors within 20 nautical miles range.

This strong emphasis on routines is also linked to the coping strategies of intense scenario planning and collection of additional information by the skippers of team Abu Dhabi Ocean Racing and team Vestas Wind. Both skippers found it easier to establish a routine when they knew what to expect. Thus, planning helped them in establishing regularity on board:

> *“This leg start was easier to find our groove, when you know what to expect it can be both an advantage and disadvantage. Night fell very quickly and shortly we found ourselves following our usual patterns. Life becomes very simple again, 4hrs to work, 4hrs to sleep, eat and rest (and that's if you can get the 4hrs).” (VEST, 20 Nov 2014)*

Moreover, the combination of routines, adjustment of routines, and planning helped *Commanders* to lower the degree of competitive uncertainty perceived and follow a conservative coping strategy. The strategies applied evoked the feeling of control. However, on the downside, when *Commanders* were unable to control uncertainty, they lacked the ability to draw on an uncertainty coping strategies that maintain the level of uncertainty, such as accepting and acknowledging uncertainty. Table 2-7 presents further illustrative evidence and representative quotes for the *Commander* posture:

Table 2-7: Illustrative evidence of the *Commander* posture

Strategic posture	Illustrative evidence	Informant
"Commander"	*"Ian rallied everyone up and we were able to respond in less than 5 minutes. A quick reaction – our higher angle paid off and we've been bow-forward on Mapfre since though the AIS watching isn't doing Ian's nerves any good."*	*Matt Knighton, OBR ADOR, 5 April 2015, leg 5*
	"There are two races we're racing right now – the race to cover the fleet and the race to Newport. In many ways they're the same, in many they're quite different. The herd mentality is back – better to cover the majority of the fleet on a sure thing rather than break away into uncertainty. Holding our collective breath during the last sked, Dongfeng agreed. Our trackers keep going in a straight line toward Antigua."	*Matt Knighton, OBR ADOR, 1 May 2015, leg 6*
	"We're trying to win the race overall and that means covering Dongfeng. Ian has been quite vocal about our strategy up until this point in the race. A conservative and consistent goal, we've always aimed to finish in the top 3 of each leg. Like an Olympic regatta, Ian's rationale was that in doing so we'd put ourselves in a place of contention where near the end of the race we could make that final push for gold. This leg is that push. There's a reason Dongfeng is labeled "Boat 1" in our AIS telemetry tab – theirs is the only data we're concerned with and all day today their range has increased."	*Matt Knighton, OBR ADOR, 20 May 2015, leg 7*
	"The boat was a little out on its own the past 24hrs but we have gybed north into the lighter air but also back into the pack, we are deep within enemy territory fighting to get north and east to the trade winds."	*Brian Carlin, OBR VEST, 24 November 2014, leg 2*
	"We find ourselves glued to "Bino duty" as the Australians put it – for the rest of us normal people that's a reference to binoculars. Alvimedica has been spotted just port side off the bow. It's early UTC time but late afternoon here in the east. We have had a good sched recently, taking a minimum of 2 miles on the girls while chasing ADOR down very quickly with an 11-mile gain."	*Brian Carlin, OBR VEST, 25 November 2014, leg 2*

Repressor

We classified the skippers of Dongfeng Race Team (DFRT) and team Mapfre (MAPF) as *Repressors*. Whereas Charles Caudrelier, skipper of Dongfeng Race Team, did not have much experience in comparable races, Iker Martínez, skipper of Mapfre, did.

Both skippers predominantly perceived competitive uncertainty. The skipper of Dongfeng Race Team also experienced strategic uncertainty, whereas the skipper of Mapfre did so to a lesser extent. Competitive uncertainty stemmed from the inability to predict how environmental changes will impact the ranking and the inability to predict whether they will be able to compete effectively. Thus, their perceptions of competitive uncertainty somewhat differed from those of *Commanders* in the sense that the uncertainty *Repressors* perceived originally stemmed from the environment. *Repressors* experienced an inability to predict how changes in the environment affect the ranking. The onboard reporter of team Mapfre frequently recited his team members that referred to the nature of uncertainty as a *“casino”* in his log book entries. This term reflects that *Repressors* may attribute outcomes more to chance than to the ability of individuals to actively control uncertainty. Thus, *Repressors* took a more passive role and rather conceptualized the environment as something that is given and that they could only exert limited influence on.

Nevertheless, both skippers were united in their approach to cope with uncertainty. They combined strategies of reducing uncertainty with strategies of suppressing uncertainty. While the former strategy implies that strategic decision-makers can actively “do” something to control uncertainty, the latter one is of more passive nature.

Competitive uncertainties relating to the impact of environmental conditions on the ranking were reduced by collecting additional information about the environmental conditions or the ranking (through tracking of competitive boats). This coping strategy is illustrated by the following observation of the onboard reporter of team Dongfeng Race Team:

> *"Charles (skipper) spent most of the day at the nav table. “At the last schedule we are still ahead. We’re not very fast and it looks like the boats from the back have come back a bit,” said Charles. I found Pascal (navigator) in the hatchway and asked him about our strategy: “We need*

to be fast. There is nothing to do except for be fast, and it's not easy. There are choppy waves and the wind is up and down. We'll have to change to manage the sails every time and the guys behind us are quite faster than us, so it's tough. No strategy, only speed." "We're always worried about them. We have to be. Even though we can't see them we have to be worried about them. They're not far away."" (DFRT, 5 May 2015)

By contrast, competitive uncertainties relating to the ability to compete effectively were mostly suppressed by both skippers. This competitive uncertainty was subsumed in a second-order category encompassing uncertainty relating to the controllability of the competition. Thus, as both skippers perceived that they were unable to control the competition, they suppressed this uncertainty through denial and wishful thinking. The following observation by onboard reporter Yann Riou describes how Charles Caudrelier, skipper of Dongfeng Race Team, uses the uncertainty coping strategy of denial to cope with competitive uncertainty:

"We've known better days on Dongfeng. After witnessing, powerless, to the return of our competitors next to us, we saw them overtake us without being able to do anything about it. We're focused and we try to make the most of what we have to move forward… the problem is, we have nothing! And the boat is moving from one side to another, and the sails flop. Not to mention the AIS[7] reports informing us of the good progress of the competitors! "I don't think we deserve this" (Charles)" (DFRT, 21 May 2015)

Wishful thinking was most salient when skippers hoped for a favorable outcome of a state of nature as illustrated by this observation of Francisco Vignale, onboard reporter of team Mapfre:

[7]AIS refers to Automatic Identification System, an onboard software that is installed for safety reasons, but that is frequently used by sailors to detect and follow surrounding competitors within 20 nautical miles range.

> *“All this seaweed is entangled in our rudder, it's crazy. We have to stop the boat completely and remove all the seaweed. We do this manoeuvre every hour between 2 and 3 times. It's frustrating. Every time we stop, the others take more and more miles from us, and this is frustrating. We hope that others are in our same situation because it would be very unlucky that only we're being attacked by seaweed.” (MAPF, 1 May 2015)*

In addition to competitive uncertainty, Charles Caudrelier also frequently experienced strategic uncertainty. Strategic uncertainty arises when strategic decision-makers perceive an inability to identify or decide between several strategic options or an unable to assess the utility of the given options. Throughout the race, the skipper of Dongfeng Race Team perceived this source of uncertainty frequently, particularly when he was in the lead and thus unable to control uncertainty through imitation or copying the moves of his competitors. As a result, he suppressed uncertainty by deferring decisions until additional information was available:

> *“Charles (skipper) can’t make up his mind today. And from my OBR desk I have a tiny window in the bulkhead that transports me in into his world of misery. Charles refuses stray from his chart screen for more than five minutes at a time. But for all his efforts Sri Lanka stays put, and Charles still can’t decide to what side we’ll pass. “I sleep well but I’m very stressed by this situation,” says Charles.” (DFRT, 11 January 2015)*

Table 2-8 presents further illustrative evidence and representative quotes for the *Repressor* posture:

Table 2-8: Illustrative evidence of the *Repressor* posture

Strategic posture	Illustrative evidence	Informant
"Repressor"	*"This morning the difference between being on watch and off watch is pretty small. It's a bit like doing a sail change every time we see a new cloud – and we've seen a lot of them! This is when we receive the six hourly position report. Before it arrives, Charles tells us, "We had rain clouds and squalls coming from every direction for the past few hours, and for sure that will have created some casualties. We'll know in an hour when the position report arrives."*	*Yann Riou, OBR DFRT, 25 November 2014, leg 1*
	"The question of the day at the nav station concerns a route choice: go south on a longer but supposedly faster route, or stay on the great circle route. Difficult choice given that the forecast changes almost with every new weather file… so we observe and we do what it takes to delay the deadline, the moment when the choice will be definitive and of no return."	*Yann Riou, OBR DFRT, 19 May 2015, leg 7*
	"The wind is not really steady, 12 to 15 knots. This is our bearing unless a shift forces us to gybe. We're expecting the wind to pick up in the afternoon. On board we are all well, tired but still wanting to catch the fleet, we hope to get the chance to pass them. In the meantime, we keep sailing east."	*Francisco Vignale, OBR MAPF, 2 November 2014, leg 1*
	"Phases without wind are quite tense because you never know who's going to gain from it, and you just hope to be that boat."	*Francisco Vignale, OBR MAPF, 27 November 2014, leg 2*
	"The North of Skagen, in Denmark, is going to be a key moment. The wind will be extremely shifty – if there is any. The rounting shows the fleet parking up there. This means all the boats will stop and gather until the new wind comes in. Anything can happen there… As Jean Luc puts it, "we expect the national lottery, the big casino there.""	*Francisco Vignale, OBR MAPF, 21 June 2015, leg 9*

Hedger

The skipper of team SCA (TSCA), Sam Davies, depicted a *Hedger* posture. Different to most of the other skippers, Davies did not participate in comparable races.

While the skipper of SCA also perceived competitive uncertainty most dominantly, it was experienced less frequently than by the other postures. In this respect, competitive uncertainty mainly stemmed from the inability to predict whether she will be able to compete effectively or be able to catch up. This may relate to the fact that team SCA was lagging behind the other boats during most of the race. Thus, the skipper of team SCA perceived proportionately more environmental and strategic uncertainties than the other postures. Overall, similarly to the *Repressor* posture, perceptions of different sources of uncertainty were more balanced.

Different from the other postures, the skipper of team SCA combined a variety of uncertainty coping strategies. Thus, SCA demonstrated the most diversified posture. Although the skipper of SCA also put strategic emphasis on reducing uncertainty, she hedged this strategy by equally applying strategies of accepting, acknowledging, and suppressing uncertainty. This diversification prevented a potentially harmful “one size fits all” approach, but, also led to an initial struggle of the skipper and her team falling into standard operating procedures and thereby reducing uncertainty as described by SCA’s onboard reporter:

> *“Add fighting constant exhaustion to the mix and life is far from pleasant. A working body clock is vital out here. It’s a constant mind and body battle—your mind knows it needs to work hard but your body can physically not or visa versa. That’s why rhythms out here are so important—to help get your body clock into sync. But getting into that rhythm this leg has not been easy. Which ultimately leads us back to the importance of having trained for so long.” (TSCA, 23 November 2014)*

The lack of routine became further evident when the skipper tried to resolve a speed issue. The skipper of SCA was confronted with uncertainty regarding why they encounter speed issues compared to other boats. As she was not able to identify the cause of the issue, she used the uncertainty coping strategy of denial as illustrated by

the following log book entry by SCA's onboard reporter when the competing skippers passed SCA:

> *"But suddenly, as if they put their rocket jets on and took off. Are we intentionally not unleashing our rocket jets or do we not have them? (...) The questions spiral through our heads—why, why, why? Why us? We've worked so hard to be here, some of the girls have been training for two years. We are hunting. We are digging deep, through the darkness, and mustering every bit of what we have left after 22 days at sea in order to put up a serious fight." (TSCA, 10 December 2014)*

The onboard reporter also described that Sam Davies struggled with anticipating *"what's going to happen next"*. Onboard reporters of other boats observed that it is easier to settle into a routine when you *"know what to expect"*, which could explain the discrepancy from SCA to other boats.

Different from the other postures, the skipper of team SCA conceptualized the environment two-folded: On the one hand, she considered the environment as something that must be dealt with and that one can only exert limited influence on. In this respect, the log book entries of team SCA frequently included the word *"luck"* when referring to the impact of weather conditions on boat speed and ranking. The lack of influence on the environment is exemplified by the following log book entry of SCA's onboard reporter:

> *"There's nothing you can do about it, you have to deal with the wind you've got, and if there isn't any, there isn't any," Abby (sailor) said. "But you hope that whatever we're stuck under is going to keep moving through and we'll come out of it. It's only a short-term thing so you have to work with it, it's not forever." This is almost worse than the Doldrums*[8] *because you expect this in the Doldrums—you don't expect no wind here." The only thing we can do at this point is hope the rest of the fleet*

[8] The "doldrums" is a colloquial expression adopted for those parts of the Atlantic and Pacific Oceans affected by low-pressure. They are located around the equator and characterized by light winds.

is in similar conditions and remember there is tomorrow.” (TSCA, 28 November 2014)

On the other hand, however, a *Hedger* considers the environment as something that may be used and shaped to one’s favor. While this also includes accepting the forces of nature, this conceptualization encompasses a more active approach by using these forces and amplifying uncertainty for oneself and others and thereby taking a more active role in shaping competition. This approach is illustrated by the following log book entry by team SCA’s onboard reporter during leg 4 when the skipper of team SCA decided to split from the fleet prior to their arrival in the Philippines:

“However, the biggest event of the day was the split from the fleet. We are heading towards Taiwan and to the north which is very much the opposite direction to where New Zealand is which sounds a bit backwards in going forwards but looking at the routings and weather ahead, it seemed to be the right thing to do." "It’s always difficult to get east in the Pacific Ocean but that’s what we need to do and we got an opportunity with a low pressure and a northerly push coming down the east of Taiwan that will give us a better angle to head south." "It will appear at first that we taken a massive loss but in about 6 days time we will see exactly how the cards has played out. We estimated that either we would gain or come out in exactly the same position as the rest of the fleet, that’s why it was worth taking the risk."” (TSCA, 11 February 2014)

The latter entry also demonstrates how the skipper of SCA took no-regret decisions (i.e. decisions where she amplified uncertainty for herself and the team as well as other boats). Yet the worst-case outcome of these decisions included a zero-sum in terms of ranking. Overall, this posture combined elements of more active, uncertainty altering strategies and “hedges” them with more passive uncertainty coping strategies that deal with the level of uncertainty that is given. Table 2-9 presents further illustrative evidence and quotes for the *Hedger* posture:

Table 2-9: Illustrative evidence of the *Hedger* posture

Strategic posture	Illustrative evidence	Informant
"Hedger"	*" "The rich will get richer at this point," Libby said yesterday afternoon. And we all felt like deflated balloons—the distance just kept growing! Yesterday afternoon we couldn't hit our performance numbers either—we had the best sailors in the correct places and they all said the boat felt slow, but couldn't figure out why."*	*Corinna Halloran, OBR TSCA, 11 November 2014, leg 1*
	"Wind luck, often, has not been in our favor and it's been an incredible challenge mentally in order to stay clear headed, focused, and determined to finish strong."	*Corinna Halloran, OBR TSCA, 12 December 2014, leg 2*
	"At 1915, when we received the 'sked,' we saw no one else had gybed. QUICK! Gybe back! Stay with the fleet! We gybed back to our original course. Then MAPFRE gybed. Then MAPFRE gybed back. Were we about to have a dual mid- Indian Ocean!? Libby and Sam sat below sussing out what to do next. Everyone else sat on the rail in anticipation, holding and waiting for the next call. "Instead of going south on one gybe, we've decided to use every single lift to try to make tiny gains on the others. So, hopefully, having MAPFRE pushing us to do that will help us gain on the leaders a little bit. I hope it's worth it because everyone's putting a lot of effort in—no one is sleeping. The good thing is it's dry on deck.""	*Corinna Halloran, OBR TSCA, 8 January 2015, leg 3*
	"The wind is constantly shifting too making things way more challenging for the people working on deck. That is kind of what's happening out here at the moment. The wind shifts and we need to change our trim mode, in the same way you might need to shift gears as you take a bend. In fact, it's actually the time to embrace it as this is only the beginning of upwind sailing."	*Corinna Halloran, OBR TSCA, 19 January 2015, leg 3*
	"As always we depend on the weather. The forecasted light winds can have a massive effect and cause changes in the positions. Whoever gets favorable tides will be laughing. Favorable conditions or not, we have to make the best out of every opportunity that comes our way and squeeze every knot out of the boat to gain on the boats ahead."	*Anna-Lena Elled, OBR TSCA, 21 June 2015, leg 9*

The relation between strategic postures and performance

Our final research question was whether there are strategic postures that are superior to others? We assessed performance through quantitative ranking data from the race. Since performance can be determined by many factors (e.g., Eisenhardt, 1989a), the results stated here represent an indication because our data suggested an underlying dynamic. Table 2-10 provides an overview of our performance assessment.

Overall, our analysis demonstrates that strategic decision-makers may be successful with most of the strategic postures described in our previous discussion as the podium positions in the overall race rankings were occupied by three skippers taking on three different strategic postures. Therefore, there is no strategic posture that is superior to others per se.

Against this backdrop, our analysis did not find evidence for a relation between level of experience and performance. While all skippers participating in this race were already highly experienced to be able to effectively sail a race, experience may only drive performance up to a certain threshold.

This suggests that the patterns in which strategic decision-makers perceive and cope with uncertainty may be located more deeply in strategic decision-makers’ cognitive underpinnings, such as personality (Alston, 1975; Hambrick, 2007; Hambrick & Mason, 1984; Ruble & Dweck, 1995), or in the way that they have been trained to cope with uncertainty (Michel, 2007) than previously assumed.

For example, Michel (2007) observed that new employees developed a collective-centric cognition that compensates for vulnerabilities of individual cognition when starting to work for a bank using practices to create uncertainty. A collective-centric cognition led employees to strengthen organizational resource connections and to accept uncertainty as persistent. This suggests that training of new employees plays a crucial task in “socializing” employees in the way they need to perceive and cope with uncertainty to thrive in an organization. Similarly, despite the alternation between two skippers onboard Mapfre, the strategic posture remained the same as the skippers Iker Martínez and Xabi Fernández have been training together since they were children. Furthermore, they competed together in the Olympics. Hence, they may have acquired similar ways of perceiving and coping with uncertainty over time.

Table 2-10: Sources of uncertainty and uncertainty coping strategies per skipper

Boat	Leg	1	2	3	4	5	6	7	8	9	Total rank
ADOR	*Predominant uncertainty perceived*	Competitive	Competitive	Competitive	Competitive	Competitive/ Environmental	Competitive	Competitive	Competitive	Competitive	**1**
	Predominant coping strategy used	Reduce	Reduce	Reduce	Reduce	Reduce	Reduce	Mixed strategies*	Reduce	Reduce	
	Rank	1	3	2	2	1	2	5	3	5	
	Skipper					**Ian Walker**					
AVIM	*Predominant uncertainty perceived*	Environmental	Competitive/ Environmental	Competitive	Competitive	Environmental	Competitive	Competitive	Competitive	Competitive/ Environmental	**5**
	Predominant coping strategy used	Mixed strategies*	Mixed strategies*	Reduce	Reduce	Reduce/ Anticipate	Accept	Accept	Acknowledge	Reduce/ Amplify	
	Rank	5	5	3	4	3	5	3	6	1	
	Skipper					**Charlie Enright**					
BRUN	*Predominant uncertainty perceived*	Competitive/ Environmental	Competitive/ Environmental	Competitive	Competitive/ Environmental	Internal	Competitive/ Internal	Competitive	Competitive/ Internal	Competitive	**2**
	Predominant coping strategy used	Accept/ Suppress	Reduce/ Accept	Accept/ Reduce	Mixed strategies*	Suppress	Mixed strategies*	Accept	Suppress	Acknowledge	
	Rank	3	1	5	5	4	3	1	5	2	
	Skipper					**Bouwe Bekking**					
DFRT	*Predominant uncertainty perceived*	Competitive	Competitive	Competitive	Competitive	Internal	Competitive/ Strategic	Competitive	Competitive	Competitive	**3**
	Predominant coping strategy used	Reduce	Reduce	Reduce	Suppress	Reduce/ Suppress	Reduce	Suppress	Mixed strategies*	Accept/ Reduce	
	Rank	2	2	1	3	NA**	1	4	7	4	
	Skipper					**Charles Caudrelier**					

** Mixed strategies are defined as three or more strategies applied equally frequent*

Table 2-10: Sources of uncertainty and uncertainty coping strategies per skipper (continued)

Boat	Leg	1	2	3	4	5	6	7	8	9	Total rank
MAPF	*Predominant uncertainty perceived*	Competitive	Competitive/ Environmental	Competitive/ Environmental	Competitive	Competitive	Competitive	Competitive	Competitive/ Environmental	Competitive	**4**
	Predominant coping strategy used	Reduce/ Suppress	Suppress/ Reduce	Reduce/ Anticipate	Suppress	Reduce	Reduce/ Suppress	Reduce/ Suppress	Reduce/ Suppress	Reduce	
	Rank	7	4	4	1	2	4	2	4	3	
	Skipper	**Iker Martínez**	**Iker Martínez**	**Xabi Fernández**	**Xabi Fernández**	**Iker Martínez**	**Xabi Fernández**	**Iker Martínez**	**Xabi Fernández**	**Iker Martínez**	
TSCA	*Predominant uncertainty perceived*	Competitive	Competitive/ Environmental	Competitive	Competitive	Environmental	Competitive	Strategic	Competitive	Strategic	**6**
	Predominant coping strategy used	Suppress	Acknowledge/ Reduce	Reduce	Reduce	Reduce/ Anticipate	Reduce	Suppress	Reduce	Accept	
	Rank	6	6	6	6	5	6	6	1	7	
	Skipper	**Sam Davies**									
VEST	*Predominant uncertainty perceived*	Competitive	Competitive						Competitive/ Internal	Competitive	**7**
	Predominant coping strategy used	Reduce	Reduce						Acknowledge	Amplify/ Reduce	
	Rank	4	NA***						2	6	
	Skipper	**Chris Nicholson**									

** Mixed strategies are defined as three or more strategies applied equally frequent ** Dongfeng had to terminate the leg early due to a broken mast *** Vestas had to terminate the race and retire from legs 3 to 7 as they grounded shore during leg 2*

Yet, our analysis also derived a different perspective on what drives performance in perceiving and coping with uncertainty. Our study suggests that strategic postures need to fit the context to be successful. Some context may favor perceptions of specific sources of uncertainty and hence specific ways of uncertainty coping. For example, overall, the Volvo Ocean Race, due to its competitive nature may give over proportionally rise to perceptions of competitive uncertainty and uncertainty reduction strategies. Therefore, in highly competitive settings, such as the Volvo Ocean Race, the *Commander* posture was better suited than other postures. However, this also implies that the *Commander* posture will be less suitable in other contexts. For example, in highly dynamic contexts, *Explorer* postures may be more successful because of their uncertainty embracing nature. By contrast, *Repressors* will be more successful in low dynamism, intermediary control environments due to their ability to blank out uncertainty and focus resources instead of allocating them to resolution. *Hedgers* may be successful in environments that are highly dynamic and intermediary in control (e.g., environments in transit) because of their adaptability.

This context-posture fit may be due to different levels of controllability of sources of uncertainty. Some sources of uncertainty are easier to control than others. For example, while strategic decision-makers may possess the ability to influence sources of uncertainty within their realm (e.g., supply, internal uncertainty), they may struggle with environmental uncertainty, which they are unable of controlling. By contrast, competitive uncertainty is situated in between the two ends because skippers may control this source of uncertainty by following their competitors. However, they may also lose sight of their rivals when choosing a different course or when a rival is sailing faster.

More specifically, more active uncertainty coping strategies, such as uncertainty reduction and amplification, seem to be coping more successfully with more controllable sources of uncertainty that lead to higher performance in highly competitive settings (e.g., *Commander* posture coping with controllable competitive uncertainty), whereas more passive uncertainty coping strategies address less controllable sources of uncertainty more successfully (e.g., *Explorer* posture coping with environmental and less controllable competitive uncertainty). For example, in leg 7, Ian Walker who depicted on a *Commander* posture, failed to obtain a podium position despite this leg being an important one for him. Through reaching the finish line before his rival Charles

Caudrelier from Dongfeng Race Team, he would have been able to obtain the race trophy prior to the end of the race.

While Ian Walkers' strategy of constant reduction of competitive uncertainty had worked well for the majority of the race, it did not during leg 7. The leg was characterized by close and less controllable competitive uncertainty because the skipper of Dongfeng Race Team, Charles Caudrelier, sailed through an Exclusion Zone[9]. Initially, Ian Walker, unable to follow and thereby control Dongfeng Race Team when they sailed through the Exclusion Zone was forced to accept this uncontrollable competitive uncertainty as illustrated by the following log book entry:

> *"I wanted to be in front of Dongfeng so we could control them", Ian said in frustration as he sat on the bow in the light wind. "Now because of all this Exclusion Zone business, they've managed to slip away from us." Will there be a penalty? We don't know. All we can do now is chase them down as Lisbon grows nearer on the horizon." (ADOR, 18 May 2015).*

However, once Dongfeng had passed the Exclusion Zone, Ian Walker attempted to reduce uncertainty again. Yet, a weather front prevented him from following Dongfeng and resulted in his splitting from the fleet instead. Further trying to reduce uncertainty, Ian Walker experienced a deterioration in performance as the skipper of Dongfeng Race Team broke away from the fleet. This is illustrated by the following log book entry of Abu Dhabi Ocean Racing's onboard reporter:

> *"Ian's (skipper) face is literally 4 inches away from the computer screen. Illuminated with the greens and blues of the wind models on the screen, as every minute passes by it seems like another wrinkle appears on his forehead. To clarify any speculation, these are the things being discussed onboard right now: our boat speed, our position behind 4 other teams, Dongfeng's breakaway, and the overall standings. To say it's been a bad day would be a vast understatement. The most concerning thing to Ian*

[9] Exclusion Zones refer to particular parts of the ocean that the sailors are normally not allowed to enter and for which penalties are assigned after the leg. In this incident, the skipper of Dongfeng Race Team entered an Exclusion Zone, so that Ian Walker was unable to follow him without risking to also receive a penalty.

right now is that we're the most windward boat and that means that as the fleet gradually turns to the right, we'll also be the most southerly boat. That means less wind in the high – not good. Unpredictable is an unfamiliar feeling onboard a team that likes to be conservative and lean on our tactics and boat handling. Then again – there's not much left to lean on at the moment." (ADOR, 23 May 2015)

Due to the loss in performance, the skipper of Abu Dhabi Ocean Racing even made use of uncertainty amplification in an attempt to get competitive uncertainty under control by turning away from the fleet the next day – a strategic decision that is untypical for the posture:

"Ian (skipper) got fed up with the one-design procession. We all got fed up with it. There was a freedom in having nothing to lose – being at the back of the pack with the only options just floating ideas of chance. About mid-day Ian abandoned the game the rest of the fleet were playing and decided to gybe north." (ADOR, 24 May 2015)

However, the skipper's move did not turn out favorable for them in terms of competitive positioning the next day resulting in a feeling of helplessness onboard:

"The atmosphere onboard hangs thick with a subtle feeling of helplessness. We thought we had gotten it right. That split has since widened and now we're back where we started – out of touch in little to no wind. We're now bobbing with the rest of the fleet in a confused ridge of high pressure extending northeast from the center of the high. All of us desperately want to get into the wind we know is just out of reach to the east." (ADOR, 25 May 2015)

This example demonstrates that Ian Walker, using his normal strategic posture "toolbox" did not work effectively in the context of the less controllable competitive uncertainty that he perceived during this leg.

