Manipulating Attention predicts Problem Solving Strategies: Evidence from Think-Aloud Protocols and a Behavioral Experiment

Abstract

Performance feedback and experience are crucial factors in understanding organizational learning and adaptation. However, in many novel, strategically relevant situations, managers cannot benefit from past experience or feedback—yet they still solve important strategic problems. How do they do it? Despite the importance of this question, the processes they use are unknown to the literature. Few studies have used primary, non-retrospective data to explore the process of problem solving in the absence of feedback—perhaps due to methodological difficulties. To bridge this gap, this paper combines different methods in two studies. First, an exploratory lab study aims at understanding with very fine-grained data how strategic problems are solved in the absence of feedback. We employ think-aloud methods combined with content, sequence, and cluster analyses. We find that two problem-solving strategies emerge. One allocates more attention to the framing of the problem, and the other to the implementation of the solution. This result leads us to the second study, where we use a mixed factorial design experiment to pinpoint the causal mechanism that explains the emergence of the two strategies for solving strategic problems. We find that manipulating attention towards problem framing increases deliberation aimed at restructuring the problem elements (i.e., a problem-focused strategy). In contrast, manipulating attention towards solution implementation increases reflection on the potential contingencies and consequences of the solution (i.e., a solution-focused strategy). We discuss how our findings can serve to extend research on problem solving, the microstructure of organizations, and learning. We conclude deriving managerial implications.

Keywords: attention; cognition; ill-structured; process; strategic problems;

1. INTRODUCTION

Organizations learn from experience.
Sometimes, however, history is not generous with experience.
March et al. (1991: 1).

Since Cyert and March (1963), a foundational idea of the Behavioral Theory of the Firm and the Carnegie School has been that managers solve problems by adapting to feedback from their prior actions. Managers learn from experience, i.e., online (Levitt & March 1988, Nelson & Winter 1982). However, while this is true for some problems, it is by no means true for all. In fact, managers must very often act in environments where they not only lack past experience, but must also solve the problem at hand without any possibility of receiving experiential learning or feedback on it (March, Sproull, & Tamuz, 1991). The need to solve problems in the absence of experience or feedback is perhaps most evident in strategic problems, which are characterized by their complexity (Simon 1962), novelty, uncertainty (Mintzberg, Raisinghani, & Theoret, 1976), and ambiguity (Nickerson & Zenger, 2004). These problems involve high-stakes decisions (Eisenhardt & Bourgeois, 1988) that are often irreversible and lead to outcomes that are very hard to predict (Ghemawat, 1991). Given these characteristics, it can be very costly, if not impossible, to engage in online learning when solving strategic problems. Hence, solutions to such problems need to be found in the absence of feedback or experience, through a process of offline learning. In this study, we focus on strategic problems.

Even though solving strategic problems is paramount for managers (Baer, Dirks, & Nickerson, 2013), and despite offline learning being at the core of strategic problem-solving, we know very little about *how* strategic problems are solved. Within the Carnegie school, Posen et al. (2018) call for us to "take a process approach" (2018: 240), claiming that "the literature has often been black-boxing the search process in the discussion of problemistic search[1], studying its antecedents and consequences without a rich connection to search itself" (Posen et al., 2018: 219). In a different stream, Langley et al. (1995) call for a departure from a middle-distance approach to organizational decision-making research, and exhort us to "zoom in closer to the people and processes under study" (Langley et al., 1995: 276).

[1] Problemistic search is the main problem-solving process in the behavioral theory of the firm (Cyert & March, 1963).

In this paper, we respond to these calls by designing and implementing an empirical strategy to open the black box of strategic problem-solving in the absence of feedback.

This paper comprises two studies. Study 1 is aimed at building theory on *how strategic problems are solved***.** We trace individuals' thoughts as they solve a strategic problem that is complex, ill-structured, and novel, involving high-stakes, irreversible decisions. We use a novel combination of methods that allows us to examine, precisely and in detail, the processes that managers follow while solving a strategic problem in a controlled environment. We combine think-aloud protocols with content analysis to give a clear view of how managers allocate their attention while solving a problem. Additionally, we use sequence and cluster analyses to extract and analyze the common strategies that managers follow while solving strategic problems.

When we analyze the process of problem-solving and the emergent patterns of attention, two clusters of managers emerge. We find that in the absence of experience or feedback, attention is focused on different problem-solving phases. One cluster focuses their attention on phases aimed at understanding numerous aspects of the problem, in order to obtain a rich framing of the situation. Another cluster, meanwhile, focuses their attention on engaging more deeply in simulating outcomes of potential solutions. Following Ocasio and Joseph (2018), we call these two emergent patterns of attention *strategies*. The first strategy, which we call *problem-focused*, allocates more attention to the phases related to the framing of the problem. The second strategy, which we call *solution-focused*, allocates more attention to the phases related to the implementation of the solution.