By contrast, our analysis indicates that the *Explorer* posture and the more passive uncertainty coping strategies used by this strategic posture may be more suitable to deal with less controllable sources of uncertainty, such as the competitive uncertainty perceived by Ian Walker in this context. For example, the skipper of Brunel, Bouwe Bekking achieved second position in the overall ranking and first during leg 7. Leg 7 was also important to him because a win could have secured a chance to still win the overall race trophy if Ian Walker and Abu Dhabi Ocean Racing finished behind Dongfeng Race Team. Contrary to Ian Walker, he relied on passive strategies to cope with less controllable sources of uncertainty, like the competitive uncertainty in this case. This is exemplified by the following log book entry from this leg:

> *“But this is also the most exciting crossing I have done, it's unbelievable how close the racing has been - and still is. The crossing of the Azores high pressure will become very important, as the first boat to get its nose out on the other side of the high will get the northerly breeze first and will always sail into more pressure. But not game over yet, as finally we will get some good breeze - 25-30 knots is possible - and big speed differences between the boats can happen, as we can carry different sail combinations in these conditions.” (BRUN, 23 May 2015)*

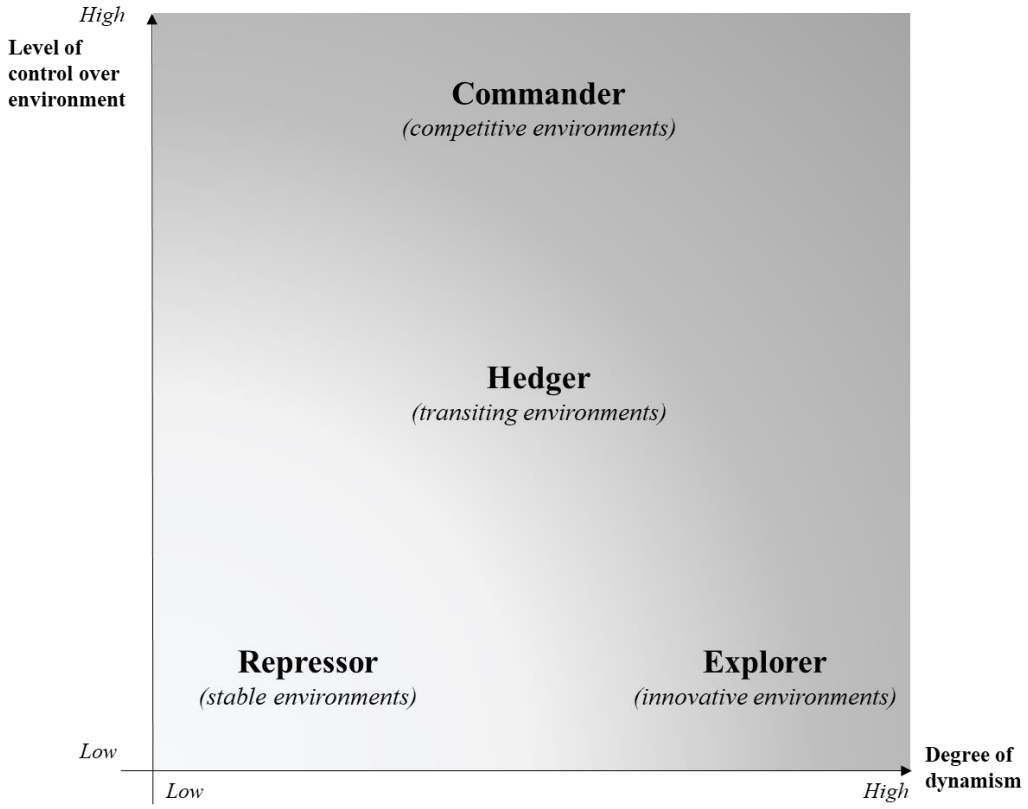
In addition, Bekking used extensive emotional regulation to contain positive and negative feelings resulting from such passive uncertainty coping strategies, thereby maintaining a level of focus amongst his men as illustrated by the following log book entry.

> *“It’s a madhouse,” whispers Rokas Milevičius (sailor). “Wind holes, running and standing still.” And just as he is saying that, the elements see fit to illustrate it. A strong gust of wind suddenly sets Team Brunel in motion and brings us 100 metres past Abu Dhabi Ocean Racing. And then the wind drops again. The sails flap. Now it’s the turn of Ian Walker’s (skipper Abu Dhabi Ocean Racing) men to get a gust, which brings them back alongside us. But the Arabs and Team Brunel seem to be better served than Dongfeng and MAPFRE, because Abu Dhabi and*

we are creeping away from them. Of course, I also know that skipper Bouwe Bekking is right, and that it can all change tomorrow. And that the prizes are only handed out at the finish." (BRUN, 20 May 2015)

These two log book entries and our performance data indicate that passive strategies to cope with uncertainty seem to be more suitable for less controllable sources of uncertainty, such as the competitive uncertainty in this context. Therefore, it favored the *Explorer* posture. By contrast, active strategies lead to better performance in contexts that induce more controllable sources of uncertainty, such as competitive uncertainty during the rest of the race as the skippers were sailing close together. Therefore, the strategic posture of the *Commander* may suit competitive contexts better than other postures. Yet, a different context may also favor other strategic postures. Figure 2-2 provides an overview of potential context-posture fits:

Figure 2-2: Posture-context fit in different environments



An overview of Ian Walkers' (ADOR) and Bouwe Bekking's (BRUN) uncertainty perceptions and coping strategies applied in leg 7 is presented in Table 2-11:

Table 2-11: Perceptions and performances of skippers ADOR/BRUN during leg 7

Boat	**Day (in leg 7)**	**18.05.2015**	**19.05.2015**	**20.05.2015**	**21.05.2015**	**22.05.2015**	**23.05.2015**	**24.05.2015**	**25.05.2015**
ADOR	*Predominant uncertainty perceived*	Competitive	Internal	Strategic	Competitive	Competitive	Competitive	Competitive	Environmental
	Predominant coping strategy used	Accept	Accept	Reduce	Suppress	Reduce	Reduce	Amplify	N/A
	Rank	3	2	3	3	4	5	5	5
	Skipper	**Ian Walker**							
BRUN	*Predominant uncertainty perceived*	Environmental	Internal	Competitive	**	Competitive	Competitive	**	Strategic
	Predominant coping strategy used	Reduce	Accept	Suppress	**	Accept	Accept	**	Acknowledge
	Rank	5	4	1	1	2	2	2	1
	Skipper	**Bouwe Bekking**							

** N/A indicates that the skipper did not apply a strategy to cope with uncertainty*

*** Empty fields indicate that log book entry does not reflect any uncertainties and coping strategies or that log book entry is dealing with a topic outside the focus*

2.5. Discussion

Our study draws on research on managerial cognitive capabilities (e.g., Eggers & Kaplan, 2013; Gavetti, 2005; Helfat & Peteraf, 2015) to develop our theory of strategic postures. Thereby, four distinct strategies postures emerged from our analysis: *Explorer*, *Commander*, *Repressor*, and *Hedger*.

While *Explorers*, *Commanders*, and *Repressors* were focused in how they coped with uncertainty, *Hedgers* were diversified and applied different uncertainty coping strategies. In addition, whereas *Explorers*, *Repressors*, and *Hedgers* held a more balanced perception of different sources of uncertainty, *Commanders* were focused only on competitive uncertainty throughout most of the race.

Through our findings, we demonstrate that not only do strategic decision-makers differ in the way they perceived uncertainty, but also in the way they cope with uncertainty. More specifically, strategic decision-makers, on the one hand, differ in the sources of uncertainty that they perceive, and, on the other hand, not always draw on one, but in most cases on several different uncertainty coping strategies to confront specific sources of uncertainty over time. Thus, trackable patterns, termed strategic postures, emerge. Moreover, even when skippers perceived similar sources of uncertainty, they used different uncertainty coping strategies to address them.

Our study makes several contributions to literature: First, our results contribute to the literatures on uncertainty coping strategies. More specifically, we integrate and extend prior findings on individual uncertainty coping strategies (Engau & Hoffmann, 2011; Hogg & Terry, 2000; Lipshitz & Strauss, 1997; Michel, 2007) by assessing strategic decision-makers use of these strategies when confronted with different sources of uncertainty instead of single ones (Ashill & Jobber, 2010; Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984). Our work not only identifies additional uncertainty coping strategies to the ones already discussed in literature, namely anticipating and accepting uncertainty, but also suggests that strategic decision-makers draw on several strategies over time to cope with different sources of uncertainty. In this respect, our work finds that strategic decision-makers indeed hold distinct strategic postures that define how they perceive their environment and how they cope with uncertainty stemming from it.

In this respect, our results suggest that strategic decision-makers holding a specific posture may be better equipped to meet some challenges, but not others. Thus,

some strategic postures are better suited for specific contexts than others to achieve superior performance. While the *Commander* posture was qualified to cope with a competitive environment that gave rise to controllable degrees of competitive uncertainty and enabled skipper Ian Walker of Abu Dhabi Ocean Racing to constantly reduce competitive uncertainty, other settings may give rise to less controllable sources of uncertainty, such as high levels of competitive uncertainty and environmental uncertainty, may be less favorable to a *Commander* posture and more advantageous for other strategic postures. For example, the entrepreneurial literature suggests that individuals that are willing to endure or bear more uncertainty, are more likely to undertake entrepreneurial action (McMullen & Shepherd, 2006). This finding is similar to the *Explorer* posture that we derived from our analysis. In this sense, Explorers may not only be able to cope with less controllable sources of uncertainty, but also endure higher degrees of uncertainty.

Transferred to a business setting, one may argue that strategic decision-makers in incumbent firms often depict a *Commander* posture, particularly in relatively stable industries. For example, the automobile industry has been a relatively stable to incrementally changing industry over the past decades (e.g., Dobrev, 2007). Therefore, executives at Daimler, a German automobile manufacturer, have been reducing uncertainty stemming from new technologies, such as electric propulsion systems and changes in customer mobility, by sequentially investing into start-up companies with alternative business models, such as Tesla in 2009 and mytaxi in 2012 (cf. McGrath et al. 2004). In a similar vein, the telecommunication company AT&T decided to combine old and new technology services into bundles and offer it to customers to lower uncertainty from acceptance of the new service offering by customers (McGrath & MacMilan, 2000).

The *Repressor* posture may even make strategic decision-makers inert in the face of disruptive trends (e.g., Christensen, 2013; Christensen & Bower, 1996) by ignoring associated sources of uncertainty in this context. For example, while BMW had already introduced two different full electric vehicle models to the market in 2013/14, other premium car manufacturers have still not taken this step. Hence, the *Commander* and *Repressor* postures may lead strategic decision-makers to become more vulnerable to less controllable sources of uncertainty stemming from disruptive innovation as initially provided by new players in the market, such as Tesla. By contrast, Elon Musk, CEO of Tesla may be considered an *Explorer* as he actively seeks out uncertainty in his business

environment to seize opportunities. He also openly communicates to his employees to disregard hierarchies if they identify an opportunity that the company should pursue and thereby fostering organizational resource connections. Therefore, the *Explorer* posture may fit to more innovative contexts, particularly in phases of technological discontinuity of previously stable industries (Kaplan & Tripsas, 2008; Tushman & Anderson, 1986). Thus, our research also speaks to the literature on adaptive fit (e.g., Chakravarty, 1982; Ginsberg, 1988; Lengnick-Hall & Beck, 2005; Miles & Snow, 1978; Zajac & Kraatz, 1993) and entrepreneurship (e.g., McMullen & Shepherd, 2006; Packard et al., 2017).

Second, our research also contributes to managerial cognitive capabilities theory (e.g., Eggers & Kaplan, 2009; Helfat & Peteraf, 2015; Gavetti 2012, 2005). Since strategic decision-makers did not only differ in terms of how they perceived uncertainty, as suggested by the theory, but also in how they coped with uncertainty despite perceiving similar sources of uncertainty, our research indicates that coping may also be a cognitive capability that strategic decision-makers hold. While perception was argued to be related to the capability of sensing opportunities (Helfat & Peteraf, 2015), coping may influence whether strategic decision-makers seize an opportunity. For example, strategic decision-makers holding an *Explorer* posture and thus predominantly drawing on uncertainty acceptance and amplification strategies may be more qualified to seize opportunities as suggested by the Austrian School (Eisenhardt & Martin, 2000; Eisenhardt & Sull, 2001).

Third, and more broadly, our results also speak to the literature on emotion regulation. Côté (2005: 510) defined emotional regulation as a process to "increase, maintain, or decrease one or more components of an emotion". Prior research associated the skill of managing emotion with the capabilities of learning, reasoning, solving problems and information processing (Côté & Miners, 2006; Mayer, Roberts & Barsade, 2003). In this sense, emotional management may also be considered a social cognitive capability as it encompasses the power to positively influence organizational members (Helfat & Peteraf, 2015). For example, Elon Musk announced that he would like to personally be informed of all injuries occurring within the company stating "this is what all managers at Tesla should do as a matter of course. At Tesla, we lead from the front line, not from some safe and comfortable ivory tower. Managers must always put their team's safety above their own." This statement also demonstrates how emotions and reasoning tie in with each other. By putting employees' safety in front of his own, Musk actively shapes reasoning (Boitnott, 2017).

Since emotional management skills are acquired over time (Côté & Miners, 2006; Izard, Fine, Schultz, Mostow, Ackerman, & Youngstrom, 2001), Bekking, as one of the most experienced skippers of the Volvo Ocean Race 2014-15 may possess a skillset in this domain that Charlie Enright (team Alvimedica), a skipper also predominantly relying on passive strategies, but with substantially less experience, did not command. The ability to regulate emotions positively relates to employees expressing voice (Grant, 2013), which, in turn, leads to favorable outcomes to the organization, such as prevention of financially costly errors (Edmondson, 1999, 1996) and generation of new ideas driving innovation (Zhou & George, 2001). Therefore, the ability to regulate emotions could explain differences in performance. Furthermore, uncertainty is mostly associated with evoking negative emotions and unfavorable organizational outcomes, such as employee resignation (Kiefer, 2005). Thus, being able to actively turn these negative emotions around may play an important role in the way strategic decision-makers effectively cope with uncertainty.

2.6. Limitations & future research

Of course, our study does not go without limitations that provide opportunities for future research: First, we selected a professional sailing race, the Volvo Ocean Race 2014-15, as our context of study. The selection of this sport context allowed us to study the nature and performance implications of strategic postures, while holding information and resources constant. Thus, our research setting enabled us to study the mental activities of perception and coping absent from noise created through information and resource asymmetry.

This allowed us to distill strategic decision-makers’ cognitive capabilities and consequentially better understand why they took specific strategic decisions throughout the race. Thus, despite similar information and resource levels, strategic decision-makers still differ in the way that they perceive uncertainty and in the way they make sense and reason based on this perception. This suggests that the cognitive capabilities of perception and reasoning may be rooted more deeply in strategic decision-makers’ cognitive underpinnings instead of being influenced by external factors, such as information or resources. Given this finding, some strategic decision-makers, due to their strategic posture may therefore also be more successful than others.

Yet, future research may want to relax these assumptions to study their influence on strategic postures. In this respect, future studies could look at information asymmetry and how it influences strategic decision-makers strategic postures while holding resources constant. For example, scholars could study stock brokers' strategic postures because they usually have access to similar resources (e.g., evaluation tools) and may therefore cope with uncertainty differently due to information asymmetry. Furthermore, even given superior information, some strategic decision-makers may still outperform others due to their cognitive capabilities. Similarly, differences in resources could influence strategic postures. For example, studies could look at strategic postures of partners in consulting companies in the pitching processes in the context of large client tenders. Consulting firms differ significantly in the resources they command. Yet, clients usually provide all consultancies with the same information with regards to the pitch.

Second, our sample was derived from a single industry setting. Thus, the number of skippers involved is limited. The Volvo Ocean Race 2014-15 is comprised of only seven boats of which one only participated in three of the nine legs in total. While the rich accounts from the race enabled us to gain deep insights into the perceptions and coping strategies of the skippers, they restrained our research to this specific sample. Due to the limitations in our sample seize, future research could explore whether additional strategic postures, besides the one identified in this paper, exist. This research may want to draw on a larger sample and cluster analysis in order to study whether there are additional strategic postures (e.g., Engau & Hoffmann, 2011 on political uncertainty).

Third, our research found that strategic decision-makers' capability to perceive and cope with uncertainty are grounded more deeply in their cognitive underpinnings than previously assumed. Thus, strategic decision-makers are predisposed to perceive and cope with uncertainty in specific ways. Yet, due to the limitations in the sample size, our data did not allow to fully clarify the origin of such differences. For example, can differences be explained in terms of personality (e.g., Alston, 1975; Hambrick, 2007; Hambrick & Mason, 1984; Ruble & Dweck, 1995), or by strategic decision-makers' training (e.g., Michel, 2007)?

Fourth, we studied strategic postures taking into account different sources of uncertainty as well as different uncertainty coping strategies. Yet, our data did not allow

us to make inferences about the degree of uncertainty experienced by strategic decision-makers holding different strategic postures. Therefore, future research may want to explore how the different strategic postures differ in the amount of uncertainty they are confronted with. This may enable us to better understand whether and how strategic decision-makers are able and willing to endure or bear uncertainty over time (e.g., McMullen & Shepherd, 2006).

And fifth, while our context allowed us to study different sources of uncertainty and consequent uncertainty coping within a short period of time (nine months), our data did not allow to study stability and changeability of strategic postures. Strategic postures may be similar to the concept of strategic schemas where individuals hold mental predispositions that provide default assumptions and expectations on how to do something (DiMaggio, 1997; Hsu, Roberts, & Swaminathan 2012). While strategic schemas help to simplify cognitive demands (Kaplan & Tripsas 2008; Anderson & Tushman 1990), they may also lead to inertial tendencies in some contexts (Benner & Ranganathan, 2017). Similarly, strategic postures may hold opportunities and threats for strategic decision-makers. While strategic postures may ease cognitive demands, they may also span boundaries to strategic decision-makers’ ways of perceiving and coping with uncertainty. More specifically, if strategic decision-makers become “stuck” in a strategic posture of uncertainty coping, they may be trapped in perceiving and acting upon uncertainty in specific, pre-determined ways that may be dysfunctional to the organization. Thus, strategic postures to cope with uncertainty may be stable and unchanging to some extent.

Yet, they may demonstrate potential for adaptation in the mid- to long-term. Similar to routines (Ashforth & Fried, 1988; Feldman, 2000; Gersick & Hackman, 1990; Weiss & Ilgen, 1985), an evolutionary or ecological perspective could help explore the role and nature of change in strategic postures. This, in turn, may have an effect on the sensing and seizing capabilities of managers (Adner & Helfat, 2003). Strategic postures of organizations may particularly be subject to adaptation when there are changes in the top management team, particularly the CEO as the strategic leader of the organization (e.g., Eggers & Kaplan, 2009; Greiner & Bhambri, 1989; Hambrick, Geletkanycz, & Fredrickson, 1993).

2.7. Conclusion

The year 2017 has been declared the year of uncertainty by the Wall Street Journal (Lublin, 2016). Therefore, understanding the way in which strategic decision-makers perceive and cope with uncertainty remains a crucial task for research. Yet, we still know too little about how strategic decision-maker can successfully cope with uncertainty. By exploring the existence, nature, and performance drivers of strategic postures from a managerial cognitive capabilities perspective, we hope to shed new light on the underlying cognitive processes uncertainty coping. Our hope is to trigger further studies in the field to ameliorate our understanding of the uncertainty concept itself and the patterns driving uncertainty coping behavior and success.

3. Reducing uncertainty: Uncertainty, governance, and partner choice in technology sourcing over a technology's life cycle[10]

Abstract:
This study explores the effect of uncertainty on governance and partner choice in technology sourcing over the course of a technology's life cycle. We draw on rationales from transactions cost economics, real options theory, and network theory to explain how organizations govern technology sourcing and choose transaction partners as the sourced technology moves through its life cycle. We argue that these choices are contingent on the degrees and sources of uncertainty that organizations face. While early phases of a technology's life cycle are characterized by numerous exogenous sources of uncertainty, which lead to hybrid forms of governance in partnerships formed with suppliers already familiar to the organization, hierarchical governance emerges in later phases due to higher degrees of endogenous sources of uncertainty. After exogenous shocks, organizations will seek market-based forms of governance and source from new suppliers because doing so helps mitigate firm specific sources of uncertainty.

Keywords: Uncertainty, governance, buyer-supplier relationship, supplier network, technology management, technology life cycle

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3.1. Introduction

Technology life cycles have received considerable scholarly attention over the past 30 years (e.g., Dosi, 1982; Kaplan & Tripsas, 2008; Nelson & Winter, 1982; Suarez, 2004; Teece, 1986; Tushman & Anderson, 1986; Tushman & Rosenkopf, 1992; see Murmann & Frenken, 2006, for a summary). Within this stream of literature, scholars share the view that technologies follow an evolutionary path from an early, ferment phase characterized by large variations in design through a phase of incremental change that ensues the emergence of a dominant design to a point of technological discontinuity at which an environmental shock leads to organizational reorientation (Anderson & Tushman, 1990; Nelson & Winter, 1982; St. John, Pouder, & Cannon, 2003; Tushman & Anderson, 1986; Tushman & Smith, 2002; Tushman & Rosenkopf, 1992). In line with this perspective, we define technology as "applied in a particular product context and embodied in a physical artefact" (Kaplan & Tripsas, 2008: 719). For example, batteries for electric vehicles and processors in laptops and computers represent technologies according to this definition.

Studies in this field share the view that technological change spurs industry- and firm-level changes, with particular implications for firms' production function. Technological changes give rise to different sources of uncertainty (e.g., Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984) that reflects the origin from which uncertainty arises (e.g., technology, competitors, market). Therefore, prior research has discussed in detail potential product and process implications, such as product variations, and effects on volume/batch size, depending on the source of the uncertainty experienced in each stage of the technology life cycle (e.g., Abernathy & Utterback, 1978; Hayes & Wheelwright, 1979a & 1979b). In addition, scholars have assessed firms' boundaries in relation to different sources of uncertainty stemming from technological change (e.g., Folta, 1998; Pisano, 1990; Van de Vrande, Lemmens, & Vanhaverbeke, 2006).

However, the extant literature remains silent on how different sources of uncertainty affect firms' governance and partner choices over time as a technology progresses through its life cycle. Nevertheless, exploring firms' boundaries over time is important if we are to better understand how firms adapt to changes in their environment. In this respect, whether to source a technology in-house (e.g., from own business units), externally (e.g., from third-parties), or a combination of both (e.g., joint

ventures), and from whom (existing/new supplier) become important strategic questions.

There are different theoretical perspectives on why organizations choose certain forms of governance and partners when confronted with different sources of uncertainty, including transaction cost economics (TCE) (e.g., Pisano, 1990; Walker & Weber, 1984), real options theory (ROT) (e.g., Folta, 1998; Santoro & McGill, 2005), and network theory (e.g., Beckman et al., 2004; Hoetker, 2005). While all of these theories highlight the importance of uncertainty, none can sufficiently explain the contingencies that organizations face when sourcing technology throughout its life cycle. For example, while TCE posits that firms internalize technology sourcing when confronted with high degrees of uncertainty stemming from suppliers' behavior (e.g., Robertson & Gatignon, 1998), it does not provide guidance on how to cope with uncertainty exogenous to the transaction because that uncertainty is outside the control of organizations. In contrast, ROT advocates a need to remain flexible in these situations (e.g., McGrath et al., 2004). In addition, neither of these theories provides insights into firms' likely partners (i.e., existing or new suppliers) in such situations.

Therefore, the purpose of this study is to draw on these different theoretical lenses to explore why firms choose one form of governance and supplier for technology sourcing rather than another over the course of a technology's life cycle. Our central thesis is that firms adapt governance and supplier choices for technology sourcing in light of the degree of uncertainty and the source of uncertainty (*exogenous* or *endogenous* to the transaction, or *firm specific*) they face as the sourced technology progresses through the stages of its life cycle (given that asset specificity is present to a non-trivial degree). Firms select a form of governance and a partner in an attempt to reduce high degrees of specific sources of uncertainty and, thereby, economize on transaction costs (Williamson, 1991, 1985). Hence, differentiating uncertainty by its degree and source is important because the attributes of some governance forms and partners make them more effective in mitigating certain forms of uncertainty than others.

Drawing on these ideas, our study makes three contributions to the literature. First, by drawing on TCE, ROT, and network theory, our theoretical exploration of the governance of technology sourcing throughout a technology's life cycle sheds new light on how organizations respond to technological change (e.g., Jacobides & Winter, 2005;

Kaplan, 2008a). Most prior research adopts a single theoretic perspective to describe governance choice and partner selection (see Folta, 1998, and Santoro & McGill, 2005, for exceptions). In contrast, we draw on different theoretical perspectives to develop a richer perspective on how changes in degrees and sources of uncertainty shape organizations’ governance of technology sourcing and their supplier choices over time. This enhances our understanding of how organizations create and capture value during each stage of a technology’s life cycle.

Second, our research emphasizes the role of uncertainty in determining organizational responses, such as governance decisions related to technology sourcing (e.g., Santoro & McGill, 2005) and supplier choices (e.g., Beckman et al., 2004; Hoetker, 2005). While prior studies have focused on a unidimensional uncertainty concept (e.g., Williamson, 1985), industry characteristics (e.g., Folta, 1998; Pisano, 1990), and capabilities as drivers of governance and partner choice (e.g., Jacobides & Winter, 2005; Williamson, 1999), our research highlights the complex interplay among different degrees and sources of uncertainty in determining firms’ boundaries. This may help alleviate current contradictory findings in literature on the relation between uncertainty and governance (e.g., David & Han, 2004; Macher & Richman, 2008). Furthermore, our emphasis on the type of supplier (existing versus new) contributes an additional perspective on how governance can help mitigate different sources of uncertainty.

And third, more broadly our study answers calls to combine different theoretical perspectives to discuss (evolutionary) phenomena (e.g., Folta & Leiblein, 1994; Gulati, 1998; Trigeorgis & Reuer, 2017) and calls for more research on how dynamic processes shape firm responses (e.g., Jacobides & Winter, 2005). While prior studies have focused on individual strategic decisions (e.g., Santoro & McGill, 2005), our research expands this perspective to the evolutionary process of technology life cycles. This dynamic perspective can enhance our understanding of how changes in the environment shape organizational adaptations over time (Chakravarthy, 1982; Lengnick-Hall & Beck, 2005; Zajac & Kraatz, 1993).

We first discuss the sources of uncertainty salient in a technology’s life cycle and different theoretical perspectives on how to govern and partner in technology sourcing. Thereafter, we move to this paper’s main contribution—a dynamic model of the governance of technology sourcing and partner choices across the technology life cycle.

3.2. Background

Organizations that source technologies confront different degrees and sources of uncertainty as those technologies evolve (Kaplan & Tripsas, 2008; St. John et al., 2003). We define uncertainty as the "perceived inability to predict something accurately" (Milliken, 1987: 136), which stems from a lack of knowledge or an inability to discriminate between relevant and irrelevant information in order to resolve a decision situation (Duncan, 1972; Gifford, Bobbitt, & Slocum, 1979). Different sources of uncertainty have been discussed and investigated by researchers in behavioral and organizational theories (e.g., Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984).

Prior research on technology life cycles has identified competitive, market, technology, behavioral, effect, and response as the most common sources of uncertainty perceived during a technology's evolution (St. John et al., 2003). These sources of uncertainty differ in terms of whether they stem from a transaction's *exogenous* environment, they are *endogenous* to the transaction, or they are unique and, therefore, *firm specific*.

Table 3-1: Different sources of uncertainty in the technology life cycle

Source of uncertainty	Definition	Locus of uncertainty
Market uncertainty	Firm's inability to predict aggregate levels of demand and customer expectations for important product specificities.	Exogenous to the transaction
Competitive uncertainty	Firm's inability to predict competitors' moves or the inability to predict whether the firm will be able to compete effectively.	
Technological uncertainty	Firm's inability to predict whether a technology will ultimately become dominant in an industry.	
Partner uncertainty	Firm's inability to predict a partner's behavior.	Endogenous to the transaction
Task uncertainty	Firm's inability to assess and monitor a partner's capabilities and contributions to the exchange.	
Effect uncertainty	Firm's inability to predict the impact of an environmental change on the firm as well as the timing and magnitude of that impact.	Specific to a single transacting partner (firm specific)
Response uncertainty	Firm's inability to analyze the utility of available response options and the options that are available overall.	

Market uncertainty refers to a firm's inability to predict aggregate levels of demand and customer expectations for important aspects of a product (Oriani & Sobrero, 2008; St.

John et al., 2003). Competitive uncertainty relates to the inability to predict competitors' moves or the inability to predict whether the firm will be able to effectively compete (Robertson & Gatignon, 1998). Technological uncertainty encompasses the inability to predict whether a technology will ultimately become dominant in an industry (Anderson & Tushman 2001; Dixit & Pindyck, 1994; Oriani & Sobrero 2008; Toh & Kim, 2013). All of these sources of uncertainty are *exogenous* to the transaction, but the exchange is contingent on them.

In contrast, behavioral uncertainty encompasses the inability to assess the direction of changes in partners' behaviors (Katsikeas, Skarmeas, & Bello, 2009; Sutcliffe & Zaheer, 1998; Williamson, 1985). This uncertainty entails threats of opportunism and conflict between the exchange parties, and is often discussed in relation to trust (Lumineau & 2012; Mesquita & Brush, 2008; Young-Ybarra & Wiersema, 1999). It originates from an inaccurate understanding of exchange partners' behaviors (Katsikeas et al., 2009; Sutcliffe & Zaheer, 1998), which is referred to as partner uncertainty, and from the inability to effectively monitor and evaluate a partner's behavior, which is known as task uncertainty (Argyres, 1995; Santoro & McGill, 2005). For example, an exchange partner may expropriate intellectual property rights developed during the exchange due to incomplete contracts (Carson & John, 2013). As these sources of uncertainty arise from the transaction, they are *endogenous* to the transaction.

Effect and response uncertainty (Milliken, 1987) are unique and often internal to the firm (Beckman et al., 2004). Therefore, they are *firm specific*. While effect uncertainty relates to an inability to predict whether and when an environmental change will affect a focal organization and to what extent, response uncertainty refers to the inability to predict strategic options or assess the utility of those options (Ashill & Jobber, 2010; Miller & Shamsie, 1999; Milliken, 1987). In the context of technological change, organizations may perceive effect uncertainty following an exogenous shock (St. John et al., 2003)—they may ask whether and how that shock will affect the organization. For example, organizations could not know ahead of time that the invention of laser technology would change several industries (McGrath & Macmillan, 2000).

Response uncertainty relates to the strategic options that can be used to react to an exogenous shock. Although these sources of uncertainty are also induced by events

outside the transaction, they differ conceptually from exogenous sources of uncertainty—instead of asking how the environment changes, they relate to the significance of that change for a firm. In this respect, firm specific sources of uncertainty are a function of the firm's management quality and skills (Miller & Shamsie, 1999).

Because all of these sources of uncertainty differ conceptually, it is important to explore whether they lead to differences in firms' responses. Prior research has demonstrated that technological change spurs evolution of firms' products and process variations (e.g., Abernathy & Utterback, 1978; Utterback & Suarez, 1993). Moreover, researchers have highlighted the importance of different degrees and sources of uncertainty in driving this evolution (St. John et al., 2003). We build on this prior scholarly work and argue that changes in degrees and source of uncertainty over a technology's life cycle not only contribute to continual adjustments of firm-internal structures but also affect firms' boundaries and partner choices.

Empirical evidence demonstrates that organizations prefer different forms of governance when sourcing technology in the face of different sources of uncertainty (e.g., Folta, 1998; Pisano, 1990; Santoro & McGill, 2005). While these studies are often unspecific with regard to the technology's life cycle stage, they share the perspective that firms adjust their boundaries depending on the degree and source of uncertainty they experience. Hence, the underpinnings of a dynamic model of technology sourcing governance and partner choices lie in the different degrees and sources of uncertainty that organizations encounter at each stage of the technology's life cycle. As such, specifying the technology life cycle stage is important, as it enables us to derive information on the degrees and sources of uncertainty that organizations face, which may lead to differences in their responses.

Theoretical perspectives on governance and partner choice given uncertainty

Although studies often differ in terms of how they conceptualize and trace various forms of uncertainty to firm-level outcomes (Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984), they share the premise that individuals and organizations strive to reduce uncertainty. The basic idea behind this theory is that "certainty renders existence meaningful and confers confidence in how to behave and what to expect from the physical and social environment" (Hogg & Terry, 2000: 124). People seek to "understand, predict, and control their environments in order to maximize positive

outcomes" (Case et al., 2004: 849). In the psychology literature, perceptions of control are associated with feelings of well-being (Alloy, Clements, & Koenig, 1993; Taylor & Brown, 1988), whereas a loss of control is associated with helplessness and other negative outcomes (Abramson, Seligman, & Teasdale, 1978; Seligman, 1975).

While researchers have found these effects on the individual level, there are similar arguments on the organizational level. The Carnegie School (e.g., March & Simon, 1958; Simon, 1976) suggests that organizations work to reduce uncertainty in an attempt to simplify cognitive demands for their employees (Michel, 2007). Along these lines, various studies trace firms' structural adaptations in their attempts to align organizational design with uncertainty stemming from changes in their environment (e.g., Beckman et al., 2004; Thompson, 1967; Williamson, 1981).

We combine perspectives from TCE, ROT, and network theory to derive implications for the resolution of uncertainty arising from different loci (*exogenous* or *endogenous* to the transaction, or *firm specific*). Thereby, TCE, ROT, and network theory complement each other in making predictions about organizational responses depending on the locus of uncertainty (Table 3-2).

Table 3-2: Overview of different theoretical perspectives on uncertainty

	Locus of uncertainty		
Theoretical lens	**Exogenous**	**Endogenous**	**Firm specific**
Transaction cost economics (TCE)	Transacting parties are unable to control exogenous sources of uncertainty.	The transaction will be internalized when it is subject to endogenous sources of uncertainty.	Not discussed.
Real options theory (ROT)	Organizations will create different options and seek flexibility when confronted with exogenous sources of uncertainty.	Endogenous sources of uncertainty create pressure to act and commit to an option.	Not discussed.
Network theory	Organizations will reinforce existing networks in an attempt to refine and extend the existing knowledge base.	Not discussed.	Organizations will reach out to new partners in an attempt to broaden their existing knowledge base.

Transaction cost economics perspective

A key tenet of TCE is the assumption that transactions are conducted in a way that minimizes the transaction costs incurred by carrying them out (Williamson, 1985). Transaction costs may arise from opportunism and administration costs. Opportunism originates from exchange parties' unwillingness to adapt to new circumstances surrounding the exchange or from the renegotiation of contractual terms at one partner's expense (Williamson, 1991). In contrast, administration costs may stem from complex contracting through formal and informal instruments designed to allow for effective information processing (e.g., Foss & Weber, 2016) and to address certain aspects of adaptation (Abdi & Aulakh, 2017; Williamson, 1979), such as evaluation and monitoring mechanisms (Santoro & McGill, 2005). Furthermore, partners have a need to monitor and control contractual arrangements, including partners' qualitative and knowledge inputs (Oxley, 1997).

The need to economize on transaction costs implies that firms will select a specific form of governance depending on the contingencies of the exchange. TCE posits that firms prefer hierarchical governance (e.g., internalizing technology sourcing), especially when there is uncertainty endogenous to the transaction (Pisano, 1989) or when one party has made a large, transaction-specific investment (Williamson, 1991). Hierarchical governance implies that the transaction is conducted within a single firm (Williamson, 1985). This may be the case because one exchange party acquires the other, the two parties merge, or a firm conducts the exchange internally (e.g., fully develops and sources a technology in-house).

By internalizing a transaction, the technology-sourcing firm gains full authority over the transaction. This resolves the threat of opportunism because hierarchical governance creates strong safeguards against the expropriation of investments (Pisano, 1989; Williamson, 1985). Hierarchical governance allows for more complete internal contracts and submits the transaction to the law of forbearance (Williamson, 1991). In so doing, exchange parties can work out their disputes by appealing to hierarchy for a decision (Carson & John, 2013; David & Han, 2004). Moreover, the exchange parties' interests and goals are likely to be aligned because they share a common frame established through a single authority (e.g., Weber & Mayer, 2014).

The TCE perspective has two notable shortcomings. First, the theory does not explicitly deal with exogenous sources of uncertainty because it assumes that such

uncertainty is beyond the control of organizations. Thus, the theory does not provide guidance for coping with these sources of uncertainty. Second, TCE advocates hierarchical governance instead of market transactions with rising degrees of transaction-specific investments and uncertainty. However, prior research has demonstrated that this is not always the case (e.g., Weber & Mayer, 2014; or David & Han, 2004 for a summary). Therefore, a different theoretical perspective is required to assess the effects of exogenous sources of uncertainty on technology sourcing across the technology life cycle.

Real options theory perspective

ROT offers an additional perspective on how to govern technology sourcing given different sources of uncertainty. Real options are defined as "the right, but not the obligation, to take an action in the future" (Amram & Kulatilaka, 1999: 5). The theory differentiates between option creation (flexibility) and option execution (commitment). While an option is created through an initial investment decision, an option is executed through the exploitation of that option (Trigeorgis & Reuer, 2017).

McGrath and Nerkar (2004) argue that organizations explicitly or implicitly use real options reasoning under conditions of uncertainty. ROT suggests that under conditions of exogenous uncertainty, organizations seek to postpone (irreversible) commitment and to diversify their investments because doing so is strategically valuable (Bowman & Hurry, 1993; Leiblein, 2003; McGrath 1997; Miller & Folta, 2002; Pacheco-de-Almeida, Henderson, & Cool, 2008). In the face of exogenous sources of uncertainty, the chosen form of governance should allow for flexibility (McGrath et al., 2004). More specifically, governance should enable organizations to make deliberate future investments and to avoid becoming locked into the exchange through irreversible investments (e.g., costs associated with contract set-up, administration, and dissolution) (Folta, 1998; Kogut, 1991). Therefore, organizations will sequentially invest through hybrid forms of governance (e.g., strategic partnerships, equity investments, joint ventures) when faced with exogenous sources of uncertainty (Kogut, 1991).

In this context, hybrid forms of governance serve as flexible arrangements because they provide growth opportunities (e.g., Reuer & Tong, 2010), a flexible ownership structure (e.g., Kouvelis, Axarloglou, & Sinha, 2001), and technology-transfer opportunities (e.g., Estrada, de la Fuente, & Martin-Cruz, 2010). For example,

firms may transfer explicit (codifiable) and implicit (non-codifiable) knowledge through hybrid forms of governance (Carson & John, 2013; Folta, 1998; Kogut, 1988). However, when sharing implicit knowledge, the threat of opportunism increases (Folta, 1998). Therefore, ROT argues that hybrids may serve as transitional forms of governance (Trigeorgis & Reuer, 2017) and that organizations irreversibly commit to an option after exogenous sources of uncertainty have been resolved.

At the same time, ROT argues that endogenous sources of uncertainty create pressure to act because these sources of uncertainty can be resolved by a firm's management (McGrath et al., 2004). Therefore, organizations are likely to commit to an option when confronted with endogenous sources of uncertainty.

While ROT discusses exogenous and endogenous sources of uncertainty in the exchange, the theory remains silent with respect to firm specific sources of uncertainty that are unique to a single party in the exchange. Furthermore, both the TCE and the ROT fail to offer predictions on the partner choices that organizations sourcing technology are likely to make. Hence, a third theoretical perspective is required to explain the effects of firm specific sources of uncertainty on technology sourcing across the technology life cycle and on partner choice.

Network theory

Network theory investigates the extent of firms' interorganizational networks. One essential tenet of the theory is that firms expand their networks to alleviate uncertainty (e.g., Pfeffer & Salancik, 1978). Firms also broaden their networks to learn about new technologies and practices (Kogut, 1988).

The theory distinguishes between exogenous and firm specific sources of uncertainty. On the one hand, when firms are confronted with exogenous sources of uncertainty, they reinforce established network relationships to refine and extend existing knowledge (Beckman et al., 2004). This is similar to the concept of exploitation in organizational learning (March, 1991). Hence, firms will attempt to transact with partners with whom they have previously engaged. This is because familiar partners hold similar ideals and values (Sjostrand, 1992), and allow for homogeneity (Hogg & Terry, 2000). In addition, reinforcing existing relationships strengthens stability and trust, which both have to be built in relationships with new partners (Beckman et al., 2004).

On the other hand, organizations that experience firm specific sources of uncertainty broaden their network ties in an attempt to uncover additional information (Galbraith, 1977; Haunschild, 1994). Network theory posits that new partners add to the firm's scope and increase the likelihood of obtaining new information, thereby broadening the firm's knowledge base (Beckman et al., 2004). This is similar to the concept of exploitation in organizational learning (March, 1991).

We have discussed different theoretical perspectives on governance that depend on the locus from which the source of uncertainty arises (*exogenous* or *endogenous* to the transaction, or *firm specific*). Using these building blocks, we suggest that, in the context of technology sourcing, there are four essential attributes by which governance forms and partner choice may be differentiated: (1) authority (ability to exert full control over a transaction), (2) reversibility of investment (flexibility versus commitment), (3) extent of inter-firm knowledge sharing (amount of information disclosed), and (4) newness of shared knowledge (adding new network members or reaching out to existing network members) (Table 3-3):

Table 3-3: Distinguishing attributes of different governance forms

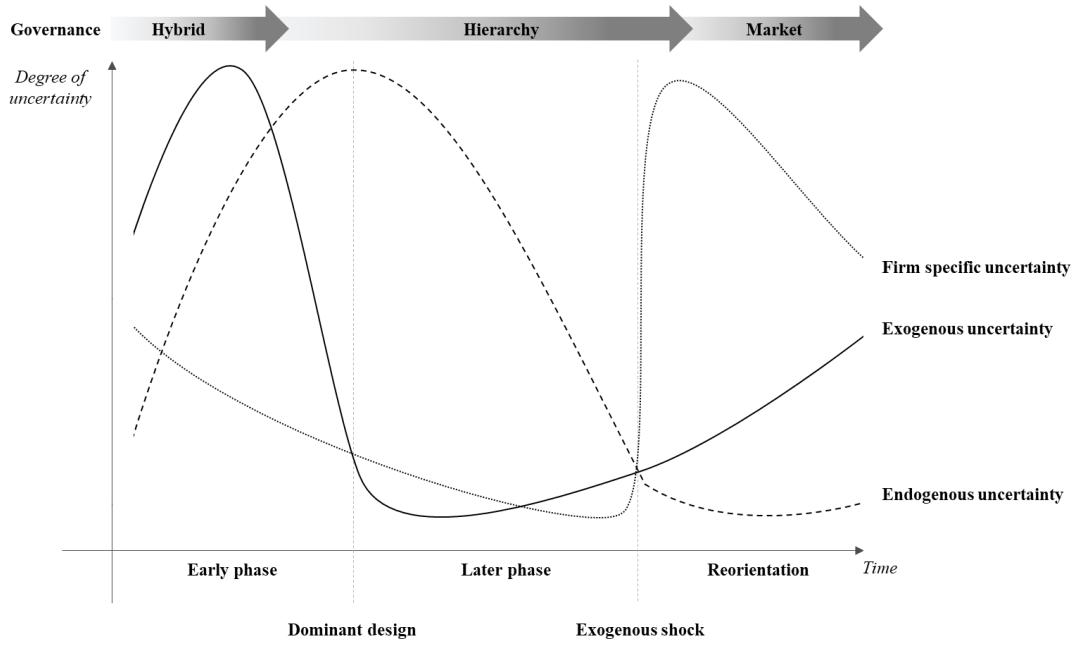
	Governance forms		
Attribute	**Market**	**Hybrid**	**Hierarchy**
Authority	0	+	++
Length of transaction lock-in (flexibility vs. commitment)	0	+	++
Extent of interfirm knowledge sharing	0	+	++
Newness of shared knowledge	++	+	0

Key: 0 = None/Low; + = Medium; ++ = High

3.3. Proposition of theoretic model

To understand why organizations adapt technology sourcing governance over the course of a technology's life cycle, we must not only differentiate among sources of uncertainty but also consider how the degrees and sources of uncertainty change over time. For each stage of the technology life cycle, we describe the sources of uncertainty that are the most salient and how they lead to the selection of a specific form of governance and supplier (Figure 3-1) given the attributes in Table 3-3.

Figure 3-1: Theoretic model



We propose that the governance of technology sourcing depends on the locus of uncertainty (*exogenous* or *endogenou*s to the transaction, or *firm specific*), and the degree of uncertainty involved in the transaction. Furthermore, they will also affect firms' partner choice. As a consequence, organizations constantly adapt the governance of technology sourcing and their suppliers as the source and degree of uncertainty change in order to avoid costs arising from maladaptation (Macher & Richman, 2008).

Early phase: Era of ferment and variation

In the early stage of a technological life cycle, organizations are unable to fully understand the direction of change in the technology, and potential market demand is still underdeveloped (Kaplan & Tripsas, 2008; Suarez, 2004). Therefore, firms' technology sourcing is embedded in an environment characterized by rising degrees of technological and market uncertainty. New firms and established firms enter the market with a variety of product configurations, and they make minor contributions to technological progress and productivity growth (Klein, 1977). Effect uncertainty declines as firms become more aware of the impact of the technological change on their organization. This process is linked to what Suarez (2004: 11) refers to as the "creating the market" phase.

In addition, the variety of technology configurations determines the possible solution spaces for organizations. The more firms in a market limit the possible solution spaces, the less response uncertainty is salient (St. John et al., 2003). As firms develop different technology configurations, users’ preferences about the technology are framed (Kaplan & Tripsas, 2008). Hence, different technologies (and firms) compete to produce the dominant design, leading to rising degrees of competitive uncertainty. Simultaneously, firm specific sources of uncertainty surrounding the effect of the technological change and possible response options decrease.

As firms involved in the sourcing transaction are unable to resolve exogenous sources of uncertainty on their own, they will turn to hybrid forms of governance at this stage of the technology life cycle. Hybrids may be viewed as a growth option because they allow focal firms to gain exclusive access to important suppliers and resources (Klein, 1977) that may not only be supportive in actively shaping the environment (e.g., Jia, 2018) but also foster a competitive advantage (e.g., Carson & John, 2013). For example, Utterback and Suarez (1993) find that firms that are able to adapt and reshape their organizational structures are most likely to survive and succeed in the early stage of the technology life cycle. In this respect, hybrid forms of governance may also be considered a follow-on investment in an option.

Hybrids are characterized by shared authority because firms mutually invest in activities and structures that facilitate knowledge and information sharing (Teece, 1992). Shared authority allows for more control over the resolution of exogenous sources of uncertainty than individual or fully independent authority. It also enables the active shaping of the environment. Shared authority supports common categorization of a specific technology (e.g., Weber & Mayer, 2014). Through common categorization, firms may create a mutual understanding of a technology (Argyres, 1995) and, as a consequence, actively shape the selection of a dominant design by creating a joint potential solution space (Kaplan & Tripsas, 2008; Warner, Fairbank, & Steensma, 2006). For example, organizations may combine resources to lobby for a specific technology (e.g., Jia, 2018).

While hybrid forms of governance create more administrative costs (e.g., from constant monitoring of suppliers’ behavior) than market-based forms, their inherent flexibility outweighs this drawback (Folta, 1998). Although organizations invest in an option through the formation of hybrid structures (e.g., Santoro & McGill, 2005), they

still maintain the option to reverse their commitment (e.g., through flexible contract durations or exit clauses). In contrast, technology sourcing under a hierarchy creates a commitment that reduces the organization's ability to abandon an option when a variety of technological configurations is still present, especially when a sourcing firm bets on a technology design that later fails (e.g., Eggers, 2012). However, the benefits of hierarchy increase as firms converge on a dominant technological design, such that exogenous sources of uncertainty decrease.

Moreover, hybrids foster information exchange, which enables firms to update their knowledge of competitor, market, and technology developments (e.g., Helper, 1991; Warner et al., 2006). Organizations are likely to reach out to established suppliers (e.g., suppliers they worked with in the past) to gain faster access to technologies and to access expertise located beyond their boundaries (Robertson & Gatignon, 1998), especially when the sourcing organization has weak technological capabilities (Jacobides & Winter, 2005; Mayer & Salomon, 2006; Warner et al., 2006).

Hybrid governance can take many forms that account for different levels of flexibility. At the beginning of the era of ferment, organizations are still confronted with rising degrees of exogenous sources of uncertainty, which lead them to seek higher levels of reversibility and independence. This need decreases as exogenous sources of uncertainty subside and the technology moves towards a dominant design that firms want to fully exploit.

More specifically, the more the variety in technological configurations decreases and moves towards a common design, thereby decreasing the degree of exogenous uncertainty, the more firms move from hybrid forms of governance that are similar to market-based forms of governance (e.g., strategic alliances) toward hybrid governance structures that are closer to hierarchies (e.g., equity investments, joint ventures). This is because hybrid forms of governance become subject to contractual hazards that are more easily mitigated by more hierarchical hybrid governance forms. Thus, when hybrid governance forms become subject to contractual hazards giving rise to endogenous sources of uncertainty, especially when asset co-specialization is high (e.g., Santoro & McGill, 2005), firms will prefer hybrid governance forms that are closer to hierarchies to economize on the transaction costs resulting from rising administrative costs (e.g., close monitoring of suppliers' behavior). In this "decisive battle" (Suarez, 2004: 11)

prior to technological dominance, hybrids are increasingly ineffective because they are more bureaucratic than hierarchical forms of governance.

The more an organization moves towards a hierarchy-related hybrid form of governance, the more a technology frame (and, thereby, a potential solution space) is aligned, accepted, and diffused to the transacting partner (see Weber & Mayer, 2014). However, because hybrid governance entails administrative and dissolution costs (e.g., Folta, 1998; Kogut, 1991), firms may not evolve through all structures of hybrid governance.

In summary, while hybrids may not fully resolve exogenous sources of uncertainty during the initial stage of the technology life cycle, they are the most effective in mitigating its effects by providing the opportunity to sequentially invest in different technology options. Hybrids allow firms to gain more direct and faster access to a technology, to sequentially invest, and to deepen relationships with existing partners and, thereby, update their knowledge base and exchange information. This, in turn, supports the alignment of technology frames and, thus, the shaping of a dominant design (Kaplan & Tripsas, 2008).

Markets do not represent viable alternatives to hybrids, as market attributes do not represent growth options that allow for implicit knowledge sharing. Nevertheless, knowledge sharing is required to resolve exogenous sources of uncertainty because it allows for joint technology development that, in turn, helps firms actively shape a technology’s life cycle. Therefore, to resolve exogenous sources of uncertainty, organizations require both flexibility and the ability to share knowledge.

Later phase: Era of dominant design and retention

After a dominant design has been selected, firms in the industry that adopted that design move into an era of incremental change (Anderson & Tushman, 1990; Kaplan & Tripsas, 2008). This era is characterized by low degrees of competitive, market, and technological uncertainty (St. John et al., 2003) because the dominant design has achieved widespread market acceptance. Therefore, new entrants have an incentive to converge (Utterback & Suarez, 1993). While the intensity of competition remains high, the ability to predict competitors’ behavior improves because competitors are well-known and established. Furthermore, with the emergence of the dominant design, effect and response uncertainty decrease to full resolution. Consequently, only minor

incremental changes occur during this period of stability (Anderson & Tushman, 1990; Gersick, 1991; Utterback, 1994).