In our second study, we uncover the mechanisms that explain *why there are two different types of strategies*. To answer this question, we rely on an experimental study. This study uses a manipulation aimed at directing attention in different ways, to see whether we could observe the emergence of the processes found in the first study, and thus explain their causality. We use move analyses to uncover the underlying cognitive mechanisms and resulting behavior as participants solved strategic problems. While participants solve the problems they move different items in the order they consider best for the goal they have been assigned. The move analyses allow us to measure the processes that precede the solution of the problem (Yu et al., 2012; Öllinger et al., 2013; Fedor, Szathmary, & Öllinger, 2015). By studying these processes, we obtain a precise account of the differences induced in attention allocation according to the type of manipulation and the resulting behavioral changes. We thus achieve an understanding of the causal mechanism (i.e., the allocation of attention) that explains the emergence of the two strategies found in our first study.

We find that manipulating participants' attention towards different phases of problem solving has the general effect of increasing the total deliberative effort they devote to solving the problem, with manipulated participants devoting more time to solving the problem than those in the control condition. Interestingly, when asked to focus their attention on the framing of the problem, participants spend the additional deliberation effort on restructuring the problem elements, which could be observed as taking more moves to solve the problem. In contrast, participants asked to focus their attention on the solution use the additional deliberative effort to pause longer and reflect more deeply before each move. Both manipulated groups expend an equivalent deliberative effort on the task, but the way they allocate their attention is reflected differently in each group, according to the type of strategy each group develops.

On the basis of the findings from our two studies, our main contribution is to explain how attention allocation leads to the emergence of different strategies. Past studies have mainly focused on how experience is gained from solving problems, and the behavioral consequences of the experience thus gained. Instead, we study strategic problems where experience is not available, and open the process black box of problem-solving to uncover, with precise evidence, how attention allocation is responsible for the emergence of different strategies.

This paper makes at least four significant contributions. First, by relying on fine-grained data, it provides a highly detailed account of the processes that emerge when individuals solve problems in the absence of experience or feedback. In many strategic situations, it would not be feasible to gain experience through experimentation. For this reason, it is useful to understand precisely how managers learn in the absence of feedback. Understanding these processes complements models of search and problem-solving, opening what Posen and colleagues (2018) call the "black-boxed elements of the search process."

Second, this paper's findings build theory that allows us to predict which strategies managers will use when they engage in solving strategic problems, and the mechanism that differentiates those strategies. Our theoretical contribution builds on the Carnegie School (Gavetti, Levinthal, & Ocasio, 2007) and tackles a knowledge gap about the processes of problem solving (Langley et al., 1995; Posen et al. 2018) by combining theories of managerial problem-solving and decision-making (Langley et al., 1995; Nickerson & Zenger, 2004; Klingebiel & De Meyer, 2013; Felin and Zenger, 2016) with the attention-based view as a lens to study strategic problem solving (Ocasio, 1997; 2011; Ocasio & Joseph, 2018).

Third, this paper makes a methodological contribution by combining new and established techniques to contribute a novel method for building and testing theory in two connected studies, in the manner of Reypens and Levine (2017). The first study is exploratory, and builds theory by exploring the processes that emerge under a controlled environment. It combines time-honored techniques (i.e., think-aloud protocols) with more recent ones (e.g., sequence analysis). The second study, meanwhile, is confirmatory in nature. It tests the findings of the first study using a mixed factorial design experiment with three conditions and each participant solving two problems. The combination of methods is a good example of the cycle of theory-building and theory-testing: methodologically complex, but foundational to the growth of scientific knowledge (Popper, 1963).

Fourth, this paper offers valuable guidance for practitioners, since multiple innovation methods and strategy-making models rely on processes similar to those we observe. For example, both lean manufacturing and Six Sigma provide a focus on the problem-definition phases of a problem, while Design Thinking makes individuals cyclically shift their attention. Our findings clearly show that different emphases are useful—but not all individuals are prone to using it (Nickerson, Silverman, & Zenger, 2007: 215–216). Since people follow different processes, it might be that the innovation and strategy-making models will work better with some people than others, in a predictable way. Since lean and Six Sigma are widely used in organizations, understanding how an individual can better learn from such processes can help organizations better target their choices to make them fit different individuals better.

This paper is divided into seven sections. Following this introduction, section 2 presents our theoretical framework. Third, we introduce our methods for Study 1, and summarize its results in section 4. Sections 5 and 6 present the methods and results of Study 2, respectively. Finally, section 7 concludes with a discussion of the managerial and theoretical implications.