When the dominant design has been selected, firms have an increasing need for swift strategic decisions (Eisenhardt, 1989a) and commitment (McGrath, 1997; Toh & Kim, 2013) because they wish to exploit the dominant design. This give rise to behavioral uncertainty in the exchange, especially when asset co-creation is asymmetrical (Santoro & McGill, 2005). Thus, sourcing organizations are faced with an increasing need to monitor suppliers' behaviors, which gives rise to administrative costs.

Furthermore, while trust may enforce relational governance in hybrid structures (e.g., Dodgson, 1993), it makes the prospects for opportunistic behavior salient in this stage (Langfred, 2004; Skinner, Dietz, & Weibel, 2014). Therefore, the perceived risk of betrayal increases (Jones & Burdett, 1994; Shapiro, 1987). Thus, partner and task uncertainties will be particularly prominent after the dominant design emerges and exogenous sources of uncertainty decrease.

As these sources of uncertainty are endogenous to the transaction, firms will be inclined to internalize technology sourcing and, thereby, reduce the threat of opportunism and the potential for conflict. The sourcing firm can internalize the transaction by acquiring the supplier. The full authority associated with hierarchies allows for faster strategic decision making (e.g., Eisenhardt, 1989a), which fosters higher levels of productivity, lowers costs, and helps optimize the exchange (e.g., Abernathy & Utterback, 1978). This may be achieved through a closer linkage between technology sourcing and the production system (St. John et al., 2003). The need for flexibility is no longer an issue because the dominant design significantly reduces the exogenous sources of uncertainty that nurtured the organization's need for reversibility. Hence, organizations are ready to commit to and execute a previously generated option.

Hierarchies offer the advantage that knowledge and information can more easily flow between the transacting parties (Warner et al., 2006). Prior studies show that the transfer and exploitation of internal knowledge is easier than the transfer and exploitation of externally acquired knowledge (Cohen & Levinthal, 1990; Pisano, 1990; Zander & Kogut, 1995). This is important because it enables the sourcing organization to assemble and quickly access all relevant knowledge surrounding the technology in order to fully exploit the dominant design. For example, sourcing organizations may

want to create tighter linkages between the producing unit and the sourcing unit when internalizing a transaction.

In addition, conflicts can be settled more efficiently through the managerial fiat inherent in hierarchies (Williamson, 1991). For example, Weber and Mayer (2014) argue that shared frame elements in a firm-internal exchange ease conflict resolution. In this stage, organizations seek long-term contractual relations, a key attribute of hierarchies, in order to exploit the dominant design.

Therefore, in later stages of the technology life cycle, firms will internalize technology sourcing because doing so allows for control over endogenous sources of uncertainty. Markets and hybrids do not represent viable alternatives because their attributes do not allow for full control over the transaction and, thus, endogenous sources of uncertainty because they are characterized by less effective conflict-settlement mechanisms that may be time consuming and, thus, hinder the exploitation of the dominant design.

Reorientation phase: Era of technological discontinuity

The era of technological discontinuity emerges as a result of exogenous shocks or environmental jolts (Barney, 1991; Dosi, 1991; Meyer, 1982) caused by an industry incumbent, a new entrant, or other external factors, such as economic, political, or ecological conditions (St. John et al., 2003). Exogenous shocks in the context of a technology life cycles induce shifts in technology. When an exogenous shock occurs, firms are likely to be aware that a disruption is happening but unaware of the direction of that disruption. Moreover, they may be unable to assess whether the disruption will affect them. Thus, organizations will face high degrees of effect uncertainty when an exogenous shock occurs. Response uncertainty will be equally salient because disruptions may create pressure on organizations to act. However, firms may be unable to predict potential solution spaces or their utility due to constraints within their organizations (Milliken, 1987).

As organizations become accustomed to low degrees of exogenous sources of uncertainty during the period of stability and are able to control endogenous sources of uncertainty, they often struggle to anticipate exogenous shocks (St. John et al., 2003; Meyer, 1982), especially shocks that might threaten their business (Utterback, 1994). Organizations may even ignore new technologies, particularly in the very early stages

following an exogenous shock, because those technologies do not fit their collective frame (Kaplan & Tripsas, 2008) or are cognitively distant (Gavetti, 2012). For example, Tripsas and Gavetti (2000) found that while Polaroid pursued large-scale technological advances, its belief in the razor/blade business model delayed its commercialization of the digital-photography technology.

Thus, effect and response uncertainty are particularly salient following exogenous shocks. High degrees of effect and response uncertainty hamper firms' abilities to react because they need time to conduct opportunity and threat analyses and to determine the most effective strategic responses. Milliken (1987) argues that under high degrees of effect uncertainty, organizations often adopt a "wait-and-see" (McGrath et al., 2004: 97) approach, because "just as an owner of a house is not likely to make any move to protect his/her house or self from a pending hurricane unless he/she is fairly certain that the hurricane might, in fact, inflict damage" (p. 140). In addition, organizations are constrained by their prior strategic choices, such as the adoption of hierarchy-based governance, because certain structures cannot be easily dissolved and, therefore, limit the ability to change (DiMaggio & Powell, 1983).

As firms begin to analyze threats and opportunities after an exogenous shock, the degree of effect and response uncertainty decreases, creating an opportunity for adaptation. Following an exogenous shock, firms may adapt through existing structures or they may establish a new business unit separate from the mainstream business to address the new realities, especially when new technologies destroy competences (Pisano, 1990). For example, Noda and Collis (2001) observed that telecommunication companies in the U.S. spun off cellular operations in the early 1990s to expand the new business and keep it independent of the old.

Due to high degrees of firm specific sources of uncertainty following an exogenous shock, firms are likely to seek market-based forms of governance for technology sourcing. Markets allow for independent authority and non-binding exchange. As firm specific sources of uncertainty can only be resolved through the actions of that firm, shared authority or full authority over the transaction are not viable ways of mitigating these sources of uncertainty. Therefore, organizations will likely start building different option spaces through initial (transaction-specific) investments, as they are unable to understand whether and how a technological discontinuity will affect them and how to appropriately respond. Thus, firms may conduct "trial-and-error"

searches to investigate effects and potential response options. This phase is similar to what Suarez (2004: 11) labels "research and development (R&D) build-up." In this respect, markets cater to firms' needs for reversibility. For example, firms may experiment with different prototypes offered by suppliers in an attempt to determine a response to an exogenous shock (e.g., Tripsas & Gavetti, 2000). Such knowledge is often safeguarded by means of isolating mechanisms in the contract, such as patents, copyright, or trademarks (Alvarez & Barney, 2004; Rumelt, 1984). Due to the independent and less formalized nature of the transaction, markets are suitable for transferring explicit, codifiable knowledge (Van de Vrande et al., 2006).

Prototyping may also mitigate initial market uncertainty because it can provide insights into users' preferences and the functionality of the technology. As a result of these experiments, firm specific sources of uncertainty decrease because the extent of the exogenous shock's effect on the organization becomes more certain and initial technological configurations emerge as potential solution spaces (e.g., in the form of a technology concept or prototype).

A technology-sourcing firm will likely reach out to suppliers outside its existing network. This is similar to the concept of exploration (Beckman et al., 2004). Exploration is associated with increasing the scope of opportunity and, thus, the potential upside of an investment (McGrath & Nerkar, 2004). New suppliers allow firms to expand their existing knowledge, access new resources, and depart from prevailing practices (Beckman et al., 2004; McGrath & Nerkar, 2004; Powell, Koput, & Smith-Doerr, 1996). Full information disclosure by a partner is not required because firms can obtain relevant information (e.g., on prices of a new technology) through market exchange (Helper, 1991) and through observation of competitors' behaviors in the market (e.g., Dobrev, 2007; Noda & Collis, 2001).

When a technology moves towards a new era of ferment and into a phase of "market feasibility" (Suarez, 2004: 11), exogenous sources of uncertainty increase because a number of technological solution spaces emerge and market demand for the different technological options becomes more difficult to predict. Furthermore, new market entrants challenge the market positions of incumbents, thereby increasing competitive uncertainty. As this trend continues, firms become increasingly likely to engage in hybrid forms of governance because hybrids allow firms to actively shape their environment by co-specializing in options.

Hierarchies would not represent viable forms of governance following exogenous shocks. This is because their structure does not allow for the independence and reversibility required to mitigate effect and response uncertainty.

Example: Daimler's battery technology sourcing for electric vehicles (2009-2018)

Throughout the late 1990s and 2000s, automobile manufacturers around the globe were confronted with new environmental regulations that forced them to reduce fleet emissions. In particular, large markets, such as China and Europe, were pushing towards tighter regulations. In response, various options for powering vehicles evolved, including ethanol, biodiesel, propane, liquefied or compressed natural gas, hydrogen, solar, steam, and electricity (Alpers & Ambos, 2017). The latter technology began to evolve as a particularly viable solution space around the year 2010 and an increasing number of automobile manufacturers invested in the technology, including Germany's Daimler.

In January 2009, the U.S. electric-vehicle manufacturer Tesla and Daimler announced a strategic partnership in which Tesla would supply lithium-ion batteries for Daimler's electric Smart model. Tesla had previously served as a supplier of batteries and charging systems for that model (Fehrenbacher, 2016). While automakers had traditionally only internalized the integration of powertrains and sourced the technology from their Tier 1 suppliers, they now increasingly moved into cell and module production as well as pack assembly by means of hybrid structures (e.g., strategic partnerships and joint ventures) (The Boston Consulting Group, 2009).

Despite the high degree of technological uncertainty regarding the further development of batteries for electric vehicles and electricity as a mean to power vehicles, the two companies agreed on a strategic partnership. A few months later, Daimler purchased 10 percent of the equity in Tesla. As one member of Daimler's management board said: "The first priority was to find the quickest and most straightforward solution" (Lamonica, 2009). Later that same year, Daimler established a joint venture, Accumotive, with the German specialty chemicals company Evonik to produce lithium-ion batteries. At this time, the lithium-ion battery industry was still in the ferment stage with five principal lithium-ion technologies competing for dominance (The Boston Consulting Group, 2009).

In 2014, Daimler sold its stake in Tesla and announced that it would produce its own batteries with Accumotive. To do so, Daimler purchased the remaining equity stake of Evonik to make Accumotive a wholly owned subsidiary. At the same time, Daimler disclosed that it would create its own electric vehicle concept under the EQ brand. The company expected to have the first cars in production by 2019/2020. Lithium-ion battery technology had advanced by this point in time increasingly giving rise to a dominant design. For example, the technology allowed for longer distances to be travelled without recharging—Nissan’s electric vehicle Leaf advanced from a single-charge range of 200 kilometers in 2010 to more than 400 kilometers in 2017 (Nissan, 2018).

Furthermore, electric vehicles had been established as relevant for automakers, thereby reducing effect and response uncertainty to such an extent that Daimler’s CEO Dieter Zetsche proclaimed: “The emission-free automobile is the future. And our new EQ brand goes far beyond electric vehicles” (Daimler, 2018). From 2014 to 2018, Daimler announced a new generation of fully electric Smart models, opened a second production plant for lithium-ion batteries within its Accumotive subsidiary, and fully integrated developers of battery technologies into its core workforce.

This brief example demonstrates how Daimler sequentially invested in the lithium-ion battery technology as the technology evolved following increasing pressure to develop sustainable modes of transportation (Alpers & Ambos, 2017). While Daimler initially sourced the battery technology from new entrant Tesla, it quickly extended the partnership to hybrid forms (strategic partnership, equity investment) and a joint venture with Evonik as varieties of the new technology emerged. As the lithium-ion battery technology matured, Daimler internalized the transaction and started assembling battery modules in-house through its subsidiary Accumotive.

3.4. Discussion

This article explores why and how organizations change the governance of technology sourcing over the course of a technology life cycle and their choice of partners during each stage. It offers a contingency model of governance choice and partner selection, which demonstrates that firms adapt technology sourcing over the course of a technology’s life cycle based on the degree and source of uncertainty that they face, assuming that asset specificity is present to a non-trivial degree.

During the early phase of the technology life cycle, organizations govern technology sourcing through hybrid structures because hybrids enable firms to benefit from flexibility on the one hand and knowledge sharing on the other in the face of exogenous sources of uncertainty. In this respect, hybrids are likely to be created with suppliers with which firms have previously worked or that are within their existing networks. When a dominant design emerges, organizations are likely to internalize the sourcing transaction because the resulting hierarchy allows for direct control over the transaction through a single authority and, thereby, mitigates endogenous sources of uncertainty, which are most salient during this phase. After an exogenous shock, firms face high levels of firm specific uncertainty. As a consequence, they seek market-based forms of governance for technology sourcing because markets cater to their need for reversibility, and enable them to seek out novel knowledge and information without requiring a commitment to a technology option.

Our theoretical discourse contributes to the literature in several ways. Our study sheds light on how organizations govern technology sourcing (e.g., Folta, 1998; Pisano, 1990; Santoro & McGill, 2005) and provides insights into likely partners (e.g., Beckman et al., 2004; Hoetker, 2005) throughout a technology's life cycle. Prior research in this field has mainly discussed organizations' product and process choices in each stage of the technology life cycle (e.g., Abernathy & Utterback, 1978; Hayes & Wheelwright, 1979a & 1979b; St. John et al., 2003). Our research adds to this perspective by showing how firms adjust their boundaries in response to technological change. In this regard, we integrate findings from TCE, ROT, and network theory. While each of these theories has enhanced our understanding of how organizations respond to different sources of uncertainty, none of them are sufficient on their own to explain how the complex dynamics underlying technology life cycles influence the governance of technology sourcing or supplier choice. However, drawing on these different theoretical perspectives improves our understanding of how organizations adapt sourcing structures to changes in the degrees and sources of uncertainty over time.

In this respect, our study suggests that, contrary to traditional TCE reasoning (e.g., Williamson, 1991), markets and hybrids are suitable for mitigating high degrees of firm specific uncertainty and exogenous sources of uncertainty, respectively (e.g., Santoro & McGill, 2005; Weber & Mayer, 2014). This is because markets allow for high reversibility and (explicit) knowledge exchange with new network partners in the face of effect and response uncertainty. While our research focuses on vertical hybrids,

firms may also introduce horizontal hybrid forms to expand technological capabilities and reduce competition in response to exogenous sources of uncertainty (e.g., Burgers, Hill, & Kim, 1993).

Furthermore, prior studies on technology sourcing mainly focused on single transactions (e.g., Folta, 1998; Pisano, 1990; Robertson & Gatignon, 1998; Santoro & McGill, 2005). In contrast, our research embeds technology sourcing in the broader context of technology life cycles, and explores how governance and supplier choice change given different contingencies of the exchange during the various stages of the technology life cycle. Thereby, we respond to calls for more research into the evolutionary mechanisms that drive firm and industry structures (Jacobides & Winter, 2005). This view complements extant static perspectives drawing on TCE, ROT, or network theory. A failure to take timing into account when assessing the governance of technology sourcing may lead researchers to erroneously analyze sources of uncertainty that are less salient during a specific stage of the technology life cycle. Hence, our evolutionary perspective can help future research focus on the sources of uncertainty that are most pressing for organizations at specific stages of the technology life cycle, and assess their effects on governance and partner choice.

In addition, we introduce effect and response uncertainty (Milliken, 1987) to real option theory. We suggest that when firms face effect and response uncertainty, they will seek even more flexibility in their investment choices than when they face exogenous sources of uncertainty. While exogenous sources of uncertainty cannot be resolved by a single firm, effect and response uncertainty arise from a firm’s inability to anticipate how its customers, competitors, and institutional forces will shape its future and to respond appropriately (Miller & Shamsie, 1996). Thus, these sources of uncertainty are directly related to exogenous sources of uncertainty. However, instead of struggling to predict the direction of change, organizations may be hampered in their opportunity and threat categorization process. The extent to which this is the case depends on the capabilities and skillset of the firm’s management (Miller & Shamsie, 1999), which may affect the processes of option identification and creation (Helfat & Peteraf, 2015; Milliken, 1987; Trigeorgis & Reuer, 2017). Thus, depending on the degree of effect and response uncertainty, some organizations may be able to identify shadow, or hidden, options (Bowman & Hurry, 1993) that could create opportunities in the future (Trigeorgis & Reuer, 2017), while others may fail to do so (Helfat & Peteraf, 2015).

Our study also suggests that governance helps in network creation (see Pfeffer & Salancik, 1978), and in exploring and exploiting (March, 1991) partners' knowledge and information. While prior research in network theory has discussed *why* firms leverage or extend their existing networks (e.g., Hoetker, 2005), and in relation to the source of uncertainty that organizations are confronted with (e.g., Beckman et al., 2004), our research provides insight into *how* they may do so (e.g., Gulati, 1998). For example, firms may gather explicit knowledge about a technology through market exchange, or adopt hierarchical governance to allow for implicit and explicit knowledge sharing (e.g., Folta, 1998).

More broadly, our work emphasizes the need to distinguish among different sources of uncertainty in order to better understand how firms adapt to environmental change (e.g., Chakravarthy, 1982; Ginsberg, 1988; Lengnick-Hall & Beck, 2005; Zajac & Kraatz, 1993). By distinguishing among different degrees of exogenous, endogenous, and firm specific sources of uncertainty, we specify the locus of uncertainty that is most salient during each phase and suggest likely organizational responses to different states of the environment. For example, our research suggests that, following jolts (Meyer, 1982), organizations will choose market governance for technology sourcing because effect and response uncertainty will be highly salient (St. John et al., 2003). Market governance enables firms to reach out to new suppliers in order to update their knowledge base. This can be seen as a form of robust transformation (Lengnick-Hall & Beck, 2005) because firms do not seek out equilibrium. Instead, they temporarily adapt to the contingencies they face following a jolt.

Our study also has several limitations that hold potential for future research. First, a logical step for future research would be to validate our theorizing. For example, the ideas presented here can be examined in a field study that follows organizations' external technology sourcing projects through interviews undertaken at different stages of the technology life cycle. Ideally, such a study would follow a firm's technology sourcing starting with the ferment phase of a technology in a fast-moving industry to allow for reasonable data-collection time frames. This would enable scholars to assess the different degrees and sources of uncertainty that organizations experience as most salient (see, e.g., Ashill & Jobber, 2010, for a questionnaire), and to study the effects on governance and supplier choice. Alternatively, historical data on different technology-sourcing projects could be used (e.g., Miller & Shamsie, 1999).

Second, our study assumed the emergence of a dominant design in the technology life cycle. However, some studies on technology life cycles (e.g., Kaplan & Tripsas, 2008; St. John et al., 2003) argue that a dominant design does not always emerge, which could prolong the era of ferment and the organization’s need for flexibility. Therefore, hybrid governance forms may prevail until a dominant design emerges. Moreover, even when a dominant design emerges, other technological varieties may continue to exist in certain market niches. This may increase firm specific sources of uncertainty because firms will struggle to predict when to converge on the dominant design (St. John et al., 2003). This could create tension between the firm’s need to remain flexible should it reject the dominant design and the pressure to commit should it adopt that design.

Third, we did not explicitly theorize on the effects of asset specificity, as we assumed it was present to a non-specific degree. Moreover, we held transaction frequency constant. Future studies may want to relax these assumptions in order to assess their interaction effects with different sources of uncertainty. For example, higher asset specificity in the early stages of the technology life cycle may increase the endogenous sources of uncertainty that organizations face because higher unilateral asset specificity increases the threat of opportunism (Williamson, 1985). Therefore, a sourcing firm may move to hierarchy more quickly than proposed by our argumentation. At the same time, the frequency with which transactions are conducted may create opposing pressures because frequent transactions may establish trust in the exchange partner and, thereby, lower endogenous sources of uncertainty (e.g., Gulati, 1998). As a consequence, organizations may maintain hybrid governance forms longer than predicted by our model. However, a high frequency of exchange during the later phase of the technology life cycle may strengthen the relation between endogenous sources of uncertainty and hierarchy because hierarchy does not need to be attended to continuously (Williamson, 1985).

Fourth, firm-level and partner factors, such as capabilities (e.g., Jacobides & Winter, 2005; Williamson, 1999), prior experience in technology sourcing (e.g., McGrath & Nerkar, 2004; Steensma & Fairbank, 1999), partner similarity in primary business fields (e.g., Folta, 1998), relevant technological knowledge held by the partner firm (e.g., Warner et al., 2006), sourcing-firm location (e.g., Pisano, 1990; Trigeorgis & Reuer, 2017), and the sharing of rights to products developed in the sourcing transaction (e.g., Carson & John, 2013), may also play important roles because they may lead to earlier movement towards hierarchy than suggested by our model. For example, a firm

that has prior experience with joint ventures may move towards hybrid structures more quickly (e.g., Robertson & Gatignon, 1998). Similarly, industry structures may influence governance and partner selection. Industries that are characterized by a small number of suppliers (see Williamson, 1975) may experience increased competition for resources and, consequently, faster internalization of suppliers (e.g., Pisano, 1990).

3.5. Conclusion

The sourcing choices firms make given different contingencies in the exchange remain one of the core issues in strategic management research. Our study explored how organizations adjust their governance and partner choices in technology sourcing over the course of a technology's life cycle. Our theorizing, which drew on different theoretical perspectives, highlighted the role of different degrees and sources of uncertainty in shaping organizational responses throughout a technology's life cycle. Our hope is that our findings will spark additional scholarly work that integrates different research streams to explore the interplay among changing degrees and sources of uncertainty underlying dynamic processes.

4. Amplifying uncertainty: Escaping the lemming's principle – Perception and reasoning capabilities in strategic decisions to deviate from the main field of competitors[11]

Abstract:
When do strategic decision-makers follow their competitors and when do they deviate? While prior work in this the management and psychology literature has focused on social and cognitive pressures as well as framing of the decision situation as influencing factors on this strategic decision, we focus on the nature of strategic decision-makers' underlying mental activities. Building on prior work in managerial cognitive capabilities theory, we argue that the strategic decision to follow or deviate from competitors is contingent on how strategic decision-makers perceive uncertainty and on the way in which they reason. Thereby, our analysis suggests that when strategic decision-makers perceive less controllable sources of uncertainty and when the reason sensibly, the likelihood of them taking the strategic decision to deviate from the direction of their competitors increases. By contrast, when strategic decision-makers perceive more controllable sources of uncertainty and reason protectively, the likelihood for strategic decisions to follow competitors rises.

Key words: Uncertainty, strategic decisions, managerial cognitive capabilities, perception, reasoning

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4.1 Introduction

Whether to follow or deviate from the general direction of competitors represents a key strategic decision that managers have to take (Dean & Sharfman, 1996; Dobrev, 2007; Greve, 1998; Ross & Sharapov, 2015). Strategic decisions are managerial choices that (re)allocate resources, set important precedents, and shape a firm's general direction (Eisenhardt, 1989a; Fredrickson, 1984; Judge & Miller, 1991; Mintzberg et al., 1976; Mitchell et al., 2011; Nadkarni & Barr, 2008; White, 1981).

The strategic decision to deviate from competitors is argued to be particularly challenging because it takes place under conditions of uncertainty (Schwenk, 1984; Thompson, 1967). Uncertainty refers to "an individual's perceived inability to predict something accurately" (Milliken, 1987: 136) stemming from a lack of confidence in one's knowledge to resolve a decision-situation (Duncan, 1972; Lipshitz & Strauss, 1997). Because it can induce negative emotions, such as stress, doubt, and anxiety (Kiefer, 2005; Lipshitz & Strauss, 1997; McKenzie et al., 2009), as well as adverse performance effects (Michel, 2007; Miller, 1992), uncertainty represents a central challenge in strategic decisions.

There are different theoretical perspectives on why strategic decision-makers would choose to follow the direction of their competitors. These perspectives share the view that strategic decision-makers, when surrounded by peers, become subject to different social and cognitive pressures, such as conformity and legitimization pressures that lead them to herd (e.g., Banerjee, 1992; Dobrev, 2007; Hirshleifer & Teoh, 2003; Olusoga, Mokwa, & Noble, 1995; Olzak & Uhrig, 2001).

Yet, oftentimes, despite these pressures, strategic decision-makers deviate from the direction of their competitors. Prominent examples include, Volvo CEO's strategic decision to only produce electric vehicles from the beginning of 2019 onwards while other incumbents in the automobile industry decided to step-incrementally change propulsion systems (Ritchie, 2017) or Warren Buffett's refusal to invest in technology stocks with Berkshire Hathaway, while other fund managers invested heavily throughout the 1990s (Schroeder, 2008).

One potential explanation for this lies in behavioral decision theory under uncertainty (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Absent social and cognitive pressures, this stream of research suggests that individuals are more likely to deviate from competitors when they expect a gain vis-à-vis their current situation

(Kahneman & Tversky, 1979). Similarly, when strategic decision-makers are confronted with a potential loss, they will seek to maintain the status quo (e.g., Bateman & Zeithaml, 1989, Fishburn & Kochenberger, 1979; Kahneman & Tversky, 1979; Laughhunn, Payne, & Crum, 1980; Tversky & Kahneman, 1992, 1986). Yet, while this perspective has contributed invaluably to our understanding of when some individuals are more likely to deviate from their competitors, it left open the question of *why* some individuals sense gains (or losses) while others do not. Furthermore, because this stream of research analyzed decisions of isolated individuals, it does not discuss *how* strategic decision-makers manage to overcome social and cognitive conformity pressures resulting from the presence of their peers (e.g., Dobrev, 2007; Olzak & Uhrig, 2001).

Therefore, a different line of thought that may reconcile these divergent theoretical perspectives lies in managerial cognitive capabilities theory. The managerial cognitive capabilities literature suggests that differences in strategic decisions stems from heterogeneity in strategic decision-makers' cognitive capabilities (Gavetti, 2012; Helfat & Peteraf, 2015; Kaplan, 2008a). A managerial cognitive capability refers to "the capacity of an individual manager to perform one or more of the mental activities that comprise cognition" (Helfat & Peteraf, 2015: 835). Thus, because managerial cognitive capabilities are distributed heterogeneously among individuals (Adner & Helfat, 2003; Gavetti, 2012; Helfat & Peteraf, 2015), some strategic decision-makers, due to their cognitive capabilities, shape the direction of their firm differently than others.

Building on this prior work, our study seeks to answer the following research questions: (1) Which managerial cognitive capabilities make strategic decision-makers follow or deviate from the general direction of competitors? And, (2) how do strategic decision-makers' cognitive capabilities influence their strategic decisions to follow or deviate from competitors?

Hence, the purpose of this study is to explore the nature and differences in managerial cognitive capabilities underlying the strategic decisions to follow or deviate from the general direction of competitors. Our central thesis is that strategic decisions differ because they are based on distinct managerial cognitive capabilities. This perspective entails that despite managerial cognitive capabilities being distributed heterogeneously among individuals, they may exhibit commonalities. Consequentially, shared patterns (cf. Eisenhardt & Martin, 2000) of mental activities that underlie specific strategic decisions may be identified.

We study our research question in the context of professional sailing races, the Volvo Ocean Races 2014-15 and 2017-18. Professional sail races represent an ideal context because they provide us with the opportunity to study strategic decisions within shorter time frames compared to other business settings. Through within and cross-case analysis at the decision-level, we study the nature of skippers’ cognitive capabilities underlying strategic decisions to deviate from the general direction of competitors and compare them to those salient in strategic decisions to follow rivals.

Given this context and approach, our research attempts to contribute to literature in several ways: First, our study speaks to the literature discussing the role of cognition in strategic decision-making (e.g., Daft & Weick, 1984; Kaplan, 2008a; Nadkarni & Barr, 2008). By exploring the nature of managerial cognitive capabilities, we specify how strategic decision-makers’ mental activities account for differences in their strategic decisions. And second, we contribute to the literature on managerial cognitive capabilities (e.g., Adner & Helfat, 2003; Gavetti, 2005; Helfat & Peteraf, 2015) by investigating the specific nature of managerial cognitive capabilities that drive differences in strategic decisions. This may enable managers to develop cognitive capabilities that help them to take more effective strategic decisions.

4.2. Background

Prior research already demonstrated that uncertainty plays a central role in decision situations (e.g., Cyert & March, 1963; Festinger, 1954; Pfeffer, Salancik & Leblebici, 1976; Thompson, 1967). Haunschild (1994: 408) acknowledged that “there are probably few situations, […] in which absolutely no uncertainty exists” underlining the centrality of uncertainty in every decision-situation.

Previous studies on behavioral decision-making under conditions of uncertainty (e.g., Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) found that individuals tend to think of a decision in terms of gains and losses vis-à-vis a reference point that may be the status quo (Levy, 1992). Hence, individuals tend to evaluate decision situations in terms of changes of wealth rather than absolute values (Kahneman & Tversky, 1979).

According to this perspective, strategic decision-makers should be particularly prone to deviate from their competitors’ direction when they expect a gain vis-à-vis a reference point (cf. Kahneman & Tversky, 1979). Similarly, the literature discusses the

effect of loss aversion (Tversky & Kahneman, 1992, 1986). Loss aversion leads strategic decision-makers to prefer inaction to action and maintenance of the status quo to change (Kahneman, Knetsch, & Thaler, 1991; Samuelson & Zeckhauser, 1988; Tversky & Kahneman, 1991). This is because other decision alternatives are misevaluated overestimating their potential for losses (e.g., Kahneman & Lovallo, 1993). As a consequence, strategic decision-makers pursue a similar direction to competitors in an attempt to reduce uncertainty surrounding the strategic decision. Prior research termed uncertainty reduction a "fundamental need" (Hogg & Mullin, 1999: 253), and a form of control (Case et al., 2004; deCharms, 1968; White, 1959), and therefore the primary guiding principal of human behavior. Hence, strategic decision-makers may only depart from their natural tendency to reduce uncertainty inherent in every decision situation (cf. Haunschild, 1994) when they expect a gain.

In a competitive context, this has two implications: First, strategic decision-makers should be more likely to deviate from their rivals, the more they are lagging behind (i.e., from market leadership). Inverted, this means that the more a strategic decision-makers is ahead of the competition, the less likely that strategic decision-maker will branch out from a reference group. And second, when promised higher rewards (e.g., through incentives), strategic decision-makers should be more likely to deviate from the direction of their competitors.

Yet, while this perspective specifies when some strategic decision-makers should be more likely to deviate from the general direction of their competitors, it leaves open the questions of *why* some strategic decision-makers sense gains or losses (e.g., Dutton & Jackson, 1987), while others do not. Furthermore, *how* do they overcome social and cognitive pressures from their peers (e.g., Dobrev, 2007; Greve, 1998), negative emotions (e.g., Kiefer, 2005; Lipshitz & Strauss, 1997; McKenzie et al., 2009), as well as uncertainty-induced tendencies to make prospective options appear less appealing (e.g., Yates & Stone, 1992)?

This suggests that strategic decision-makers' underlying mental activities may play a central role in determining whether strategic decision-makers will follow or deviate from the general direction of their competitors.

Managerial cognitive capabilities underlying strategic decisions

Cognition is an important element in strategic decisions that causes regularity in the choices of individuals and organizations (Greve, 1998). Managerial cognition scholars suggest that bounded rationality prevents strategic decision-makers from developing a complete understanding of their environment (Daft & Weick, 1984). Thus, strategic decision-makers make choices based on their subjective representation of the environment (Adner & Helfat, 2003).

Managerial cognitive capabilities theory is concerned with the study of strategic decision-makers' mental activities. According to this perspective, individuals differ in their ability to perform mental activities comprising cognition (e.g., Helfat & Peteraf, 2015). Thus, managerial cognitive capabilities are distributed heterogeneously among strategic decision-makers leading to differences in resource allocation and consequentially strategic decision content (Barr, Stimpert, & Huff, 1992; Tripsas & Gavetti, 2000; Gilbert, 2006).

Helfat and Peteraf (2015) identified and described several distinct managerial cognitive capabilities underlying individuals' ability to sense and seize opportunities as well as reconfigure organizational resources. Among these are strategic decision-makers' perceptions and the way they reason. These two capabilities are particularly important in shaping strategic decisions (cf. Adner & Helfat, 2003; Gavetti, 2012).

Perception encompasses the "construction of meaningful information about a particular environment" (Gazzaniga, Heatherton, & Halpern, 2010: 180) that help in identifying patterns in the environment and interpreting data (Helfat & Peteraf, 2015). Therefore, through the mental activity of perception, strategic decision-makers construe a reality on which they base their strategic decisions. Perceptions enable strategic decision-makers to sense and create opportunities (Baron & Ensley, 2006), or strategic decision option spaces (McGrath, 1997; Trigeorgis & Reuer, 2017). More specifically, depending on how strategic decision-makers perceive uncertainty may affect their ability to identify an opportunity. For example, perception capabilities may support strategic decision-makers in sensing first-mover opportunities for early entry into a market prior to competitors (e.g., Klingbiel & Joseph, 2015; Lieberman & Montgomery, 1988).

Through reasoning, strategic decision-makers then evaluate the information they perceive and draw conclusions for strategic decisions (Adner & Helfat, 2003; Gazzaniga

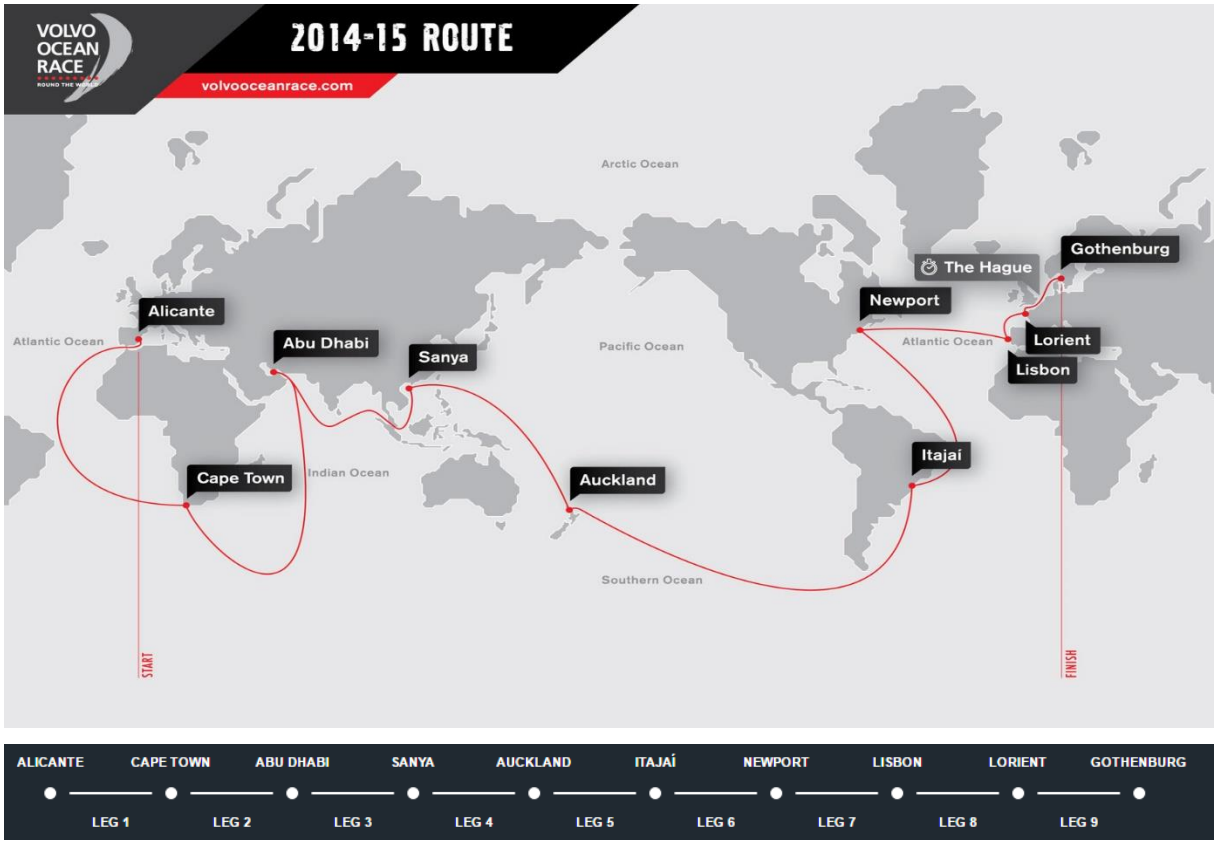
et al. 2010; Helfat & Peteraf, 2015). Thus, the cognitive capability of reasoning may support strategic decision-makers in finding solutions to decision problems (e.g., Colman, 2006; Nadkarni & Barr, 2008). Thereby, individuals rely more on controlled mental processing instead of short-cuts (Stanovich, 2009). Once different strategic decision option spaces have been identified, the cognitive capability of reasoning provides a rationale of why one strategic option should be superior to another. Like other cognitive capabilities, reasoning is heterogeneous among individuals. Thus, depending on how a strategic decision-makers reasons, he or she may be more effective in designing business models and more successful in investment decisions (Helfat & Peteraf, 2015).

In summary, strategic decisions are shaped by how managers perceive and then make sense of changes in their environment (e.g., Child, 1972; Eggers & Kaplan, 2013; Weick, 1995). This suggests that studying how strategic decision-makers perceive uncertainty and then make sense of it may provide insights into our research questions. Thereby, we argue that the managerial cognitive capability of perception informs the capability of reasoning by providing the information available for evaluation. As Knight (1921: 201 emphasis in original) put it "we *perceive* the world before we react to it, and we react not to what we perceive, but always to what we *infer*". Consequentially, despite managerial cognitive capabilities being separate processes (Helfat & Peteraf, 2015), they may interact with one another.

4.3. Methods & data

Our dataset stems from two editions of a head-to-head professional sailing competition, the Volvo Ocean Race 2014-15 and 2017-18. The Volvo Ocean Race (VOR) is one of the world's longest professional sailing competitions taking sailors around the world in nine months. Seven boats with one skipper each participated in the both of the races respectively. Overall, the races are divided into several legs that equal stages of the race sailed continuously (i.e., without an intermediate stop on land to, e.g., fill up supplies and rest). The race starts and terminates in different countries in Europe while stopping on all continents in between. Figure 4-1 provides an overview of the 2014-15 edition route as an example:

Figure 4-1: VOR 2014-15 route and legs (Volvo Ocean Race, 2017)



Study context

Sailing contexts are already well-established in empirical research and have rendered valuable theoretical contributions to management literature (e.g., Boumgarden, et al., 2012; Bouty & Drucker-Godard, 2018; McGrath et al., 2004; Ross & Sharapov, 2015). Hence, there are several reasons why a sailing race also represents an ideal context to develop our theory around managerial cognitive capabilities in strategic decisions:

First, the Volvo Ocean Race is one of the world's longest professional offshore sailing competitions. This offered us two advantages: On the one hand, the duration of the race allowed for a sufficient timeframe to study different occasions where skippers decided to part from the main field of competitors, while others followed competitors. Thus, professional sailing races are characterized by an accelerated pace of decision-situations compared to other business settings, because skippers need to select and adjust the general direction of their boats (i.e., through tacks and gybes)

within short periods of time, sometimes on a daily basis, to sail towards their target destination. And, on the other hand, both races were characterized by the skippers staying close to each other with their boats. This held two advantages for our research: It ensured that all skippers were exposed to the same objective environment to study differences in their cognitive capabilities. And, it allowed us to more easily identify cases of different strategic decisions where skippers decided to part from the fleet.

Second, the context provided us with the opportunity to study the managerial cognitive capabilities of perception and reasoning of highly experienced strategic decision-makers (cf. Heerkens & van der Heijden, 2011; Helfat & Peteraf, 2015), professional sailing boat skippers. As this race is one of the most physically challenging sailing races in the world, participants require ample sailing experience and long-winded training prior to the start of the competition to be able to endure the conditions of this around-the-world race. Skippers participating in the Volvo Ocean Race are highly knowledgeable and skilled in their domain due to prolonged practice and rapid feedback to their judgments (i.e., performance implications against their competitors, speed). Thus, they are likely to command skilled intuition (Kahneman & Klein, 2009). Skippers are the ultimate decision-makers onboard and carry the responsibility for their teams. Thus, their hierarchical position is similar to that of a CEO, a strategic decision-maker, whose perceptional frames are crucial in determining the organization's strategic choices (Gavetti, 2012; Helfat & Peteraf, 2015; Kaplan, 2008a; Knudsen, 2001).

And third, as with other sports, sailing races have pre-defined boundary conditions and rules that are enforced as soon as an incident occurs. Sports offer the advantage of a controlled setting where participants are not being made aware of the context of study. Sport settings allow to eliminate noise created by differences in institutional settings as influencing factors (Holcomb et al., 2009). Hence, the race enabled us to focus on the cognitive capabilities of skippers to their nature in the strategic decision to part from the main field of competitors and to compare them to those of skippers who followed the fleet. Thereby, all participating boats are made of one design and equipped with the same technology. Crew sizes are fixed with a pre-defined age range of participants and maximum crew weight (resource similarity). In addition, skippers are restricted in their information acquisition and supplied with the same information at pre-defined points in time (information symmetry). In this respect, they are not allowed to search for information online or interact with others

outside the race. They only receive position reports on their competitors from Race Control every six hours. Hence, the context of the Volvo Ocean Race eliminated noise created from heterogeneous information and resources from our data.

Furthermore, as the race enjoys public attention around the world through diverse channels, such as live-broadcasting, TV documentaries, and press reports, skippers have an interest in performing well. Not only is winning the Volvo Ocean Race considered highly prestigious among sailors, it may also help skippers obtain future sponsorship for campaigns. These are often based on performance in past races. Thus, all skippers share an aspiration to obtain a podium position.

Tables 4-1 and 4-2 provide overviews of the participating teams and skippers in the race as well as boundary conditions that allowed us eliminate noise in our data analysis.

Table 4-1: Participating boats and skippers in the VOR 2014-15

Boats 2014-15 edition	**Skipper**	**Abbrevia-tion**	**Color**	**Gender**	**Crew size** *(incl. OBR)*	**# of legs won**	**Overall standings** *(based on points)*	**Comment**
Abu Dhabi Ocean Racing	Ian Walker	ADOR	Yellow	Male	9	2	1	
Alvimedica	Charlie Enright	AVIM	Orange	Male	9	1	4	
Brunel	Bouwe Bekking	TBRU	Green	Male	9	2	2	
Dongfeng Race Team	Charles Caudrelier	DFRT	Red	Male	9	2	3	
Mapfre	Iker Martínez*/ Xabi Fernández**	MAPF	White	Male	9	1	4	
SCA	Sam Davies	TSCA	Magenta	Female	12	1	6	*Received 3 additional crew members as an all-female team*
Vestas Wind	Chris Nicholson	VEST	Blue	Male	9	0	7	*Grounded shore during leg 2, only re-entered the race for legs 8 and 9*

** Skipper during legs 1, 2, 5, 7, 9 ** Skipper during legs 3, 4, 6, 8*

Table 4-2: Participating boats and skippers in the VOR 2017-18

Boats 2017-18 edition	Skipper	Abbrevia-tion	Color	Gender	Crew size *(incl. OBR)*	# of legs won	Overall standings *(based on points)*	Comment
Akzo Nobel	Simeon Tienpont	AKZO	Violet	Mixed	10	0	4	
Dongfeng Race Team	Charles Caudrelier	DFRT	Red	Mixed	10	0	3	
Mapfre	Xabi Fernández	MAPF	White	Mixed	10	0	2	
Sun Hung Kai Scallywag	David Witt	SHKS	Grey	Mixed	9	0	5	
Team Brunel	Bouwe Bekking	TBRU	Yellow	Mixed	10	0	6	
Turn the Tide on Plastic	Dee Caffari	TTOP	Blue	Mixed	11	0	7	*Only crew with 50-50 male-female team*
Vestas 11th Hour Racing	Charlie Enright	VS11	Orange	Mixed	10	1	1	

Dataset

We used two main sources of qualitative data from the Volvo Ocean Races 2014-15 and 2017-18 to answer our research questions:

Our dataset encompasses log book entries written by onboard reporters (OBR) sailing with the teams in both editions and skippers, and strategic reviews of each leg written by race experts. Drawing on Miles and Huberman's (1984) suggestions for analyzing data from multiple sources, we triangulated our dataset by numeric data of the Volvo Ocean Race tracker, a tool where boats' positions and courses can be observed at defined intervals and in retrospect, daily blog entries ("tweets") from the boats and the race administration, and video interviews as well as quantitative data from the races, including rankings of the boats at six hourly intervals.

In the Volvo Ocean Race 2014-15 edition, the sailors spent approximately 160 days at sea creating a total of 18 strategic decisions in which skippers decided to part from the main field of competitors whereas the Volvo Ocean Race 2017-18 yielded 19 strategic decisions in which this happened. The Race was characterized by the skippers staying close to each other in both editions. Thus, the rare occasions on where some skippers decided to deviate from competitors represent an ideal context of study to answer our research questions. Table 4-3 provides an overview of the case data:

Table 4-3: Description of the case data

Characteristics	Volvo Ocean Race 2014-15	Volvo Ocean Race 2017-18
Number of strategic decisions studied*	18	19
Number of boats in the race	7	7
Informants	Onboard reporters Skippers Sailors	Skippers Onboard reporters Navigators Sailors
Number of log book entries	156	93
Database	Log book entries Strategic reviews Race rankings Race videos	Log book entries Strategic reviews Race rankings Race videos

** Strategic decision to deviate from the main field of competitors*

Log book entries. We used log book entries by onboard reporters and skippers on a total of seven boats taking part in both, the Volvo Ocean Race 2014-15[12] and the 2017-18[13] edition, to study our research questions. Onboard reporters may be considered "neutral" observers of life onboard. They are part of the crews and day-to-day observe skippers' perceptions and reasoning as well as consequent strategic decisions, which they reflect in log book entries. This allowed an up-close perspective of what happened onboard. Furthermore, while onboard reporters sailed with the crews, they were not permitted to interfere with the racing. They were only allowed to support daily life onboard in terms of cooking, cleaning, pumping water for the sailors and themselves, and preparing meals. Onboard reporters' accounts were created on the day of observation. Therefore, ex-post reasoning and biases are limited. We used the log book entries to identify skippers' strategic decisions to part from the fleet on the one hand, and to analyze the nature of their perceptions and reasoning prior to the strategic decision on the other hand.

Strategic reviews. We triangulated our data from the log book entries with official Volvo Ocean Race strategic reviews by race experts identifying and analyzing key strategic decisions made during each leg of the Race. These accounts helped us in making sure to only include strategic decisions in our dataset where skipper consciously decided to part from the main field of competitors.

Study design

We conducted our data analysis following a two-step approach: We first analyzed the data from the Volvo Ocean Race 2014-15 to develop propositions on the nature of managerial cognitive capabilities using a synthesized strategy approach (Langley, 1999). We contrasted the managerial cognitive capabilities of perception and reasoning of the skipper(s) that deviated from the direction of their competitors with the skippers that followed the fleet's direction. Hence, our unit of analysis is the strategic decision

[12] One team, Team Vestas Wind, in addition to the six boats mentioned, was forced to terminate the race early after the second leg (stage of the race) as their boat was destroyed when hitting a reef due to a navigating error. They re-entered the race in leg 8. Therefore, our dataset for this skipper and his team only comprises legs 1 and 2 as well as 8 and 9.

[13] One team, Team Vestas Wind, in addition to the six boats mentioned, was forced to retire from leg 4 and did not participate in legs 5 and 6 due to an accident with a Hong Kong fishing vessel during leg 4. They re-entered the race in leg 7. Furthermore, Team Scallywag had to retire early from leg 7 due to a man-over-board incidence.

of skippers to leave their main field of competitors compared to strategic decisions of skippers that followed the general direction of competitors in the same decision situation.

Consistent with our interpretative research approach, we relied predominantly on how onboard reporters and skippers (as well as other informants within the different teams, if available) described perceptions and reasoning in the strategic decision skippers took. Interpretative research of these rare accounts provides the researcher with the opportunity to further interpret and structure the information of the informants considering the context and contingencies in which they happened (Corbin & Strauss, 1990). Through the ranking data, we were also able to control for skippers' ranking at the point the strategic decision was made.

We then triangulated the developed propositions based on data collected from the Volvo Ocean Race 2017-18. The Volvo Ocean Race 2017-18 edition is characterized by a different incentive structure than the previous edition. This allowed us to substantiate our findings from the Volvo Ocean Race 2014-15 as some key dimensions changed in the 2017-18 edition. While the 2014-15 race granted equal points for each leg completed to the respective winner, the 2017-18 edition provided double points for legs that include ocean crossings and extra point for passing specific geographic points, such as Cape Horn[14]. Thus, some legs offered skippers more points than others.

According to our literature review and due to their shared aspiration of obtaining a podium position, the further away skippers are from fleet leadership, the more likely that they deviate from the main field of competitors during these legs (cf. Kachelmeier & Shehata, 1991; Tversky & Kahneman, 1992). Therefore, the 2017-18 edition of the race was ideal because it offered skippers higher rewards for deviating from their competitors' general direction than the previous race in three of the eleven legs sailed. We were thus able to substantiate our propositions in a similar context that relaxed the assumption of equal overall rewards per leg. This two-step approach allowed to us to strengthen the inferences on the managerial cognitive capabilities responsible for following or deviating from the general direction of competitors drawn from the

[14] In the Volvo Ocean Race 2017-18, bonus points were awarded to the winner of every leg, while the two Southern Ocean legs and the transatlantic leg score double points. An additional bonus point is awarded at the end of the race to the team with the best overall elapsed time. The respective legs with additional points are marked in the table summarizing our analysis of the Volvo Ocean Race 2017-18 data.

different datasets. This provided us with a rich context to derive even more robust propositions than drawn from a single setting.

Analytic approach

In a first step, we analyzed each strategic decision of skippers participating in the Volvo Ocean Race 2014-15 in detail. We coded the log book entries of each strategic decision separately on the basis of in-vivo terms or phrases used by the informants. Thereby, we relied on constant comparison across multiple informants (if available) and over time to detect concept patterns (Glaser & Strauss, 1967). First order, *in vivo* codes reflecting skippers’ perceptions of the environment were derived by analyzing how they key informants described their perceptions of the environment immediately prior to a strategic decision in the log book entries using the language of the informants whenever possible. Furthermore, we coded for how strategic decision-makers reasoned and thus evaluated the information they had at hand for making a strategic decision. As we identified codes that were similar, we aggregated them into second-order concepts (Gioia et al., 2012) to derive broader categories of perceptions and reasoning.

Once preliminary analyses had been conducted based on the respective data from the 2014-15 edition, we combined the analyses and induced initial propositions using methods for building theory from written accounts (Eisenhardt, 1989b; Eisenhardt & Graebner, 2007; Glaser & Strauss, 1967). Propositions were derived from us contrasting perceptions and reasoning of strategic decisions where skippers deviated from the direction of competitors with those that took the strategic decision to follow the competitor group. This allowed us to identify similarities and differences between the skippers’ strategic decisions.

In a final step, we collected and coded data from the Volvo Ocean Race 2017-18 to further substantiate our findings. We followed the same data coding process as described for the 2014-15 edition. Thus, based on the derived data structure, we triangulated our previously developed propositions in this new context. We used existing literature to sharpen the insights from this inductive process following several iterations between data and literature. The result of our analyses of the two datasets is a set of propositions about the interaction between different sources uncertainty, strategic decision-makers’ reasoning, and the content of their strategic decisions.

4.4. Results

Our research focuses on the question of how differences in strategic decision-makers' cognitive capabilities influence strategic decisions to follow or deviate from the general direction of competitors. Because strategic decisions inhibit uncertainty, we study how strategic decision-makers perceive uncertainty and reason when taking the strategic decision to deviate from the main field of competitors and compare these mental activities to those who decided to follow the general direction of competitors. We controlled for differences in ranking of the individual skippers during these decisions.

While our research context eliminated noise from differences in environmental context as well as heterogeneous resources and information of strategic decision-makers from our data, prior research highlights the role of gains/losses vis-à-vis a reference point (e.g., Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) as a driver of strategic decisions to deviate from the general direction of competitors.

In this respect, our data cautions the use of a more fine-grained perspective to understand this mechanism. Skippers, independent from their ranking took the strategic decision to deviate from their main field of competitors. Hence, our analysis of skippers' strategic decisions in the Volvo Ocean Race 2014-15 derived that strategic decision-makers' perceptions of uncertainty and the way in which they reasoned were crucial determinants of strategic decision-makers' choices. Therefore, strategic decisions need to be evaluated in light of strategic decision-makers' cognitive capabilities.

Perceptions of different sources of uncertainty in strategic decisions

We identified five main sources of uncertainty that skippers were confronted with as they sailed around the world: internal, supply, competitor, strategic, and environmental uncertainty. While internal uncertainty is related to the team and boat, supply uncertainty is concerned with an inability to predict sufficiency of supplies. By contrast, competitive uncertainty relates to skippers' own ability to compete vis-à-vis their rivals. Strategic uncertainty describes an inability to find an appropriate course of action in a decision situation and environmental uncertainty entails an inability to predict how skippers' general environment will develop.

Table 4-4 provides an overview of our conceptualization of skippers' perceptions and depicts the way in which the coding proceeded.