2. THEORY

In this paper, we take a micro-level view of problem-solving. We base our work on the problem-solving perspective (Nickerson & Zenger, 2004), and use the attention-based view of the firm (Ocasio, 1997, 2011) as a lens that allows us to design a fine-grained study of the micro-processes involved in problem-solving as they unfold. In this section, we start by presenting the phenomenon of interest: strategic problem-solving. We then discuss what prior studies tell us about solving strategic problems: first, studies of the different phases that are involved in solving a strategic problem, and second, studies exploring the sequence in which such phases unfold.

2.1 Defining strategic problems

Strategic problems are different from other types of problem in several ways. They involve an *irreversible* decision; they involve *high stakes* with significant upsides or downsides; and they are *complex*, *novel*, and *ill-structured*[2]. There is a rich literature on each of these five characteristics. For example, a strategic problem needs to involve high stakes because if there is no risk involved, making the decision incurs no potential cost or gain for the organization (Eisenhardt & Bourgeois, 1988). The same holds for irreversibility (Ghemawat, 1991): if the decision can be reversed without significant costs, then the problem is operational rather than strategic. Levinthal (1997) started an important discussion on how complexity provides a competitive advantage, and Gavetti, Levinthal, and Rivkin (2005) added to it by explaining how novelty opens up strategic opportunities. In addition, the structure of a strategic problem is a defining factor. In an ill-structured problem, the means-end relationships, initial states, end states, and actions tend to be ill defined, so the decision-maker can never be sure about the possible solutions they might reach. An ill-structured problem, therefore, is inherently uncertain.

[2] Uncertainty is another key characteristic, but if the problem is ill structured, it is necessarily also uncertain, as we explain below. For parsimony, we do not include uncertainty as a key characteristic of strategic problems.

With a well-structured problem, solutions can be found through an algorithmic approach, but finding a solution may imply many steps and computations. Thus, the strategic advantage to be gained from solving such a problem is limited, which instead is not the case with ill-structured problems.—for example, if one was the first to do so. Fernandes and Simon (1999: 226) defined six different dimensions that a problem must exhibit in order to be considered well structured. In sum, they explain that the goals, beginning and end state, actions, and constraints of the problem need to be well-defined. Each of the six dimensions can be more or less structured, and thus problems will differ greatly depending on the level of structure on each dimension, creating multiple types of ill-structured problems; in contrast, in any well-structured problem, all six characteristics are equally well defined. Perhaps for this reason, the literature on solving ill-structured problems appears to be rather dispersed. In the next section, we show how the literature has tried to understand how problems are solved by proposing different phases, and sequences of such phases. We then present a model that combines multiple research streams that study problem-solving.

2.2 How are strategic problems solved?

2.2.1 The phases of problem-solving

Problem-solving has been studied since at least the early 20th century (e.g., Dewey, 1910). Research has studied how organizations develop solutions (Mintzberg et al., 1976), and how individuals solve their everyday problems (Klein, 1997) or make judgments (Tversky & Kahneman, 1975). The literature has taken some giant leaps forward over the past 50 years, with significant attention being paid to the study of well-structured problems. This has given us a deep theoretical understanding of the process through which such problems are solved. For example, studies have shown how solutions are affected by the speed with which they are arrived at (Ratcliff & McKoon, 2008), the biases and heuristics of the decision-maker (Tversky & Kahneman, 1975; Gigerenzer & Goldstein, 1996), or the general effect of problem framing (Baer et al., 2013). Studies have proposed models[3] that summarize the process by which well-structured problems are solved.

[3] Depending on the study, models include more or fewer phases, and more or less rigid sequences. Simon's (1965) model contained three phases (*intelligence, design,* and *choice*). Later on, models tended to break these phases

Once we start to relax some of the requirements of well-structured problems, we move into the realm of ill-structured problem-solving. In contrast with well-structured problems, the study of ill-structured problems has been less abundant, and fewer models are available. Some foundational models are presented in Table 1. For example, models proposed by Simon (1965) and Mintzberg et al. (1976) acknowledge that for ill-structured problems, the set of actions is not given, and knowledge is not complete. Thus the process of problem-solving involves an initial phase that is absent from models of well-structured problems. In this phase, called *design* in Simon's model, the possible set of directions and actions are planned and studied. In a similar vein, Schwenk (1985) recognized that many strategic problems involve high stakes and irreversibility, and added a phase referring to the *implementation* of the solution.

Insert Table 1 about here.

In order to understand the process of problem-solving more precisely, we believe it is useful for a model to include more phases rather than fewer—even if some of them might not take place in every scenario. Therefore, in this study, we present an integration of the different phases that previous models have proposed. This results in seven different phases that can take place while solving a strategic problem.