Table 4-4: Progression of analysis in identifying perceptions of uncertainty

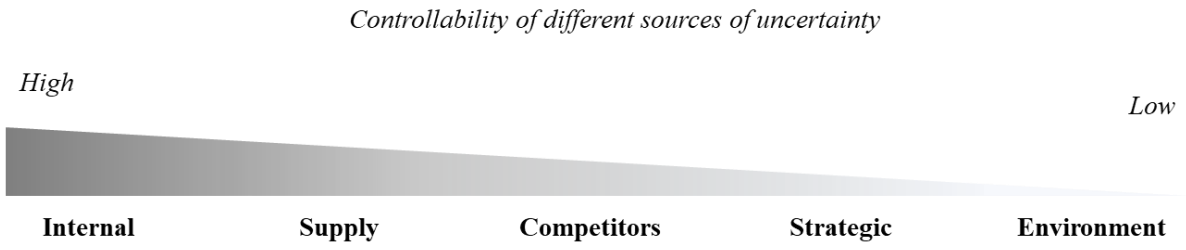
First-order (informant) concepts	Second-order themes	Aggregate (theoretical) dimension
Inability to predict whether one will be able to obtain a podium Inability to predict the impact of an environmental condition on the ranking Inability to predict utility of competitors' move Inability to predict whether one will be able to catch up	*Uncertainty relating to the ranking*	**Competitive uncertainty**
Inability to predict where the competitors are Inability to assess whether one is able to compete effectively	*Uncertainty relating to controllability of the competition*	
Inability to predict change in and impact of weather conditions Inability to predict direction of the current Inability to assess a pattern to the waves	*Uncertaint regarding environmental forces*	**Environmental uncertainty**
Inability to assess the impact of obstacles on their course Inability to assess the identity of obstacles on their course	*Uncertainty regarding obstacles*	
Inability to predict whether the intactness of the boat will remain in place Inability to assess the cause of a boat-related issue (e.g., water streaming into the boat) Inability to assess whether one is able to repair important, but broken equipment Inability to assess whether a problem has been finally resolved (e.g., provisionary repair)	*Uncertainty relating to the boat*	**Internal uncertainty**
Inability to predict how strainuous conditions will affect team members' ability to stay healthy Inability to predict when a crew member will recover to full strength from illness Inability to predict the safety of the crew	*Uncertainty relating to the crew*	
Inability to identify or decide between several/conflicting strategic options Inability to predict the utility of the different options	*Uncertainty relating to a strategic decision*	**Strategic uncertainty**
Inability to predict duration of a leg Inability to assess whether supplies will last for this leg	*Uncertainty relating to the availability of supplies for duratrion of the*	**Supply uncertainty**

We found that strategic decisions were contingent on the degree of controllability of the source of uncertainty. At the point in time when skippers made a strategic decision whether to follow their competitors or whether to deviate from the fleet, they either seemed reassured that their decision was the right one or they perceived sources of uncertainty that were similar in terms of their controllability depending on which strategic decision they took.

We mapped the different sources of uncertainty according to their controllability by strategic decision-makers (e.g., Beckman et al., 2004; McGrath et al., 2004). Whereas internal, supply, and competitive sources of uncertainty are relatively easier to control by strategic decision-makers, strategic and environmental uncertainty are more difficult to control. This is due to strategic decision-makers in the races having tools and means available to manage internal, supply, and competitive uncertainty. For example, they may reduce competitive uncertainty through watching their competitors directly through binoculars, the AIS[15] on board, or are updated through reports on their rivals' positions every six hours by race control.

By contrast, strategic and environmental uncertainty are more difficult to manage. For example, while skippers possess different forecasting tools in order to map the fastest route towards the respective destination they are aiming at, these models were often reported by sailors to be inaccurate and unreliable, particularly in remote areas of the ocean and for long-term predictions. Therefore, skippers only have limited ability to reduce these sources of uncertainty. Figure 4-2 depicts the different degrees of controllability assigned to the respective sources of uncertainty perceived by skippers during both races:

Figure 4-2: Controllability of different sources of uncertainty



[15]AIS refers to Automatic Identification System, an onboard software that is installed for safety reasons, but that was frequently used by sailors to detect and follow surrounding competitors within 20 nautical miles range.

High degrees of controllability enable strategic decision-makers to reduce uncertainty (e.g., March & Simon, 1958; Simon, 1976). Because uncertainty reduction is a guiding principle of human behavior (Hogg & Mullin, 1999; Hogg & Terry, 2000), the controllability of different sources of uncertainty plays a central role in determining strategic decisions. The following log book entry from the Volvo Ocean Race 2014-15 by the onboard reporter of Abu Dhabi Ocean Racing (ADOR) illustrates how his skipper, Ian Walker, longed for control during the race after one of his competitors, Charles Caudrelier from Dongfeng Race Team has managed to slip away during leg 7:

> *"The most stressful moment was last night in the shadow when we could see the other boats coming and we had no wind," said Charles (skipper). Like one of those dreams where you open your mouth to speak but nothing comes out and it's the most hopeless feeling in the world. Boom. Boom..Boom… Splash. "It's still very complicated and still very random where you don't control the race because you don't know what's going to happen," he says. (DFRT, 13 January 2015)*

Our data indicates that depending on the source of uncertainty that skippers experienced, their strategic decisions differed. Skippers that perceived more controllable sources of uncertainty, such as internal, supply, and competitive uncertainty, followed their main field of competitors, whereas they deviated when they perceived less controllable sources of uncertainty, namely strategic and environmental uncertainties.

Perceptions play a crucial role in determining whether strategic decision-makers are able to identify and create strategic decision option spaces to select from (e.g., McGrath, 1997). For example, Charles Caudrelier, skipper of Dongfeng Race Team (DFRT) decided to pass off the coast of Sri Lanka along India more north than the other skippers. Thereby, Charles Caudrelier was confronted with strategic uncertainty on how high to pass as illustrated by the following log book entry written by himself:

> *"One thing that is obsessing me at the moment is how far off India should we pass – an almost impossible decision. The island of Sri Lanka is more than 2000 metres high, and creates a wind shadow to its south of more*

than 200km... we can head south but we'll sail many more miles, and there isn't much wind in the south either." (DFRT, 11 January 2015)

When facing the same decision, other skippers were more concerned with competitive uncertainty as illustrated by the log book entries from the onboard reporters of teams Abu Dhabi Ocean Racing (ADOR) and SCA (TSCA):

"Yes, there have been subtle differences in mode and sail changes but everybody has pretty much sailed the same route. It is disappointing that we haven't gained more on Brunel as we thought we had passed them before, but one very light period cost us everything we had gained. Still we are happy to be in touch with them and have them on AIS for company. As we approach the end of the second section we have some work to do to catch Dongfeng. In reality we are only two hours behind with two weeks of racing to go so it isn't insurmountable." (ADOR, 11 January 2015)

"We've been moving south but also across in order to line ourselves up better with the fleet. As a result, we haven't always been in the best wind. However, we are all still together in our little square of Volvo Ocean Race boats. Before leaving, our coaches said we had to remain with the fleet until at least Sri Lanka; if we lose them before then it will be a challenge to make up for it." (TSCA, 11 January 2015)

These three log book entries demonstrate that being focused on more controllable competitive uncertainty may prevent skippers from identifying strategic decision option spaces, such as Dongfeng Race Team (DFRT). Thus, these skippers, different from Charles Caudrelier of Dongfeng Race Team (DFRT), fell subject to negative effects of uncertainty, such as foregoing prospective options (cf. McMullen & Shepherd, 2006), and followed the direction of the majority of competitors. Thus, more controllable sources of uncertainty led skippers to reduce and thereby control uncertainty, whereas less controllable sources of uncertainty led strategic decision-makers to consider different strategic option spaces and thereby generate the opportunity to deviate from the main field:

Proposition 1a: Perceptions capabilities that induce strategic decision-makers to experience more controllable sources of uncertainty increase the likelihood of them following their main group of competitors.

Proposition 1b: Perception capabilities that induce strategic decision-makers to experience less controllable sources of uncertainty increase the likelihood of them deviating from their main group of competitors.

Protective and sensible reasoning in strategic decisions

The data from our research produced several forms of reasoning that skippers demonstrated over the course of the race. Generally, there may be additional forms of reasoning depending on environmental context. However, several different forms already emerged from our analysis: control-oriented, competition-oriented, safety-oriented, legitimization-oriented (external and internal), chance-attributing, long-term, and opportunity-oriented reasoning.

When reasoning in a control-oriented way, skippers focused on factors they could regulate to take a strategic decision. Competition-oriented reasoning was motivated by rivals (e.g., matching an individual rivals’ move or not letting a specific skipper escape). Furthermore, skippers focused on safety of their teams when taking strategic decision or on legitimization by external (e.g., group of competitors) or internal (e.g., skippers’ team support) parties to justify their strategic decisions. Chance-attributing reasoning was applied when skippers attributed the rationale of their strategic decision to luck or fate. When reasoning long-term-oriented, skippers focused on benefits that would only materialize in the long-run – often acknowledging that a strategic decision would make them loose out in the short-term. Opportunity-oriented reasoning was applied when skippers became aware of a unique occasion that they deemed favorable to seize.

Overall, the forms of reasoning diverged in the way that strategic decision-makers evaluated and drew conclusions from the information they had at hand. Whereas some forms of reasoning were associated with strategic decision-makers being open-minded about new ideas and alternative courses of action, independent from their main field of competitors, others induced strategic decision-makers to arrive at a supportive conclusion about the status quo. Thus, we clustered the different forms of reasoning along two categories: *protective* and *sensible* reasoning.

Table 4-5: Progression of data analysis in identifying different types of reasoning

First-order (informant) concepts	Second-order themes	Aggregate (theoretical) dimension	
Focusing on controllable factors Avoiding to make any mistakes	*Reasoning based on what one can control short-term*	**Control-oriented reasoning**	***Protective reasoning*** *(maintaining status quo)*
Covering key competitors Comforting presence of competitors	*Reasoning based on following or remaining with competitors*	**Competition-oriented reasoning**	
Not committing too early to something that could endanger competitive position	*Reasoning based on protection of competitive position*		
Protecting own boat and crew	*Reasoning based on preserving boat intactness and crew health*	**Safety-oriented reasoning**	
Being in the lead/ among the race leaders Assuming that others will follow	*Reasoning based on external legitimization*	**Legitimization-oriented reasoning**	***Sensible reasoning*** *(change status quo for the better)*
Team standing behind the decision Sailing in a way that the skipper feels particularly experienced/skilled with	*Reasoning based on internal legitimization*		
Belief in luck or chance rather than experience or skill	*Reasoning based on phenomena that are outside of control of strategic decision-maker*	**Chance-attributing reasoning**	
Belief in long-term benefit/ favorable outcome	*Reasoning based on beneficial outcomes that are distant*	**Long-term oriented reasoning**	
Following simple rules based on experience Following a plan	*Reasoning based on pursuing long-term goals*		
Anticipation of favorable weather/environmental phenomena Following more risky routing, assuming the picked lane is the most beneficial one	*Reasoning based on seizing immediate opportunities*	**Opportunity-oriented reasoning**	

Reasoning was found to either be *protective* of the status quo or *sensible* to new ideas or opportunities. Whereas strategic decisions to follow the main field of competitors were associated with strategic decision-makers reasoning in a protective way, sensible reasoning increased the likelihood of strategic decisions to part from the main field of competitors.

For example, when the skippers sailed from France towards Sweden during leg 9, they needed to pass Point du Raz close to France. While Sam Davies, skipper of team SCA (TSCA), decided to take the inshore option to pass Point du Raz, the other skippers took the offshore route. Thereby, Sam Davies reasoned based on an opportunity-oriented perspective as demonstrated by the following log book entry by team SCA's onboard reporter:

> *"We were the only team to choose to go this close to Point du Raz. The rest of the fleet took a route further offshore. (...) Sam Davies explains: "For me, and all the sailing I have done, no matter how much tide there is and how many attempts you have to make you still get around quicker compared to sailing all the way around on the outside, because there you have lots of rocks and islands and quite a strong tide as well. We'll see whether our decision comes out right or not." (TSCA, 17 June 2015)*

By contrast, other skippers that passed offshore with the main fleet reasoned in more protective ways and thus "insensibly" as illustrated by the following log book entry by the onboard reporter of Dongfeng Race Team (DFRT):

> *"When we got to the Raz de Sein, there were already 3 knots of adverse tide. To let our main competitors go to pass on the outside, and risk being alone on the inside, against the strong tides, was too risky," says Charles Caudrelier." (17 June 2015)*

This quote demonstrates how Charles Caudrelier, due to his focus on comceptitors, was insensible to the opportunity to pass inside as the skipper SCA (TSCA) did. Eventually, the skipper from team SCA (TSCA) came out faster than the other skippers from Point du Raz. Therefore, sensible reasoning can support strategic

decision-makers in taking a strategic decision that entails irreversible resource commitment and altering the general direction they were heading previously.

Proposition 2a: Reasoning capabilities that induce protective argumentation increase the likelihood of strategic decision-makers following their main group of competitors.

Proposition 2b: Reasoning capabilities that induce sensible argumentation increase the likelihood of strategic decision-makers deviating from their main group of competitors.

Our study uncovered that strategic decision-makers often altered the form of reasoning depending on the source of uncertainty they experienced. More controllable sources of uncertainty were associated with protective reasoning, whereas less controllable sources of uncertainty lead to sensible reasoning.

For example, during leg 4 of the Volvo Ocean Race 2014-15, when approaching the Philippines on their way from Sanya in China to Auckland, New Zealand, the skippers were confronted with the strategic decision whether to cross the Philippines north via Taiwan or whether to sail straight through the islands. The skippers of teams Brunel (TBRU) and SCA (TSCA) decided to split from the main fleet and head north via Taiwan towards Auckland. Whereas the other skippers were concerned with internal and competitive uncertainty and competitor-oriented reasoning, the skippers of team Brunel (TBRU) and SCA (TSCA) experienced no uncertainty at all or strategic uncertainty respectively at the point of the strategic decision. Furthermore, they reasoned in a sensible way.

This suggests that the managerial cognitive capabilities of perception and reasoning may be related. Thus, when strategic decision-makers are confronted with less controllable sources of uncertainty, this also increased the likelihood of them reasoning in a sensible way. However, they may also reason in a sensible way without perceiving less controllable sources of uncertainty. Hence, our research suggests a mediating role of reasoning in the relation between perceptions of uncertainty and strategic decision content.

A summary of the evidence regarding this decision situation is illustrated in Table 4-6 that depicts evidence and quotes from the log book entries relating to the strategic decision taken as the skippers approached the Philippines during leg 4:

Table 4-6: Perception and reasoning in strategic decision on 10/11 Feb 2015

Informant	Skipper	Boat	Rank	Source of uncertainty	Reasoning	Quote
Onboard reporter	Sam Davies	TSCA	6	Strategic	Opportunity-driven	*"It's always difficult to get east in the Pacific Ocean but that's what we need to do and we got an opportunity with a low pressure and a northerly push coming down the east of Taiwan that will give us a better angle to head south.""It will appear at first that we taken a massive loss but in about 6 days time we will see exactly how the cards has played out. We estimated that either we would gain or come out in exactly the same position as the rest of the fleet, that's why it was worth taking the risk."*
Onboard reporter	Bouwe Bekking	TBRU	5	N/A	Legitimization-oriented (internal)	*"All the men of the team, however, stand firmly behind the decision! "This makes it interesting," says Rokas Milevicius. "Nothing ventured, nothing gained." And skipper Bekking? He is convinced that the investment of 300 miles will pay out before we reach the Equator."*
Onboard reporter	Ian Walker	ADOR	2	Competitive	Competitor-oriented	*"Dongfeng is only 4 miles upwind from us at the moment and every watch change it seems that number either goes up or goes down. Though AIS says we should be able to see them, it's difficult to spot anyone through the 4-5 meter waves."*
Onboard reporter	Charlie Enright	AVIM	4	Internal	Competitor-oriented	*"Routing agrees on tacking up the coast of Luzon (that will be fun), so for now the brief is simple: go east until the wind begins to shift from the coast. We've still got Brunel in sight behind us so we know we're going just fine in this test of attrition, everyone's just trying to stay conservative and keep the boat as fast as possible but more importantly: in one piece."*
Onboard reporter	Charles Caudrelier	DFRT	1	Competitive	Competitor-oriented	*"“It was a mistake,” admitted Charles. “We wanted to go north but no one else was so we stayed with the group.” I didn't say anything, only gave him the look, which has become code for give me something better than that. “It was a lack of courage,” he admitted. “Like lemmings!” I added maybe a bit too brightly. He gave me a blank stare."*
Onboard reporter	Iker Martinez	MAPF	3	Internal	Competitor-oriented	*"The six Volvo Ocean 65s in the fleet keep sailing upwind in the start of a tough fourth leg. It's like rodeo bull riding, really. At times we sail against 30 knots of wind, in spite of which the boat remains in one piece and we have good speed as well. We have Abu Dhabi Ocean Racing in sight to leeward, Dongfeng Race Team in front, and Team Alvimedica to windward."*

After the strategic decision of Brunel and SCA had been made, Charles Caudrelier, skipper of Dongfeng race team admits that he had also thought about parting from the fleet. However, he eventually lacked the “courage” to do so as illustrated by a log book entry from the on board reporter from Dongfeng Race Team (DFRT):

> *““It was a mistake,” admitted Charles (skipper). “We wanted to go north but no one else was so we stayed with the group.” I didn’t say anything, only gave him the look, which has become code for give me something better than that. “It was a lack of courage,” he admitted. “Like lemmings!” I added maybe a bit too brightly. He gave me a blank stare.” (DFRT, 12 February 2015)*

This log book entry also demonstrates how skippers needed to overcome perceptual pressures (seeing that no one else is turning north) to take strategic decisions that altered the current course of action vis-à-vis their peers, and how they tended to seek out factors that they could control.

Tables 4-7 summarizes this study’s evidence on perception and reasoning capabilities associated with the strategic decision to part from the main field of competitors from the Volvo Ocean Race 2014-15:

Table 4-7: Strategic decisions to split taken during VOR 2014-15

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
1	18.10.2014	1	Onboard reporter (Yann Riou)	Charles Caudrelier	DFRT	2	When sailing down the African coast, Dongfeng's skipper decides to remain inshore when all other skippers head further offshore and enjoy better winds.	Strategic	Long-term oriented	*"For example, this morning, the latest "position report" showed that three boats had a very different wind offshore, and more favourable at the time… What to do? Sail away from the coast to control them, or follow our initial strategy, which we believe is better long term? "If you invest everything in the left, it's not to cash it immediately!" (Pascal).*
2	19.10.2014	1	Onboard reporter	Chris Nicholson	VEST	2	When approaching the Cap Verde islands, the skippers had the options of going through the center, south between the east and central islands, or north.	N/A	Long-term oriented	*"Our decision to cross east was taken before the Cape Verde Islands," explained Wouter in a phone call to the boat. "We saw a tropical storm developing with good wind ahead of us, and light spots too. We went further east to avoid these calms, and managed to get the new wind from the east first."*
3	23.11.2014	2	Onboard reporter	Ian Walker	ADOR	5	There is a high pressure developing and the skippers have to place their bets on which way is the best to cross it.	Environmental	Opportunty-oriented	*"The rest of the fleet who have opted to sail further east did not match our gybe to the north in the middle of the night. (...) However, in the Nav Station Ian points out that there's a circle of red on the routing giving him optimism. "I think that what's happened is the currents are playing a major factor in what type of wind everyone's got." (...) The longer this trend holds over the next few hours, the longer we'll have a slight edge on the other six teams."*
4	30.11.2014	2	Onboard reporter	Iker Martinez	MAPF	2	The skipper of team Mapfre decided to head east, away from the other boats, in order to catch the trade winds.	Strategic	Long-term oriented	*"(...) We're heading east to try and catch the new trade winds which are starting to rebuild. "I think the best place to cross the two Doldrums in the Indian Ocean is to try and be in the east close to Diego Garcia – that's why we decided to make a separation from the fleet." But it was a ballsy manoeuvre, and one that wouldn't pay off for a few days, if at all. It meant that Abu Dhabi Ocean Racing grabbed the lead, opening up a 6nm advantage on Dongfeng and Brunel in the runner-up spots."*
5	11.01.2015	3	Onboard reporter (Sam Greenfield)	Charles Caudrelier	DFRT	1	The skippers have to decide on which side they will pass Sri Lanka. They eventually end up passing Sri Lanka as the most northern boat.	Strategic	Long-term oriented	*"One thing that is obsessing me at the moment is how far off India should we pass – an almost impossible decision.* *This could be the key to winning this leg and unfortunately one probably needs more luck than skill to get it right. We don't like that."*
6	19.01.2015	3	Onboard reporter	Charlie Enright	AVIM	3	The skipper of team Alvimedica decides to split from the fleet as they enter the Malacca Strait.	Strategic	Long-term oriented/ Opportunity-oriented	*"It seems at least a little ironic that our first day in the AIS-hectic Malacca Strait is the first day of this leg we break from convention and consciously sever our own AIS dependencies; we've split with the fleet and can no longer see the competition on the computer. It is as much a belief in the early game plan as it is a bit of good fortune from a beneficial wind shift last night that was too good to pass up. (...) It's energizing and makes the trip south to Singapore, rife with obstacles and hurdles, less chore and more opportunity."*

Table 4-7: Strategic decisions to split taken during VOR 2014-15 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
7	11.02.2015	4	Onboard reporter	Sam Davies	TSCA	6	As the skippers approach the Luzon Strait in the Philippines, they face two options to head to New Zealand: Either tack north towards Taiwan (in the opposite direction of New Zealand, but with often more favorable weather features) or continue across the Philippines. The skippers of TSCA and BRUN decide to split with the fleet.	Strategic	Opportunty-oriented	*"It's always difficult to get east in the Pacific Ocean but that's what we need to do and we got an opportunity with a low pressure and a northerly push coming down the east of Taiwan that will give us a better angle to head south.""It will appear at first that we taken a massive loss but in about 6 days time we will see exactly how the cards has played out. We estimated that either we would gain or come out in exactly the same position as the rest of the fleet, that's why it was worth taking the risk."*
8	11.02.2015	4	Onboard reporter	Bouwe Bekking	TBRU	5	As the skippers approach the Luzon Strait in the Philippines, they face two options to head to New Zealand: Either tack north towards Taiwan (in the opposite direction of New Zealand, but with often more favorable weather features) or continue across the Philippines. The skippers of TSCA and BRUN decide to split with the fleet.	N/A	Legitimization-oriented (internal)	*"All the men of the team, however, stand firmly behind the decision! "This makes it interesting," says Rokas Milevicius. "Nothing ventured, nothing gained." And skipper Bekking? He is convinced that the investment of 300 miles will pay out before we reach the Equator."*
9	19.03.2015	5	Onboard reporter	Charlie Enright	AVIM	2	There is a high pressure approaching that the skippers try to avoid. While some skippers go south to avoid the high pessure, but Charlie Enright decides on pursue a different path.	Environmental	Opportunty-oriented	*"We're following the path of Pam and as it fades so too will the winds, but the sea state will worsen as it destabilizes. (...) They're our limiting factor, the waves, and regardless of how much or how little wind we have, we're always fighting the sea state. Will feels the faster we get east the better our chances of avoiding the High are, so we're pushing hard--very hard. Some of the other boats have gone south, upwind with smaller jibs probably looking to get underneath it all, but Will is confident with our course so long as we can keep going fast so we're hammer down with the bigger Fractional-Zero."*
10	27.03.2015	5	Onboard reporter	Charles Caudrelier	DFRT	3	While the other boats climbed further north, Charles Caudrelier decided to gybe south towards the exclusion zone in the ice limits.	N/A	Opportunty-oriented	*"Last night when we got the positions in I saw a big smile on Pascal's (navigator) face. The others climbed further north, probably all just covering each other, while we gybed along the exclusion zone line. This morning they came back to our line, but behind us! "You are at your best when when you take decisions for yourself, without worrying about the others." - Pascal Bidégorry*
11	03.04.2015	5	Skipper	Iker Martinez	MAPF	3	A favorable wind shift made the skipper of Mapfre tack on port so that they are now positioned further to the west compared to the other boats	Environmental	Opportunty-oriented	*"The dice has rolled. Now it's down to a high-speed race for the last few miles, while we wait for a right wind shift to sail on starboard tack again. There are 750 miles left, around three days, and we are further west than anybody else, so the last shift's favoured us, but the next won't. The boat in front always plays with advantage, but as we are close to land, there are a lot of thermal effects influencing the wind and there's room for short term strategies."*

Table 4-7: Strategic decisions to split taken during VOR 2014-15 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
12	25.04.2015	5	Onboard reporter	Charlie Enright	AVIM	1	On their way from Brazil, the skippers have to decide on which lane to choose for their path up north towards Newport in the United States.	Environmental	Legitimization-oriented (external)	*"It's funny how having a conservative game plan and generally trying to stay with the leaders, how quickly that can change with just a few clouds. We're relatively happy with our boatspeed and gambling this early in a leg with so few fleet-compressions seemed unnecessarily risky. (...) But then we tacked north 40 miles before the fleet and now we've lost control of the situation. We are by ourselves to the west and very much "on an island," as Charlie likes to say. At some point during the night while drifting around all the rain and clouds it was agreed that getting north was best."*
13	24.05.2015	7	Onboard reporter	Sam Davies	TSCA	6	The boats are crossing the Atlantic to Lisbon and approaching the Azores High. The skippers have to select a lane around the high pressure system. Sam Davies decided to head the furtherst north.	Strategic	Opportunty-oriented	*""It's no guarantees for gains," says Sam. "The forecast is "rich getting richer"", at the same time we take this option because we think it's our quickest route to Lisbon. Unfortunately, because we are behind the fleet and the high is growing with time, we might be forced to go a bit wider."*
14	24.05.2015	7	Onboard reporter	Ian Walker	ADOR	5	The boats are crossing the Atlantic to Lisbon. When approaching the Azores High, Ian Walker decides to gybe north.	Competitive	Opportunty-oriented	*"Ian got fed up with the one-design procession. We all got fed up with it. There was a freedom in having nothing to loose – being at the back of the pack with the only options just floating ideas of chance. About mid-day Ian abandoned the game the rest of the fleet were playing and decided to gybe north. An immediate loss of additional mileage, the idea was to get into better breeze further away from the center of the Azores High."*
15	17.06.2015	9	Onboard reporter	Sam Davies	TSCA	6	Sam Davies decides to take the inshore option at Point du Raz when all other skippers go offshore.	N/A	Opportunty-oriented	*"We were the only team to choose to go this close to Point du Raz. The rest of the fleet took a route further offshore. For us it meant extremely strong tide around the corner but shorter distance and with a little bit of luck better wind conditions. Sam Davies explains: "For me, and all the sailing I have done, no matter how much tide there is and how many attempts you have to make you still get around quicker compared to sailing all the way around on the outside, because there you have lots of rocks and islands and quite a strong tide as well. We'll see whether our decision comes out right or not.""*
16	18.06.2015	9	Onboard reporter	Charles Caudrelier	DFRT	1	The boats approach the English Channel and can have two options: Either take the northern or southern route along the exclusion zone*. Charles Caudrelier opts for the northern option.	Strategic	Legitimization-oriented (external)	*"There's an exclusion zone in the middle of the English Channel that we mustn't go in. So we have two options… north or south ? While we thought about it, we waited. Thinking that, like usual, the boats would choose their side and stick to it with everyone going for the same option. But actually, what happened was totally the opposite."*

Table 4-7: Strategic decisions to split taken during VOR 2014-15 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
17	18.06.2015	9	Onboard reporter	Iker Martinez	MAPF	2	The boats approach the English Channel and can have two options: Either take the northern or southern route along the exclusion zone. Iker Martinez opts for the northern option.	Competitive	Competitor-oriented	*"That's the case of MAPFRE with Dongfeng. Even when they lead, they're stuck to us. Like Messi always dribbling the defenders during a match, Dongfeng and Brunel are on us. The three of us are fighting for a podium place and anything can happen."*
18	21.06.2015	9	Onboard reporter	Charlie Enright	AVIM	1	Sailing along the coast of Denmark, the skippers could either stay inshore of head offshire. Charlie Enright opted for an offshore route sailing more miles than the other boats.	Environmental	Long-term oriented	*"Navigating TSS hell was a practice in patience and adaptability, the exit from The Hague complicated enough that we significantly changed our strategy several times during the early hours as the weather continued to evolve."*

** Exclusion zones are areas of the ocean where the boats are not allowed to go (e.g., as these areas are busy trade areas or military zones)*

Triangulating our propositions in the Volvo Ocean Race 2017-18

Our data analysis from the Volvo Ocean Race 2014-15 suggests that skippers not only differed in the source of uncertainty they perceived when they decided to deviate from the main field of competitors, but also in the way in which they reasoned. When skippers perceived more controllable sources of uncertainty and/or reasoned in a protective way, they were more likely to remain with the main field of competitors. By contrast, when skippers perceived less controllable sources of uncertainty and/or reasoned in a sensible way, they were more likely to deviate from competitors.