Table 1 shows our combined model. It separates *goal formulation* and *problem identification* from Schwenk's (1985) model into two phases, while retaining *valuation* and *action selection* from the more recent and well-established model devised by Rangel, Camerer, and Montague (2008). In addition, our proposed model preserves the phases of *implementation, implementation evaluation*, and *direction setting* common to other models.

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into subphases where specific actions took place. A recent and very well-established model by Rangel et al., (2008) starts with the phase of *representation,* where one recognizes the different actions possible in this setting; there follows the *valuation* phase, where the value of each alternative is assessed, according to individual wishes. This is followed by *action selection* phase, where a choice is made. The final phase is *outcome evaluation*, which evaluates the desirability of the choices; this assessment is then internalized through *learning* in case the same problem has to be solved again.

Having reviewed the phases involved in solving strategic problems, we now turn to the sequencing of such phases as the decision-making process unfolds.

2.2.2 The sequencing of problem-solving phases

In a landmark paper, Mintzberg et al. (1976) argued that the process through which managers solve problems and reach decisions involves multiple transitions, some between phases that do not follow the order expected from a linear model. They showed that in many decisions, managers allocate very little of their deliberation time to the initial phases of problem-solving, and cycle back and forth repeatedly between some others. Brightman (1978) explained how for complex problems, each phase of problem-solving is a micro-problem-solving process in itself, necessitating smaller cycles within the problem-solving process. Fernandes and Simon (1999) showed that while solving complex and ill-structured problems in a think-aloud protocol, individuals cycle through phases of analysis in different manners depending on their professional background (lawyer, physician, architect, orengineer). The study focused on cognitive processes, not problem-solving phases, and presented only two participants per condition, limiting its generalizability. However, the way Fernandes and Simon (1999) studied the process of problem-solving makes their paper a remarkable example, given the study of the process in real time (in contrast with most other studies, which use retrospective techniques) and the level of granularity, which supports a deeper understanding of the problem-solving process.

In all these studies, the problem complexity resulted in "messy" sequences with dynamic linkages between phases. Langley et al. (1995) put forward a complex view of decision-making and problem-solving. Interestingly, the authors identify three basic types of linkages between decisions: sequential, lateral, and precursive. Langley et al. (1995) call for studies that examine how the process of solving a problem unfolds beyond the mere linear sequences of decomposed phases, and capture the back-and-forth linkages between different phases. They call for future research to trace problems as they are solved, and sequence the events and decisions that comprise the problem-solving process. They also suggest that researchers "zoom in closer to the people and processes under study" (Langley et al., 1995: 276), taking a micro-perspective, acknowledging inter-individual differences, and tracing the strategies in real time, to ensure "that perceptions are not biased by a knowledge of a final outcome, as has been the case in most decision making research (Schwenk, 1985)" (Langley et al., 1995: 276).

However, answering this call means overcoming several methodological difficulties. We need reliable ways to track the concurrent development of thinking processes. We need to follow these processes with fine-grained measures that will allow us to understand which problem-solving phase is being used. In addition, to answer Langley and co-authors' call in full, we also need to be able to measure how much attention each problem-solving phase is receiving. This is vital to avoid the assumption that all phases are equally important. In the next section, we build upon the attention-based view to propose a theoretical lens that complements the study of problem-solving.

2.3 Strategic problem-solving and attention

Strategic problem-solving can be studied through different lenses and at different levels of analysis. The problem-solving perspective started at the organizational level (Nickerson & Zenger, 2004) and continued at the meso level. This perspective limits its theorizing to teams, and excludes the micro-processes followed by individuals. However, this perspective does recognize that "numerous individual-level decision biases exist" (Baer et al., 2013: 200). In this paper, we study individual-level micro-processes and use the attention-based view as a lens to examine the antecedents of behavior. Crucially, the attention-based view allows us to infer the strategy of an individual from how and where they direct their attention (Ocasio, 2011; Ocasio & Joseph, 2018).

In the attention-based view, strategy is defined by attention rather than action—a departure from prior theories. For example, Andrews (1971) defined corporate strategy as "the pattern of decisions in a company that determines and reveals its objectives, purposes, or goals" (Andrews, 1971: 13). The attention-based view adopts a more processual view, defining strategy as "a pattern of attention" rather than a set of actions (Ocasio & Joseph, 2018: 289). Within this view, "what decision-makers do depends on what issues and answers they focus their attention on."

The attention-based view provides a meta-theoretical structure to explain how attention is a key resource to be managed by organizations (Ocasio, 1997, 2011; Ocasio & Joseph, 2005). The attention-based view can be seen as having two different pillars, set in an environment where a decision is made (Ocasio, 1997: 192). The first pillar is normative, and relates to organizational structure and the internal processes that guide attention within a firm (Joseph & Wilson, 2018). The second pillar is descriptive: it explains how decision-makers attend to stimuli. Joseph & Ocasio (2018) proposed an organizational-level explanation of how the organizational structure leads to the allocation of attention to a focused set of problems and firm's issues creates value. We propose a complementary stance to Joseph and Wilson (2018) and propose to study the second pillar of the attention-based view by focusing on how the allocation of attention results in the strategies used to solve a strategic problem (Ocasio & Joseph, 2018). Our focus is on the micro-processes that explain how attention allocation are the cause of the very emergence of problem solving strategies.

Summing up, there is a gap in understanding how strategic problems are solved. Past studies have proposed that solving strategic problems must involve multiple iterations between different phases, deviating from linear models. Given the characteristics of strategic problems (i.e., novelty, lack of structure, complexity, high stakes, and irreversibility), we might expect decision-makers to devote much of their attention to structuring and simplifying the problem. Indeed, as Einstein famously observed, "The formulation of a problem is often more essential than its solution…" (Einstein & Infeld, 1938: 92). We do not expect the process of solving a strategic problem to follow a linear sequence. Instead, we follow March's idea that managers have to solve the most difficult problems, and that "unfortunately, God gave all the easy problems to the physicists. It is difficult. It's a world that is complex, that is shifting all the time" (Dong, March, & Workiewicz, 2017: 12). Due to this complexity and lack of structure, we expect the problem-solving process to be characterized by multiple iterations across different phases. In addition, we expect decision-makers to devote more attention to phases that aim at framing the problem and structuring its key elements, to familiarize themselves with the novel and complex situation and give it some structure. In Study 1, we carry out an exploratory study to investigate this initial expectation and increase our understanding of how strategic problems are solved.

This paper comprises two studies, and accordingly we present our methods and findings in two separate sections for each. Sections 3 and 4 present a laboratory study aimed at exploring how strategic problems are solved, while sections 5 and 6 present an experiment aimed at investigating why strategic problems are solved in two different ways.

3. STUDY 1: METHODS

"To grasp cognition in action," Reypens and Levine (2017) recommend that we "combine experiments with protocol analysis." Following this methodology, our first study focuses on protocol analysis to understand cognition in action (Andrews, 1971), while the second uses a behavioral experiment to study the causes of different behavior (Ocasio, 1997).

In our first study, we examine the problem-solving process of experienced managers by employing a combination of think-aloud protocols (Ericsson & Simon, 1980) and content, sequence, and cluster analyses. We use these techniques firstly to collect fine-grained data, and then to reduce its dimensionality in a structured way, in order to avoid discarding meaningful insights.

We present our methodology in three parts: the development of the problem, the data collection, and finally, the data analyses.

3.1 Strategic problem: The "Karabayos" problem

In this study, we employ a problem that has been tested and validated in a prior management study (Laureiro & Brusoni 2018). The problem required participants to imagine that they were the leader of a small aboriginal tribe, managing limited resources, under threat from external invaders. The objective of the tribal leader is to keep the tribe safe. Setting the problem in a distant geographical location does not prevent it from fulfilling all the essential characteristics of a strategic problem. In fact, the task, known as the "Karabayos" problem, shares many commonalities with difficult situations that managers, group leaders, and entrepreneurs might face when leading their groups to a common goal. First, the problem is ill-structured and complex: a starting point is provided, but it includes contradictions. Several major uncertainties are involved: the time available to achieve the goal (i.e., save the tribe), the reactions from relevant stakeholders (e.g., the level of resistance to their actions decision-makers encounter), and even how the primary goal is defined (e.g., it could be to save only the current generation, or to ensure that future generations can survive)—among others. Moreover, neither the possible actions nor their outcomes are well defined (e.g., can I communicate with the "enemy?"), and there is a potentially infinite range of alternatives to explore. The "Karabayos" problem also presents participants with a high-stakes, irreversible decision. The tribe might survive, or it might perish, and there is no possibility of receiving any process or potential performance feedback as events unfold. An additional advantage of using this task is that we wanted to avoid past experience with the specific problem setting, and it was easy to find managers without experience in the context of the tribal leader problem.

3.2 Data collection: Think-aloud protocols

In this study, experienced managers solved a strategic problem while thinking aloud (Ericsson & Simon, 1980; Fox, Ericsson, & Best, 2011). Think-aloud protocols follow a similar temporal flow as silent thinking (Ericsson & Simon, 1998), and provide the researcher with an unobtrusive and more accurate reflection of the thinking process than retrospective verbal protocol analysis, or descriptions and explanations of the thinking process (Kuusela & Paul, 2000; Ericsson & Simon, 1998).