Based on these findings, we triangulated our propositions with data from the Volvo Ocean Race 2017-18. The data from the race confirmed our initial propositions. Independent from their prior competitive position and the incentive structure of the leg, skippers decided to deviate from their main field of competitors when perceiving certainty with regards to the decision or less controllable sources of uncertainty, and when reasoning in a sensible way. By contrast, skippers who were confronted with more controllable sources of uncertainty and who reasoned in a protective way were less likely to branch out from their rivals.

Similar to indications from the previous race edition, our analysis suggests a relation between the managerial cognitive capabilities of perception and reasoning. In this respect, perceptions of more controllable sources of uncertainty reduce strategic decision-makers' likelihood to deviate from the main field of competitors because they focus on controlling uncertainty. This becomes evident through protective reasoning.

For example, when the skippers crossed the Doldrums[16] on their way from Melbourne to Hong Kong during leg 4 of the Volvo Ocean Race 2017-18, most skippers were more preoccupied with resolving internal and competitive uncertainty as illustrated by the following log book entry written by onboard reporter of team Vestas Wind (VS11) reporting how the team felt unable to predict when they will be able to gain speed again. Thus, reasoning is oriented towards what competitors were doing. Thereby, they found comfort in having them around at the moment:

> *"(...) but today it looked like it could be and we all wondered just how long we might float here sweating through our days. The good news is that*

[16] The "doldrums" is a colloquial expression adopted for those parts of the Atlantic and Pacific Oceans affected by low-pressure. They are located around the equator and characterized by slow winds.

we're not alone in our lack of progress and we don't need to wait six hours for a sked to find out. We can clearly see AkzoNobel, MAPFRE, Dongfeng and TTOP (Turn the Tide on Plastic), and it appears like everyone's in the same zone of weather." (VS11, 9 January 2018)

This is also reflected in a log book entry by the navigator, Simon Fisher, of team Vestas Wind (VS11) later on the same day:

"We have seen gains and losses, sometimes slowly and sometimes frustratingly fast however it seems like currently we are being rewarded for our patience and steady focus as we can see ourselves gaining bearing on the lights of the other boats dotted around the horizon." (VS11, 9 January 2018)

Similarly, Dee Caffari, the skipper of team Turn the Tide on Plastic (TTOP), discusses how she almost lost sight of her competitors and consequently worried about regaining control of them as the following quote from her illustrates:

"Sadly as a result of this crazy cloud action, we went from heroes to zeroes in the rankings. So we have some work to do. They are still in sight but sadly we are not controlling them anymore. We need to fight our way back and there is opportunity to do that as we will have more of this activity (...)." (TTOP, 10 January 2018)

These exemplary quotes provide evidence for our hypotheses 1a and 2a. Strategic decisions to follow the main field of competitors were more likely when strategic decision-makers perceived more controllable sources of uncertainty and reasoned in a protective way. By contrast, perceptions of less controllable sources of uncertainty enable strategic decision-makers to identify strategic decision option spaces that increase the likelihood of sensible reasoning and strategic decisions to deviate from the main field of competitors.

For example, in the same decision situation, the skipper of team Brunel (TBRU), Bouwe Bekking, experienced environmental uncertainty as to how the weather will develop. This made him sensible to alternative strategic decision option spaces. Therefore, he reasoned in a long-term-oriented way as the following log book entry written by himself illustrates:

> *"But we are enjoying it some way, somehow. Trimming all the time, shifting gears to try to get the maximum out of each puff of breeze. Sometimes tacking, sometimes gybing as the wind is all over the show. So the weather forecast / models again show they suck in this area, so we are aiming to what we think is the best course in the long term."*
> *(TBRU, 9 January 2018)*

The quote depicts how Bouwe Bekking developed a long-term oriented reasoning from perceiving environmental uncertainty unable to get a hold of the wind patterns or the weather forecast. This is in line with our propositions 1b and 2b.

Our propositions become particularly salient in the strategic decision that the skippers were facing during the last leg of the 2017-18 edition. Three skippers, those of teams Brunel (TBRU), Dongfeng Race Team (DFRT), and Mapfre (MAPF), were tied in overall points. Thus, winning this leg would ensure the overall win of the Volvo Ocean Race 2017-18.

When the skippers were facing a final exclusion zone prior to arriving in The Hague, they had the strategic option to either pass it inshore along the coasts of Denmark, Germany, and the Netherlands or offshore. The skipper of Brunel (TBRU), Bouwe Bekking, being fourth decided to pass offshore early on because it was their initial plan not perceiving any uncertainty regarding the strategic decision at that point in time:

> *"We thought we had made the right choice (to go further offshore) and we expected a windshift. It came 90-minutes too late and that was the race. But that's yacht racing." (TBRU, 28 June 2018)*

By contrast, the skipper of Dongfeng Race Team (DFRT), Charles Caudrelier, experienced strategic uncertainty when he decided. He pursued the option to go inshore and reasoned in a long-term oriented way as illustrated by his log book entry:

> *"The decision hurt the team in the short term as they tumbled down the leaderboard. But by Sunday morning, with less than 100 miles left to race, weather routing projections had the top boats finishing within minutes of each other. None had been able to break away overnight, despite the significant splits on the race course. "We knew that we would fall behind initially and that if it came good it would only be at the end. The last position report (1300 UTC on Sunday) we were 27-miles from the finish and they were 20-miles and we thought it was over. But then I did a small weather routing and it showed we could end up one-mile ahead so I woke everyone up and said, 'let's push!'" (DFRT, 28 June 2018).*

Xabi Fernández, skipper of team Mapfre (MAPF), however, was less decisive. While at first, it seemed as if he sought to pursue Dongfeng Race Teams (DFRT) course, as it was initially his plan, he decided to follow team Brunel (TBRU) last minute being confronted with competitive uncertainty. Therefore, he reasoned that it was more important to cover Brunel (TBRU) than Dongfeng Race Team (DFRT) as illustrated by the following interview when he arrived second place in The Hague:

> *"This is very hard decisions to make (...) and once you made them, you have to commit. First we did one decision and then we changed them (...) we really thought we were ok with Dongfeng, but when the last sched came, we saw that they were across (...). But we were busy enough because we had to catch the other two." (MAPF, 28 June 2018)*

The skipper of Dongfeng Race Team (DFRT) eventually won the leg and the race, while the skippers of Mapfre (MAPF) and Brunel (TBRU) finished second and third. This example demonstrates how perceptions of controllable sources of uncertainty, such as competitive uncertainty, and protective reasoning can lead strategic

decision-makers to forgo opportunities and take the strategic decision to follow the main field of competitors. By contrast, perceptions of less controllable sources of uncertainty and sensible reasoning enable strategic decision-makers to take strategic decisions idiosyncratically. Table 4-8 provides further evidence on perception and reasoning capabilities associated with the strategic decision to part from the main field of competitors from the Volvo Ocean Race 2017-18.

Table 4-8: Strategic decisions to split taken during VOR 2017-18

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
1	16.11.2017	2	Skipper	Simeon Tienpont	AKZO	1	The boats head down the eastern coast of Brazil and have to position for turning east towards Cape Town. The skipper of Akzo Nobel chose a more easterly route with less wind, but fewer distance than the other skippers.	Strategic	Opportunity-driven	*"Offcourse there is the excitement of the inside route we are trying to take to Cape Town. We all know we are in a little less pressure then the rest of the fleet but hopefully have to sail less miles because of it. Upcoming 24 hours will see how we are going to line up with the fleet as everyone will see a big lift and will make a dive down south again into the southern ocean. Apart from the excitement of the position report every 6 hours if we are still hanging in there with the fleet little news reaches our boat. Looking forward what the changes in weather is going to bring for us and how we line up with the fleet."*
2	19.11.2017	2	Skipper	Xabi Fernandéz	MAPF	5	The skipper of Mapfre maintains significant leverage and gybes last of all boats and further south when they turn east towards Cape Town. He locates 80 miles south of the fleet, unable to see other boats anymore.	Strategic	Opportunity-driven	*"We are pretty excited after that gibe close to the HP and our positioning with the rest of the fleet and now we are sailing with good wind (14-17knots) towards the first front which is going to give as a good push. On board the most common questions are, ETA, how much wind will come with the front and how far south we are going! The leader board seems not to be so important anymore!"*
3	12.12.2017	3*	Skipper	Dee Caffari	TTOP	7	A low pressure system is approaching. The skippers have to decide how far to the center they would like to position. If they position too close to the center, the may incurr damage to gear and boat as the winds are stronger and if they position too far away from the center, the boat may slow too much. The skipper of TTOP positions the furthest north of all boats. Thereby, she leaves the fleet that is positioned closer to the center out of AIS** range.	Environment	Responsibility-driven	*"It was warm, sunny and lovely cruising, but frustrating to be racing in such conditions as the wind was shifty and gusty. (...) It is 24 hours of these conditions, flat water and easy breeze, then we will be negotiating a secondary low. Waves of 10 metres are being predicted and winds over 50 knots. These are boat-breaking conditions and decisions are being made by myself and Nico over what level we want to sail in. You get to a certain stage and then you stop sailing and just start surviving. We will sail faster if we can manage the conditions. So looking to keep racing but give ourselves a chance and not risk injury to people or boat."*
4	04.01.2018	4	Navigator	Charlie Enright	VS11	4	The boats sail along the eastern coast of Australia towards Sydney. They have the option of leveraging the East Australia Current and strong winds from a tropical storm offshore to propel them north or turn closer to the coast with less wind, but fewer distance. The skipper of VES11 selected the inshore option heading away from the fleet that sails offshore.	Strategic	Opportunity-driven	*"After lots of work to weigh up the options of our inshore option vs the more easterly option; both on shore and aboard; the die was cast by just a short gybe back into the coast shortly after Green Cape. A big header with pressure and we were pretty much locked onto our inshore track. With MAPFRE alongside us we in are in good company though, it is good to have someone alongside us to push us hard. The conditions too looked favourable for this option despite being more complex outside than it looked on the screen. With the routing now favouring setting up further to the west we remain cautiously optimistic we are in the right place."*

Table 4-8: Strategic decisions to split taken during VOR 2017-18 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
5	09.01.2018	4	Skipper	Bouwe Bekking	TBRU	4	The fleet is passing the Doldrums on their way from Melbourne towards Hong Kong. The skipper of Brunel positions the furthest west of all skippers. Thus, he is not able to see the other boats on AIS* anymore.	Environment	Long-term oriented	*"(...) But we are enjoying it some way, somehow. Trimming all the time, shifting gears to try to get the maximum out of each puff of breeze. Sometimes tacking, sometimes gybing as the wind is all over the show. So the weather forecast / models again show they suck in this area, so we are aiming to what we think is the best course in the long term."*
6	24.02.2018	6	Skipper	Bouwe Bekking	TBRU	4	When heading towards Auckland, Bouwe Bekking decided to go into stealth mode and hide their strategy change and choosing a more direct route towards Auckland.	Environment	Opportunity-driven	*"We thought we were in "fat" city, but the weather has changed and moved the centre of the high pressure into our path, so we changed also to a more southerly route. It is pretty hard to explain this to the crew, first your sail two days hard on the wind and then of all sudden a course change of 40 degrees, but the above says it all."*
7	18.03.2018	7*	Navigator	Libby Greenhalgh	SHKS	7	On their way from Auckland to Itajai in Brazil, the fleet clears Square Top Island and the northern limit of Coromandel close to New Zealand. Heading south-east down the eastern side of the Peninsula, the skipper of Sun Hung Kai / Scallywag decide to tack offshore away from the fleet while the fleet continues along the coast.	Environment	Long-term oriented	*"As we split from the fleet we were also suffering an instrument failure which meant in someways we were sailing blind so less than ideal. We probably should have tacked back and kept a visual on the fleet but we chose to stick with our plan and hold slightly further offshore to not fall into the lighter winds of the Bay of Plenty."*
8	21.03.2018	7*	Navigator	Libby Greenhalgh	SHKS	6	During the passage of the fleet of the Southern Ocean, the skipper of Sun Hung Kai / Scallywag decides to take a route all on their own of about 10 nautical miles north of Turn the Tide on Plastic and the rest of the fleet further south.	Strategic	Legitimized action	*"(...) but that has been the yo yo decision we have been trying to make (...). I am sure the viewers are watching us yet again break away from the pack and taking a higher risk decision with mile losing consequences. Bold it may look like but not entirely in our control no. The unintentional switcharoo we did on the fleet when we peeled to our FR0 initial wasn't as bad as we thought we had gained on the fleet as in fact a few hours later we could see our favourite friends TTOP, however the 8 nm further north put us closer to the high and we been lifted and lighter and are in a mile losing position. Should we gybe south and take a loss and hook into the same pressure as our fleet in an attempt to minimize the loss, probably. Will we probably not. Difficult decisions with a front chasing us down (...)"*
9	24.03.2018	7*	Skipper	Dee Caffari	TTOP	6	Sailing in brutal physical conditions, a low pressure system continued its path in front of the fleet, while the wind shifted to west. The fleet is sailing close to the ice limits*** when the skipper of Turn the Tide on Plastic decides to continue to sail in the south while the rest of the fleet (except Mapfre) heads further north.	Strategic	Opportunity-driven	*"We are playing the area just above the ice exclusion zone. If we go too far north we get into lighter winds and sail the wrong direction, if we go to far south we risk running into the ice exclusion zone. As a result we ave been doing multiple gybes. We seem to be the only two playing down here as the rest have seemed to remain to the north. Let's hope our hard work pays off."*

Table 4-8: Strategic decisions to split taken during VOR 2017-18 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
10	25.04.2018	8	Navigator	Libby Greenhalgh	SHKS	3	The fleet has to manage a geographical wind shift along the Brazilian coast that created competing benefits: Sailing on port tack would guarantee more easterly breeze when it was reached, but it also meant sailing more miles. By contrast, sailing further offshore meant more winds and less miles, but even more extra miles. The skipper of SHSK decided to head north prior to everyone else separating from the fleet.	Environment	Opportunity-driven	*"A transition of global weather systems another equator crossing and probably people talking a lot about weed, not the kind you smoke but big long tentacles of Sargasso weed. But the depth of this team shows well and we have hung on in there making initially some significant gains today to be throwing stones at most. Since then we made a now punchy decision to split from the fleet as we were getting headed behind them. We then wiggled our way up but while latest ached has us leading the reality is we perhaps were a little impatient and should have taken a smaller loss with the fleet."*
11	25.04.2018	8	Skipper	Dee Caffari	TTOP	3	The fleet has to manage a geographical wind shift along the Brazilian coast that created competing benefits: Sailing on port tack would guarantee more easterly breeze when it was reached, but it also meant sailing more miles. By contrast, sailing further offshore meant more winds and less miles, but even more extra miles. The skipper of TTOP decided to head the furthest east away from the fleet.	Environment	Long-term oriented	*"We have sailed within sight of Vestas for the last 24 hours having lost sight of the others as we all tacked on the shifts around a huge cloud yesterday afternoon [from 25 Apr 2018}. Yesterday was all about making short term losses to make long term gains. That is what I was telling the team as we pushed out to the East while it was easy to gain miles in that direction. We lost AIS and visual on the other boats and it was not until we saw the position report that we realised we made made the split as big as we had [from 26 Apr 2018]."*
12	29.04.2018	8	OBR	Richard Edwards	SHKS	7	The fleet is approaching the doldrums on their passage from Brazil to North America. They have to pick a lane whether to remain more west and sailing a shorter distance or sailing further east in stronger winds, but incurring extra miles. The skipper of SHKS was the first to choose from the fleet to head further east offshore.	N/A	Opportunity-driven	*"Separated from the rest of the fleet after making the surprise decision to tack early resulted in lost mileage and relative isolation, living out the repetitive tasks of cloud dodging, navigating average winds, and preparing for day to night pressure changes.Navigator Libby Greenhalgh pulled no punches. "We're 75 miles behind and been losing 6-12 miles per sched. It resulted from us choosing to head north earlier than the rest of the fleet who pushed east, and we probably got punished for that. It definitely wasn't the right decision, and we should have stuck with our original plan.""*
13	29.04.2018	8	Skipper	Charles Caudrelier	DFRT	3	The fleet is approaching the doldrums on their passage from Brazil to North America. They have to pick a lane whether to remain more west and sailing a shorter distance or sailing further east in stronger winds, but incurring extra miles. The skipper of DFRT was the last to remain in coastal waters and heading further west than the rest of the skippers prior to gybing north.	Environment	Opportunity-driven	*"If only we knew how to manage small clouds - right now we are under a huge one. Sometimes they bring rain, sometimes not; sometimes strong wind, sometimes nothing. Again they are a source of big stress on board each time. Playing with this cloud, we are moving west of the fleet, hoping for a bit more wind."*
14	21.05.2018	9*	Skipper	Xabi Fernandéz	MAPF	2	When crossing the Atlantic on their way from Newport (US) to Cardiff (UK), the skipper of Mapfre decides to gybe away from the fleet crossing further to the north than the rest of the fleet.	N/A	Long-term oriented	*"We were happy when we gibed as it was the plan we had even before the start, hoping to get the northerly winds earlier after a transition, but what happened was we had a very slow transition to get to the north winds and by then the 4 boats in the south had travelled a lot to the ESE."*

Table 4-8: Strategic decisions to split taken during VOR 2017-18 (continued)

Strategic decision #	Date	Leg	Informant	Skipper	Boat	Rank	Decision description	Source of uncertainty	Reasoning	Quote
15	22.05.2018	9*	Navigator	Libby Greenhalgh	SHKS	6	After seeing Mapfre and Dongfeng Race Team split from the fleet when crossing the Atlantic from Newport (US) to Cardiff (UK), the skipper of Scallywag decides to gybe away from the main fleet after some hesitation earlier on.	Environment	Opportunity-driven	*"The cowboy in me would have gybed us at about 0800-0900 on the 21st but we didn't as we are playing less of the early split and hanging with our friends to try pounce at the end. Though never say never. Right now the weather situation is complex and difficult to really have faith in the short term and the big picture shows that we ultimately all converge so you could say do whatever?! But there are larger risks with different routes and while we are chossing the biggest distance I think we also have the best winds."*
16	11.06.2018	10	Sailor	Emily Nagel	AKZO	2	When reaching the Fastnet rock on their way from Cardiff, UK to Gothenburg, Sweden, the skippers of team AkzoNobel and team Mapfre decide to head further north while the rest of the fleet continues sailing west.	Environment	Long-term oriented	*"We're now constantly leap frogging other teams having rounded the Fastnet rock literally right next to TTOP. Now past Mizzen Head we're trying to get north, although the breeze has different plans."*
17	12.06.2018	10	Skipper	Xabi Fernandéz	MAPF	1	When reaching the Fastnet rock on their way from Cardiff, UK to Gothenburg, Sweden, the skippers of team AkzoNobel and team Mapfre decide to head further north while the rest of the fleet continues sailing west.	Environment	Opportunity-driven	*"Last night after a bit of tacking and sailing with quite a shifty conditions, we managed to position ourselves north of the fleet. Right now, it looks we are leaving the ridge behind and we are sailing with the new S-SW winds, doing about 11 knots of BS so looks promising. Hopefully we can stretch with Akzonobel and put some ground between us and the rest of the boats but as I said, for the moment it just looks promising."*
18	23.06.2018	11	Skipper	Charles Caudrelier	DFRT	2	In their final push from Norway towards The Hague in the Netherlands, a split develops in the fleet. The fleet either had the option to go inshore sailing along the coasts of Denmark, Germany, and the Netherlands, or to stay offshore and sail straight most of the time prior to turning east to The Hague (finish line). While the majority of skippers opts for the latter route, the skipper of Dongfeng chooses the inshore route.	Strategic	Long-term oriented	*"The decision hurt the team in the short term as they tumbled down the leaderboard. But by Sunday morning, with less than 100 miles left to race, weather routing projections had the top boats finishing within minutes of each other. None had been able to break away overnight, despite the significant splits on the race course. "We knew that we would fall behind initially and that if it came good it would only be at the end. The last position report (1300 UTC on Sunday) we were 27-miles from the finish and they were 20-miles and we thought it was over. But then I did a small weather routing and it showed we could end up one-mile ahead so I woke everyone up and said, 'let's push!'""*
19	23.06.2018	11	Skipper	Dee Caffari	TTOP	6	In their final push from Norway to The Hague in the Netherlands, a split develops in the fleet. The fleet either had the option to go inshore sailing along the coasts of Denmark, Germany, and the Netherlands, or to stay offshore and sail straight most of the time prior to turning east to The Hague (finish line). While the majority of skippers opts for the latter route, the skipper Turn the Tide on Plastic chooses the inshore route.	Environment	Long-term oriented	*"So the fleet have split and we are in the company of Dongfeng and Scallywag. This is not looking too glamorous right now but we are playing the long term picture which could be good if the weather does what it says its going to do and that is a big ask."*

** Marks legs with double point score (different incentive structure)*

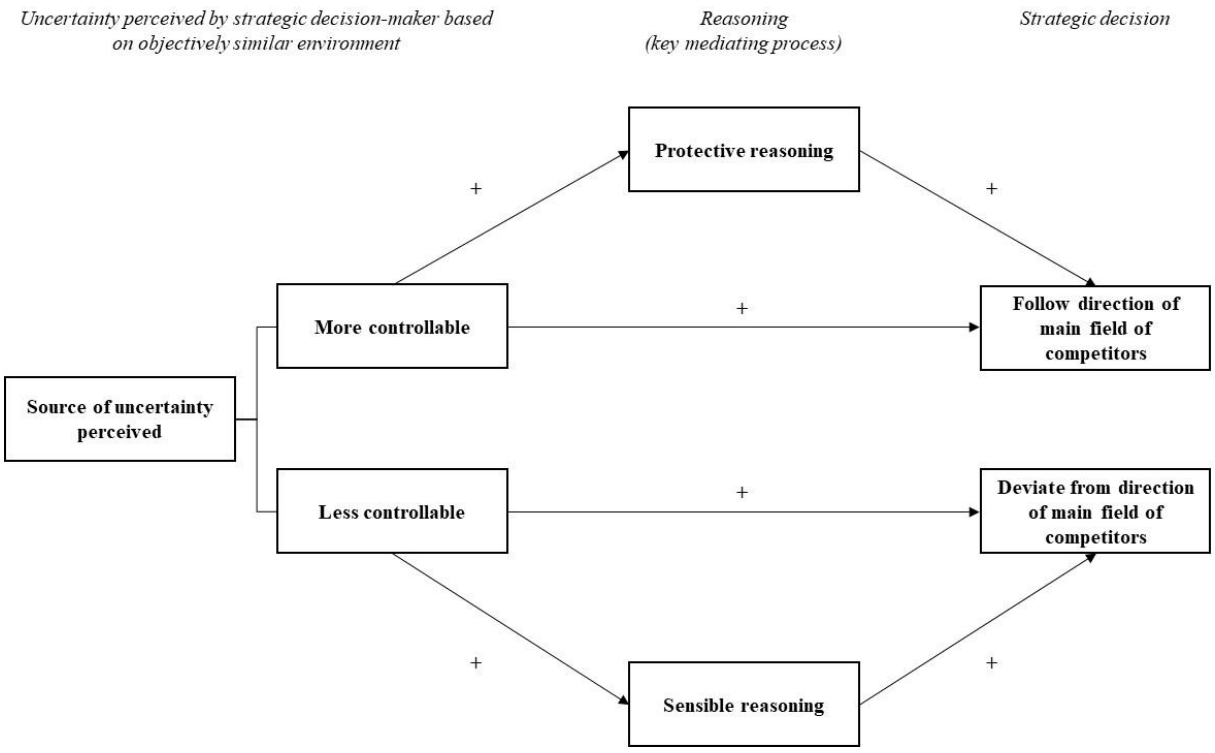
*** AIS refers to Automatic Identification System, an onboard software that is installed for safety reasons, but that is frequently used by sailors to detect and follow surrounding competitors within 20 nautical miles range.*

**** The ice limits refer to a technically imposed barrier by Race Control in which boats are not allowed to sail. They are imposed as precautions for icebergs and other physcial objects that might impede the safety of the boats and crew.*

4.5. Discussion

This research explored how differences in strategic decision-makers cognitive capabilities influence strategic decisions. From our analysis of the Volvo Ocean Race 2014-15, we derived several propositions that we substantiated in the following race edition depicted. Figure 4-3 summarizes our findings:

Figure 4-3: Relation between perception, reasoning, and strategic decision content



Our propositions focus on the managerial cognitive capabilities of perception (of uncertainty) and reasoning that are crucial mental activities in determining whether strategic decision-makers will deviate or follow the general direction of competitors. Thereby, we find that depending on which sources of uncertainty strategic decision-makers perceive, they will decide one way or the other (Propositions 1a & 1b). Individuals follow a natural tendency to obtain control over their perceived state of the world through a human control system of constant comparison between perceived and desired state of the world (Powers, 1973). As a result, when strategic decision-makers perceived sources of uncertainty that were easier to control (e.g., internal, supply, competitive), they followed their main field of competitors. However, when they perceived sources of uncertainty that were more difficult to control (e.g., strategic,

environment), strategic decision-makers decided to deviate from their main field of competitors. We found this to be influencing the way that strategic decision-makers reasoned. Protective reasoning was associated with following the main field of competitors whereas sensible reasoning induced strategic decision-makers to take the strategic decision to part from their main field of competitors (Propositions 2a & 2b). These propositions hold independent from the size of rewards are granted suggesting that the way in which strategic decision-makers perceive and reason influences their strategic decision to follow or deviate from the general direction of their competitors.