Participants were assessed individually in a quiet and secluded location and given written and verbal instructions, which in turn were preceded by training sessions. We followed Ericsson and Simon's (1998) method to instruct participants about how to produce consistent, non-reactive verbalized thoughts during problem completion. All participants completed a minimum of three exercises to make them familiar and comfortable with the think-aloud method. After each exercise, participants received verbal feedback. The study's problem was presented only when the participant felt comfortable with the method, and the researcher was satisfied with the technical aspects of the verbalizations (i.e., the speed, vocalization, and type of language did indeed reflect thinking, and not a retrospective verbalization). Participants required as many as six familiarization exercises before sufficient reliability was achieved.

3.2.1 Potential issues with think-aloud protocols

There are three main issues related to the use of think-aloud protocols that can affect the reliability of the data. Below, we summarize each of them and present our solutions, consistent with the state of the art as described in Ericsson (2003).

First, the setting might put pressure on participants, leading to biased responses. To avoid this, we informed participants that, during their search for a solution, no interaction with the researcher would be allowed. The researcher would intervene only if the participant failed to think aloud, and then merely remind them to verbalize their thoughts. During the training phase, we told the participants about our interest in their thinking process.

In order to avoid differences among participants due to time pressure, we told participants that they could work on this task for as long as they wanted. We had reserved two hours of the participants' time, and all participants took less than half of this, the longest taking 51 minutes. Hence, participants had no reason to rush their answers. They were directed to signal when they had arrived at a solution, which indicated the end of the task.

A second issue is that the verbalization might not reflect the actual thinking process, but a narrative created by the participant to paraphrase their thinking process to the researcher. To address this issue, we used concurrent think-aloud protocols. The participants had to verbalize their thoughts at the same time as they solved the problem, not having seen the problem before, which avoids retrospective and introspective biases.

A third issue is that the verbalization might reflect the talkativeness of the participant, rather than their thinking process. To prevent this, we carefully instructed participants not to describe or explain how they solved the problem. Instead, we told them to remain focused on solving it, and to verbalize those thoughts that emerged in their attention while generating the solution under normal (silent) conditions. Having completed the task, we asked the participants to restate their final answer, and then the debriefing started. The aim of the debriefing was for us to understand the general experience while solving the problem and to check whether the participants had experience with this kind of problem; none had any experience in a similar context. All participants appeared motivated while solving the problem and many reported that they had empathized with the role of the tribal leader and had given serious thought to how to solve the difficult problem they were confronted with.

3.2.2 Sample

Forty-nine managers took part in our study. The participants were executives in multinational firms, founders of small companies, or unit managers in medium-sized organizations. We selected participants who had at least four years of experience, budget allocation responsibilities, and played a leadership role in a group with at least two members. The sample consisted of 40 men and 9 women, with an average age of 35.4 years (s.d. = 6.7 years).

The processing of think-aloud protocols is complex and time-intensive. For this reason, previous studies based on think-aloud protocols have worked with 15 or fewer participants (Grégoire, Barr, &

Shepherd, 2010; Sarasvathy, Simon, & Lave, 1998; Isenberg, 1986; Fernandes & Simon, 1999). Our sample, while still small for quantitative analysis, is larger than that of similar studies.

3.3 Data analysis

3.3.1 Content analysis

After we collected the think-aloud protocols, they were transcribed verbatim by research assistants involved in the project. We analyzed participants' verbalization using content analysis techniques (Krippendorff, 2012; Neuendorf, 2002). For each protocol, we analyzed the content and, with the help of three independent raters, selected the specific passages that represented "chunks of thought" corresponding to specific problem-solving phases. The protocols were coded according to the seven phases of the combined model presented in the theory section and the grey column of Table 1.

Table 2 presents a more detailed view of how the coding was operationalized. The table presents the seven phases of problem-solving, a short description of the construct, and a couple of quotes representative of each specific code. The initial phase is *frame stating* (FS), in which the subject analyzes the problem by repeating or paraphrasing the data mentioned in the text provided. *Frame assuming* (FA) follows when the participant develops their own hypotheses and assumptions about the problem at hand and begins taking them for granted, even when they were not mentioned in the problem description. *Direction setting* (DS) consists of defining general paths one intends to follow without stating a specific proposal, or generating alternative proposals for what to implement later on. *Evaluation (EV)* is when the participant judges the merits of a proposed path, and considers the solution without evaluating specific details of it. The *decision (DE)* phase is when the participant manifests a clear choice regarding what they intend to do. In *implementation* (IM), the participant designs the sequence of actions to carry out their proposals. The seventh stage is *implementation evaluation (IE),* where the participant evaluates the feasibility of their implementation. We codify any unintelligible sounds as *babble*.