Based on these findings, our research provides several implications for literature: First, this study contributes to the literature on cognition in strategic decision-making (e.g., Eisenhardt, 1989a; Dean & Sharfman, 1996) by identifying and specifying cognitive capabilities that lead to differences in strategic decisions. While prior research highlighted the role of environment its relation to cognition in strategic decisions (e.g., Hough & White, 2003; Mitchell et al., 2011; Nadkarni & Barr, 2008), our research uncovered specific mental activities that strategic decision-makers share when they take a strategic decision to follow or deviate from the general direction of their competitors. By developing capabilities that enable strategic decision-makers to perceive the environment as one that is less controllable as well as sensible reasoning capabilities, strategic decision-makers may become more effective at seizing appealing opportunities (cf. Teece, 2007).

Second, our research speaks to the managerial cognitive capabilities literature (e.g., Adner & Helfat, 2003; Eggers & Kaplan, 2013; Gavetti, 2005; Helfat & Peteraf, 2015). In this sense, our study does not only specify the nature of the managerial cognitive capabilities of perception and reasoning (Helfat & Peteraf, 2015) in the strategic decision to follow or deviate from the general direction of competitors, but also finds that these managerial cognitive capabilities are related. Thus, if strategic decision-makers possess cognitive capabilities that allow them to perceive the world in a certain way (Adner & Helfat, 2003), they may not only be better equipped to sense more opportunities than others (e.g., Barr, 1998; Jackson & Dutton, 1988), but they may also be more capable in seizing them when others cannot as their perceptions inform reasoning. This underlines the crucial role of individual perceptions in shaping strategic decisions (e.g., Fiol & Huff, 1992; Gavetti, 2012, 2005; Helfat & Peteraf, 2015; Huff, 1990; Walsh, 1995). Because cognitive capabilities develop through repeated practice (Helfat & Peteraf, 2015), strategic decision-makers may become more sensible to

sensing and seizing of opportunities, the more they are exposed to context where these capabilities are required and trained. In this sense, our research also addresses calls for more scholarly work on how strategic decision-makers can better identify and pursue opportunities absent radical environmental change (Eggers & Kaplan, 2013, 2009).

Third, previous empirical work suggested that gains and losses vis-à-vis a reference point play an important role in determining whether strategic decision-makers may deviate from their competitors (e.g., Kahneman & Tversky, 1979; Tversky & Kahneman, 1992, 1986). While this work has contributed invaluably to our understanding when strategic decision-makers should be more likely to deviate the strategic decisions of competitors, it neglected the cognitive underpinnings, such as managerial cognitive capabilities (cf. Helfat & Peteraf, 2015), underlying such decisions, particularly in the presence of cognitive pressures (e.g., Dobrev, 2007; Greve, 1998). Therefore, our work speaks to this perspective by going beyond understanding strategic decision-makers’ behavior. Instead, we explore strategic decision-makers’ mental activities that account for differences in their strategic decisions. We found that skippers that were positioned lower in rank (and thus in a gain frame) were not always more likely to branch out from the main field of competitors than those in higher ranks (and thus in a loss frame). This could be due to the fact that less controllable sources of uncertainty can lead strategic decision-makers to miss out on sensing opportunities (Teece, 2007), and thus to forego a chance to frame a decision-situation as a gain or loss (e.g., Dutton & Jackson, 1987; Kahneman & Tversky, 1979). Similarly, even when strategic decision-makers may sense an opportunity, they may fail to sense a reward because of their protective reasoning. This suggests that apart from a reference point (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992, 1986) strategic decision-makers’ cognitive underpinnings, such as cognitive capabilities play an essential role in determining their choices.

Fourth, our work also contributes to the literature on risk-taking (e.g., Bromiley, 1991; Palmer & Wiseman, 1999; Wiseman & Bromiley, 1996). This stream of literature suggests that managers of firms with poor performance were more likely to take risk than managers of well-performing organizations (e.g., Bowman, 1982; Fiegenbaum & Thomas, 1988; Singh, 1986). This is similar to the strategic decision to deviate from the general direction of competitors that strategic decision-makers took in our study. Hence, specific perception and reasoning capabilities may also foster risk-taking behavior in strategic decision-makers. Kahneman and Lovallo (1993: 17) stated that “it is the

optimistic denial of uncontrollable uncertainty that account for managers' views of themselves as prudent risk-takers, and for rejection of gambling as a model of what they do". Thus, building up perception capabilities that allow strategic decision-makers to experience the world as less controllable may lead them to take more risk. As managerial cognitive capabilities may be build-up through repeated practice (Helfat & Peteraf, 2015), risk-averse individuals could train these specific capabilities in order to become more proactive risk-takers as a proactive risk-taking attitude may be essential to engage in certain fields, such as entrepreneurship (e.g., McMullen & Shepherd, 2006), entry into new markets (e.g., Lumpkin & Dess, 1996), and creation of new ventures (e.g., Gartner, 1985).

And fifth, this study also contributes to previous research on inertia (e.g., Barr et al., 1992; Kaplan, Murray, & Henderson, 2003; Milliken & Lant, 1991) by studying how strategic decision-makers may overcome tendencies to procrastinate or forgo attractive strategic options because of the presence of uncertainty. In identifying cognitive capabilities that lead strategic decision-makers to deviate from the general direction of competitors, we specify how strategic decision-makers can overcome these tendencies. For example, because managerial cognitive capabilities are built through repeated practice (Helfat & Peteraf, 2015), strategic decision-makers could expose themselves to experiences that allow them to overcome pressures to reduce uncertainty. This could help them in better seizing appealing opportunities (e.g., Teece, 2007). In addition, because managers are often not aware of what their organizations are capable of doing (e.g., Eggers & Kaplan, 2013), fostering sensible reasoning may help managers in matching resources to the opportunities they identified in the environment.

More broadly, our results may also inform the literatures on market positioning (Dobrev, 2007; Greve, 1998), strategic positioning (Porter, 1996; Ghemawat & Rivkin, 1999), observational learning (Banerjee, 1992; Bikhchandani, Hirshleifer, & Welch, 1998; Gaba & Terlaak, 2013; Hirshleifer & Teoh, 2003), and imitation (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Ross & Sharapov, 2015). On a firm-level, organizations are positively influenced by what others do (Strang & Still, 2006). Thus, prior research in these fields demonstrated that although organizations may adopt idiosyncratic strategies, the existence of other organizations as a reference group makes it more likely that it adopts the strategy selected by this reference group (DiMaggio & Powell, 1983; Dobrev, 2007; Greve, 1998; Huff, 1982; Mascarenhas, 1989; Porac, Thomas, & Baden-Fuller, 1989; Reger & Huff, 1993). Our research adds to this view

that strategic decision-makers that command perception capabilities that lead them to experience less or less controllable sources of uncertainty as well as sensible reasoning may be more likely in overcoming these behavioral bounds. Furthermore, our research makes the cognitive underpinnings of strategic decision-makers’ deliberate decisions (e.g. Klingbiel & Joseph, 2015) explicit.

4.6. Managerial implications, limitations & future research

Our findings also suggest some practical implications. Individuals have a natural tendency to reduce uncertainty (Hogg & Terry, 2000). Taking the strategic decision to deviate from competitors entails uncertainty regarding the potential rewards this move might be offering (e.g., Klingbiel & Joseph, 2015). Therefore, strategic decision-makers often orient themselves on what competitors are doing (e.g., Dobrev, 2007).

Yet, our research demonstrates that some cognitive capabilities that strategic decision-makers possess can help them overcome these tendencies and take action when others cannot (yet) do so. For example, the CEO of the Swedish premium car manufacturer, Hakan Samuelsson, presented its electrification strategy in 2017 and announced that it would no longer manufacture traditional gasoline or diesel engines by 2019 (Ritchie, 2017). Volvo’s CEO was the first premium car manufacturer to proclaim this strategic decision stating that “we have an ambition to be fastest in this transition (to electrification). We want to be the first company to clear this, and we want to do this change. It’s a very decisive decision” (Taylor, 2017). Hence, Samuelsson may possess cognitive capabilities that helped him overcome social and cognitive pressures exerted from competitors in his market segment and deviate from the general direction that competitors were taking. Hence, building up cognitive capabilities through repeated practice (cf. Helfat & Peteraf, 2015) can help managers to look beyond what their reference group is doing and sense and seize opportunities when others cannot.

Of course, our study also has limitations that provide several avenues for future research: First, we selected two professional sailing races as our contexts of study. The selection of this sport context allowed us to study the nature of managerial cognitive capabilities in strategic decisions, while holding the objective environment, information and resources constant. In this respect, our study was conducted in a single industry setting that offered a similar objective environment to all skippers because they were sailing close together. Thus, our research setting enabled us to study the mental activities

of perception and reasoning absent noise created through environmental context, information and resource asymmetry.

Future research may want to relax these assumptions and study the interrelation of them with managerial cognitive capabilities. For example, by studying different industry contexts, scholars could explore whether some cognitive capabilities are particularly present in some industry contexts than others. Less dynamic industry contexts, such as the furniture industry, could lead strategic decision-makers to develop perceptions of controllable sources of uncertainty and more protective reasoning making reducing their capability to react to radical changes in the environment should the industry be disrupted (e.g., Barr, 1998; Barr et al., 1992). By contrast, highly dynamic environments, such as the biotechnology sector, could facilitate strategic decision-makers development of perception capabilities for less controllable sources of uncertainty and sensible reasoning because of repeated exogenous jolts (Meyer, 1982) that they have to deal with in this industry context. Hence, future research could compare managerial cognitive capabilities across industries in order to better understand what drives capability build-up (e.g., Eggers & Kaplan, 2009).

In addition, studies could assess whether possessing superior information and resources to others supports strategic decision-makers in identifying and seizing opportunities, e.g., by leveraging first-mover advantages (e.g., Lieberman & Montgomery, 1988). Because uncertainty entails the inability to predict a change in the environment, superior information could help alleviate uncertainty. Hence, strategic decision-makers should be able to reason in a more sensible way and seize opportunities (e.g., Gavetti, 2012; Teece, 2007) because they are more certain that seizing an opportunity will add value to the organization. Yet, Greve (1998) argued that information is often difficult to attain. Thus, strategic decision-makers with a superior resource base should be better able to search for information that may help alleviate or preempt uncertainty. For example, early entrants into a market may build a superior position in a geographic or technology space as well as defend and expand their position vis-à-vis competitors (Carpenter & Nakamoto, 1989; Lieberman & Montgomery, 1998 or Zachary, Gianiodis, Payne, & Markman, 2017 for a summary). By reducing uncertainty, strategic decision-makers may thus be able to train their sensible reasoning capabilities because they become accustomed to environments that support them in overcoming uncertainty (e.g., Michel, 2007).

Second, our research focused on two strategic decisions: The decisions to follow or deviate from the general direction of competitors. Yet, strategic decision-makers are continuously confronted with other strategic decisions, such as governance (e.g., Carson et al., 2006), partner choice (e.g., Beckman et al., 2004), and imitation (e.g., Gaba & Terlaak, 2013). Thus, these different research streams could also benefit from including a managerial cognitive capabilities perspective. Moreover, we studied the managerial cognitive capabilities of perception and reasoning. Yet, Helfat and Peteraf (2015) also conceptualized the capabilities of language, communication, and social cognition that are crucial in the reconfiguration of resources and thus in overcoming resistance to change. Hence, future research could look at situations of change in organizations to better understand how these managerial cognitive capabilities contribute to strategic decision-makers adapting or remaining inert in the face of change (e.g., Tripsas & Gavetti, 2000).

And third, because our research exclusively focused on two strategic decisions and the underlying managerial cognitive capabilities, this study does not encompass any predictions about antecedents and outcomes of the relation between managerial cognitive capabilities and strategic decisions. For example, while we did not explicitly assess the performance effect of these strategic decisions in our study, our research demonstrated that some of the strategic decisions that skippers took led other skippers to regret that they did not seize this opportunity as well, although having sensed it. In our example from the Volvo Ocean Race 2014-15 during leg 4, when the skippers approached the Philippines and the skipper of teams Brunel (TBRU) and SCA (TSCA) decided to part from the main field of competitors and head via Vietnam to Auckland, the skipper of Dongfeng Race Team (DFRT), Charles Caudrelier, stated that he regretted that he did not have the courage to break from the fleet, particularly as it became evident that teams Brunel (TBRU) and SCA (TSCA) were going faster due to better winds. This example demonstrates that following the direction of competitors to be able to play tactics is not always the “better” option in terms of performance, but that taking strategic decisions and overcoming cognitive and behavioral bounds may also pay off, at least in the short-term. In this respect, future research may want to study the performance implications of strategic decision-makers’ cognitive capabilities underlying their strategic decisions.

Similarly, future research may want to link strategic decision-makers traits and such as personality (e.g., Alston, 1975; Hambrick, 2007; Hambrick & Mason, 1984;

Ruble & Dweck, 1995), environments, such as culture (e.g., Hofstede, 1980; Schneider & De Meyer, 1991), or the way in which strategic decision-makers have been trained to cope with uncertainty (Michel, 2007) to managerial cognitive capabilities. This could help us in better understanding why some individuals possess or develop cognitive capabilities that others do not command, and consequentially why their strategic decisions differ despite being exposed to an objectively similar environment (cf. Nadkarni & Barr, 2008).

4.7. Conclusion

By exploring the nature of managerial cognitive capabilities that leads to differences in strategic decisions, we shed new light on managers' mental activities that drive strategic decisions. Thereby, we extend the relatively new stream of research on managerial cognitive capabilities. Exploring strategic decision-makers cognitive capabilities may help us in better understanding why strategic decision-makers decide differently and ultimately also how their differences in cognition drives performance. Our hope is that our study provides a first step into this direction and that it may spark future research in this stream.

5. Discussion and conclusion

This dissertation explored effective ways of coping with uncertainty and the effects of a decomposed uncertainty concept on individual strategic decisions. It started out by asking how strategic decision-makers cope with uncertainty, how their uncertainty coping relates to performance, and how different sources of uncertainty affect their strategic decisions.

5.1. Recapitulation of the individual studies

Three studies were conducted to shed light on the research questions that were presented at the beginning of this dissertation.

The first study applies a managerial cognitive capability lens to delve into the question of how strategic decision-makers cope with different sources of uncertainty. Overall, it finds that not only do strategic decision-makers perceive an objectively similar environment differently, but they also applied divergent strategies to cope with similar sources of uncertainty. We present four strategic postures that describe how strategic decision-makers manage uncertainty. Moreover, this study suggests a strategic posture-context fit. Hence, no single posture is suitable for all contexts and different contexts favor different strategic postures to cope with uncertainty. This underlines the fundamental importance for strategic decision-makers to tailor their strategic posture to the environment they face.

The second study is concerned with strategic decisions related to uncertainty reduction. Drawing on arguments from TCE, ROT, and network theory, it explores how organizations adapt governance and partner choice in technology sourcing as the technology progresses through its life cycle. This study finds that firms adapt governance and partner choice to the source of uncertainty most salient at each stage of the technology life cycle.

The third study focuses on strategic decisions to amplify uncertainty. Building on the same theoretical perspective as Study 1, it explores the role and nature of perception and reasoning capabilities in strategic decision to follow or deviate from the general direction of competitors. This study demonstrates that strategic decision-makers were more likely to deviate from their rivals when they were confronted with less controllable sources of uncertainty and when they reasoned sensibly. By contrast, more

controllable sources of uncertainty and protective reasoning increased the likelihood of strategic decisions to follow competitors.

5.2. Overarching contributions and outlook

By addressing the research gaps presented initially, this dissertation provides several overarching contributions to academia and implications for practice respectively.

Contributions to academia

First, the work presented here speaks to the literature connecting cognition to strategic outcomes (e.g., Porac et al., 1989; Plambeck & Weber, 2009; or Kaplan, 2011 for a review). More specifically, this dissertation sheds light on how strategic decision-makers may more effectively cope with uncertainty arising from different sources. While previous work focused on one source of uncertainty or one way to cope with different sources of uncertainty, a more comprehensive perspective has been neglected to date (Engau & Hoffmann, 2011). This dissertation finds that strategic decision-makers differed significantly in the way they managed uncertainty. Despite being exposed to an objectively similar environment, they experienced uncertainty differently (e.g., Weick, 1995). This finding highlights the importance of cognitive representation (Berger & Luckmann, 1967; Gavetti, 2012, 2005). Moreover, even when strategic decision-makers were confronted with similar sources of uncertainty, their way of coping differed. Thus, through my findings, I expand current literature on uncertainty coping (e.g., Engau & Hoffmann, 2011; Lipshitz & Strauss, 1997; Michel, 2007) by deriving strategic postures to cope with uncertainty and exploring their respective performance implications.

Second, this dissertation strengthens literature calling for a deconstructed conceptualization of uncertainty (e.g., Duncan, 1972; Miller, 1992; Milliken, 1987; Tosi & Slocum, 1984). By decomposing uncertainty into its sources and exploring their differential effects on strategic decisions, I contribute to the growing body of work analyzing how different sources of uncertainty influences strategic decisions (e.g., Beckman et al., 2004; Carson et al., 2006; Gaba & Terlaak, 2013; Weber & Mayer, 2014). Thereby, I analyze the effects of different sources of uncertainty from an individual and an organizational-level perspective. Prior scholarly work predominantly conceptualized uncertainty as one-dimensional and only assessed strategic outcomes

based on different degrees of uncertainty (e.g., Haunschild, 1994; McMullen & Shepherd, 2006; Ross & Sharapov, 2015; Williamson, 1975). Yet, uncertainty may not only be distinguished by its degree, but also by the source from which it arises. Thereby, the source of uncertainty may not only encompass the environment (e.g., Duncan, 1972; Lengnick-Hall & Beck, 2005), but also decision situations (e.g., Michel, 2007). Distinguishing uncertainty by the source from which it arises allows us to specify the controllability of different sources of uncertainty (e.g., Beckman et al., 2004). This has important implications for the strategic decision-making process and behavior as demonstrated in Study 1 and Study 3. Therefore, the studies presented in this thesis not only speak to the literature on outcomes of uncertainty, but also to studies conceptualizing and measuring uncertainty (e.g., Ashill & Jobber, 2010; Duncan, 1972; Miller, 1992; Milliken, 1987; Priem et al., 2002; Tosi & Slocum, 1984).

Third, this dissertation contributes to cognitive capability theory (Adner & Helfat, 2003; Eggers & Kaplan, 2013; Helfat & Peteraf, 2013). Managerial cognitive capabilities represent a relatively new theoretical perspective (Helfat & Peteraf, 2015). By operationalizing two of the constructs proposed in the theory, perception and reasoning, and by conceptualizing coping as a managerial cognitive capability, I specify the nature and the relation between the different constructs. Thereby, the studies presented in this dissertation contribute to our understanding of how managerial cognitive capabilities enable some strategic decision-makers to sense and seize opportunities while others cannot (Adner & Helfat, 2003; Gavetti, 2012). Hence, our research paves the way for the identification of specific natures of cognitive capabilities that drive performance.

Finally, fourth, and more broadly, this dissertation also has empirical implications. Study 1 and Study 3 are based on a unique and contemporary dataset that reflect the zeitgeist of media, log book entries that were published in real-time. This offered two advantages: First, it allowed us to explore perceptions of uncertainty, consequent coping, and strategic decisions as they happened. This limited ex-post biases and sensemaking by the informants (Kaplan, 2011). And second, the real-time data publications allowed us to get close to and observe an event on a daily basis over a period of nine month to generate insights into our phenomenon of study within a short period of time. Datasets like these are particularly useful for individual-level studies as they allow to get close to the subject of study and analyze mental processes underlying strategic decisions. Furthermore, they allow to in-depth study phenomena from distance

because the researcher does not have to be on sight in order to collect data. Looking ahead, similar datasets could provide interesting insights into themes and relationships making cognitive constructs visible, particularly by means of (e.g., artificial intelligence-aided) textual analysis (Kaplan, 2011).

Implications for practitioners

Besides the above stated theoretical implications, this dissertation also has practical relevance: One implication for practitioners is to become aware of one’s way of coping with uncertainty (e.g., Engau & Hoffmann, 2011; Michel, 2007). My dissertation sheds light on four different strategic postures that strategic decision-makers demonstrated over time. While the different postures describe uncertainty coping behavior over time, my performance analysis also provides some indications when each strategic posture may be performance driving or attenuating. Thus, by becoming more aware of how managers cope with uncertainty, we can better predict in which environments they will thrive or fail.

For managers, this has two important implications: First, knowing one’s own way of coping with uncertainty may help them in selecting environments where they will be more likely to cope with uncertainty effectively, and second, it may also help to better understand the outcomes of their behaviors and how they may be able to change attitude towards uncertainty in order to more effectively cope with uncertainty. For example, *Repressors* may better understand why their constant suppression of uncertainty may not help them in controlling it, and how they can learn from *Commanders* how to control uncertainty in an effective manner. Hence, given that uncertainty remains one of the most important challenges for managers in the strategic decisions they need to take on a daily level (e.g., Teece & Leih, 2016; Thompson, 1967), better understanding how they can more effectively cope with uncertainty may support them in adapting their coping to the environment they are facing and thereby taking better strategic decisions.

Another important implication for practitioners is to not only focus on the degree (e.g., Courtney, Kirkland, & Viguerie, 1997), but also on the source of uncertainty (e.g., Duncan, 1972; Miller, 1992; Priem et al., 2002; Tosi & Slocum, 1984). Analyzing the source of uncertainty is important to better understand the controllability of uncertainty (Beckman et al., 2004; McGrath et al., 2004). While the resolution of some sources of uncertainty is easier to control by strategic decision-makers, others are more difficult to

control. For example, political and market uncertainty may often not be resolved through the actions of a single firm. Yet, collectively, organizations and individuals alike may reduce uncertainty (e.g., through joint lobbying initiatives). In this sense, U.S. Secretary of Defense, Donald Rumsfeld compared uncertainty to "unknown unknowns" (see introductory quote to this dissertation). Whereas a "known unknown" refers to uncertainty that can be known when sufficient time and resources are invested, an "unknown unknowns" describes uncertainty that is difficult to resolve or that emerges unexpectedly (Teece & Leih, 2016).

Yet, by decomposing uncertainty along its sources, we enable managers to better understand where to commit their attention, time, and resources to develop tailored levers that address individual sources of uncertainty and to make some more sensible to situations in which uncertainty needs to be accepted because resolution is difficult or impossible to attain. Thus, while managers may prioritize different sources of uncertainty according to their degree on the one hand, this dissertation recommends adding controllability as a second dimension to the analysis. This allows executives to more effectively manage different sources of uncertainty. For example, while more controllable sources of uncertainty, such as endogenous sources of uncertainty, may be resolved within the organization, strategic decision-makers may want to reach out to partners to resolve sources of uncertainty that they cannot control themselves, such as political uncertainty. Alternatively, they may take idiosyncratic action and actively shape their environments (Child, 1972; Galbraith, 1967) when they cannot control it.

Building on this argumentation, a second implication for practitioners is to be more self-aware of how they cope with uncertainty. Since a typical reaction to treat uncertainty is to reduce or completely avoid it (Cyert & March, 1963), managers may be prone to treat all sources of uncertainty with the same coping strategy. However, this pattern of coping with uncertainty may not always prove most effective. Hence, there may be contexts where uncertainty reduction is not suitable because it does not allow to sense and seize superior opportunities, particularly when they are cognitively distant (Adner & Helfat, 2003; Gavetti, 2012).

My dissertation speaks to this perspective and demonstrates how less controllable sources of uncertainty lead strategic decision-makers to undertake more idiosyncratic action compared to when they experience more controllable sources of uncertainty. In this respect, this dissertation provides managers with guidance on how to overcome

legitimization and competitive tendencies may induce them to pursue similar actions to their competitors. Managers need to balance between a long-term orientation that prevents them from tendencies to pursue similar actions of competitors and believe in their ideas, and opportunity-orientation that helps them to stay open to new ideas. In this sense, Gavetti (2012) hypothesized that cognitively distant opportunities may only be spotted by managers when they overcome cognitive and behavioral bounds. Naturally, managing this trade-off is not always easy and not every opportunity may prove fruitful to organizations. Yet, by becoming more aware of one’s own coping behavior, particularly of one’s strategic uncertainty coping posture, managers may overcome natural tendencies to reduce uncertainty and critically reflect on their own uncertainty coping behavior given different contexts.

In sum, this dissertation contributes to our understanding of how strategic decision-makers experience uncertainty in an objectively similar environment and how they can (more effectively) cope with uncertainty. Thus, this dissertation helps practitioners to make more informed strategic decision when being confronted with different sources of uncertainty.

5.3. Conclusion

Uncertainty remains one of the central challenges that strategic decision-makers need to contend. Yet, we still know (surprisingly) little about how to effectively cope with uncertainty. This dissertation not only advances our understanding of how strategic decision-makers experience an objectively similar environment, but also how they cope with the various sources of uncertainty that they encounter. In doing so, this dissertation helps us in better understanding the nature of uncertainty managers are confronted with, in identifying more effective ways of coping with, and responding to uncertainty. It is my hope that scholars will continue exploring uncertainty and more effective ways of managing it so that we may have a better repertoire in place to confront the “known unknowns”, and “unknown unknowns” that we encounter not only in strategic decisions, but also in our daily lives.

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