Insert Table 2 about here.

The raters were tasked with coding every word of the think-aloud protocol into one of the seven phases of problem-solving or babble. We should highlight that in order to achieve a more objective interpretation of the think-aloud protocols, the researchers were involved in refining and piloting the code, but not in the actual coding process.

In order to ensure the robustness of our results, we calculated two measures of intercoder reliability. The first was the average percentage of agreement, which was 93.4%. Average agreement is useful in the case of simple codes, but when the data is complex, prior studies recommend using Cohen's Kappa. We found a value of 0.51 for this metric. Both values are satisfactory for the type of text we studied (Neuendorf, 2002; Lombard, Snyder, & Bracken, 2002).

3.3.2 Code merging

Each rater provided a fully coded transcript for each participant's protocol. Although we achieved high reliability, a perfect match for every word in every protocol is almost impossible. However, a prerequisite for sequence analysis is that each passage must be assigned a single code. We therefore followed a second content analysis process where we compiled the coded transcripts of each rater and followed a simple process of code merging.

By code merging, we mean taking multiple codes for a single passage and converting them to a single code. Our code-merging process had three steps. First, in cases of consensus between the three raters, we kept the agreed-upon code. Second, in cases of partial agreement (i.e., two select the same code, and one disagrees), we saved the value chosen by the majority. Third, in cases of complete disagreement between the raters (i.e., all three assign different codes), two authors conferred and selected the appropriate code for the passage in question from the three codes proposed by raters.

The output of these three steps was a fully coded transcript in which every passage was coded into a single problem-solving phase. This resulted in a sequence of phases for each participant that represented their entire problem-solving process. At this stage, we removed the *babble* codes (i.e., unintelligible sounds that in total were 2.8% of the protocols) from the sequence, since they do not represent the problem-solving process.

3.3.3 Sequence analysis

Next, we shifted our attention from the content of the phases to the transitions between them. Although the duration of phases can vary widely, we assigned them all the same unitary length for the purposes of this analysis, in order to focus solely on transitions.

Figure 1 illustrates the problem-solving sequences of two participants: Person A and Person B. Problem-solving phases are shown as color-coded rectangles, defined in the key shown above Figure 1.

Insert Figure 1 about here.

The problem-solving sequences of Person A and Person B differ considerably, although both employ all the phases of problem-solving. Person A focuses more on *frame stating* and *assuming,* and only spends time on *implementation* and *implementation evaluation* towards the end. Person B, in contrast, performs *frame assuming* and *frame stating* on far fewer occasions, and performs *implementation* and *implementation evaluation* earlier and more often.

Person A follows a more standard way of solving a problem, devoting considerable attention to understanding the situation, and only then making decisions and implementing the solution. In contrast, Person B performs many *decision* and *implementation* rounds throughout the protocol, with considerably less *framing.*

3.3.5 Transition matrices

We reduced the variance of the information comprising the problem-solving sequences by creating transition matrices. Transition matrices provide comparable summaries of the participants' problem-solving processes. Our work on transition matrices is based on the research by Lipshitz and Bar-Ilan (1996), who developed a lag-analysis of transition probabilities between problem-solving phases in recollections of successful and unsuccessful problem-solving cases in military organizations.

Lipshitz and Bar-Ilan (1996) focus their analysis on a matrix in which each cell represents a transition between phases. The starting phase of the transition is given by the row of the cell, while the destination phase is denoted by its column. These structures were originally referred to as "transition matrices" by Gibbs, et al., (1971). Transition matrices are used to study similarities between sequences, focusing on the number of transitions between elements in the sequence (i.e., problem-solving phases). For instance, in the case of Lipshitz and Bar-Ilan (1996), their focus was on studying the order of events, and not their duration, as is commonly the case in other analyses.

In this study, we have seven phases, which give rise to 42 transitions between phases. The 42 values are entered in the off-diagonal cells of the transition matrix and represent all the transitions made by the participant during their problem-solving process. We normalized these values to obtain transition numbers that were comparable between participants, i.e., for each protocol the sum of all transitions (i.e., off-diagonal cells) sum up to 1. In addition to the transition between phases, we included the percentage of time spent in each of the seven problem-solving phases. In sequence analysis is common to have transitions within the same phase. However, think-aloud protocols do not have clear transition within thoughts for coding within-phase transitions. As a proxy for within-phase transitions we take the percentage of time spent on each phase.

The 42 normalized transitions and seven time allocations comprised the data we used to compare the problem-solving processes of the participants in our sample. Although we created 49 variables to characterize a problem-solving process, we performed cluster analysis on this data to reduce the dimensionality of this data to one categorical variable.

3.3.6 Example of linear problem-solving

Table 3 and Figure 2 illustrate how to read the transition matrices we use in this study. For illustrative purposes, we start by using a simple linear model. As stated above, in a transition matrix such as Table 3, the row denotes the starting phase and the column denotes the destination phase, with each value denoting the frequency of that transition. For example, the transition between *frame stating* and *frame assuming (FS → FA)* was made 16.7% of the time.

The transition matrix of Table 3 depicts a linear model because there are only transitions in the cells next to the diagonal (every other cell has a 0 value). The key (uppermost bar) of Figure 1 depicts this transition matrix in sequence form: seven phases, one after the other, from *frame stating to implementation evaluation*. There is no circling back to *frame stating,* as the value of that transition is zero. Since there are only six transitions, each represents 16.6% of the total. Additionally, each phase of problem-solving has the same duration: 14.3% of the total.

Insert Table 3 about here.

Figure 2 provides a visualization of the transition matrix depicted in Table 3. The sizes of the circles denote the duration of each phase, while the widths of the connecting lines denote the frequency of the transitions between them. In this simple linear model, all the circles are of equal size, since each phase lasts for the same amount of time. Similarly, the linking lines are all equally wide, as each transition is made an equal number of times, i.e. once. In the results section below, we present more sophisticated visualizations for non-linear cases where the transition frequencies and percentage of time spent vary.

Insert Figure 2 about here

3.3.7 Clustering

The transition matrices for each participant provide information about how they allocated their attention across the seven phases of problem-solving. We use clustering algorithms to extract the commonalities between the transition matrices. By using clustering, we can classify the common patterns of attention our participants used when solving a strategic problem—that is, the strategies they followed (Ocasio & Joseph, 2018: 289). We did not cluster via the optimal matching of sequences, as in Salvato (2009), because sequence length varied significantly between participants and led the optimal matching algorithm to give spurious results. Namely it matched protocols by sequence length, this happened with any setting of the algorithm. We chose instead to use transition matrices as they are indifferent to the length of the sequence.

We employed a clustering method called *partitioning around medoids* (Kaufman & Rosseeuw, 1990). This method selects the best number–k–of clusters for a data set, and groups the rest of participants around a set of the k most representative participants, called "medoids." The benefit of this method compared to others is that its clustering output is consistent and deterministic. The categorical variable assigns the same observations to the same cluster every time—something that k-means and other non-medoid clustering methods cannot do, except for clearly separate data sets.

We clustered our data using the *pamk* method from R's library *fpc* (Hennig, 2015). The *pamk* method starts by developing a variance ratio criterion (Calinski-Harabsz index) to determine the number of clusters, and then goes on to estimate whether there is a real benefit from splitting the dataset into two clusters (Duda-Hart test). The procedure is followed by an iterative process known as the building phase. In this phase, a total of k participants are selected and referred to as medoids. Afterward, a dissimilarity matrix of each of the remaining participants to every medoid is calculated. Finally, the algorithm places each of the remaining participants into a cluster, minimizing dissimilarity between clusters. The following phase is swapping: one participant is exchanged for a medoid, the average dissimilarity of the new configuration is calculated, and if it is lower than the original, then the change is saved. The process continues until it results in the set of k medoids that provides the lowest average dissimilarity to its cluster members.

After the *pamk* function was completed, we were left with a categorical variable that assigned each think-aloud protocol to one cluster. In our case, it is a dichotomous variable. This dichotomous variable is the outcome of the structured dimensionality reduction procedure of this study. We started with 49 think-aloud protocols, all completely different. We did content analysis and merged the coding differences we found. We did sequence analysis and transformed these sequences into transition matrices to create comparable data structures that captured the problem-solving processes of every participant, independent of their length. We then used a robust clustering procedure, *partitioning around medoids*, to create a single variable that summarizes the similarities between the think-aloud protocols.

In the results section, we use this clustering variable to characterize how the participants assigned to each value solved the "Karabayos" problem. From this, we can reach an understanding of how these problems are solved, and how problem-solving approaches differ. Instead of seeing strategic problem-solving as a homogenous process, we can study the commonalities and differences within it. Having reduced our data to a single key variable, we can use it to attain insights into how managers solve problems in the absence of feedback.

3.3.8 Performance scoring

We also coded the performance of the solutions given to the "Karabayos" problem. Two coders (different from those who coded the problem-solving phases) were assigned all 49 protocols, and each coder independently assigned a score to each one. The scores exhibited acceptable interrater reliability of 92.2%. After all the scores were assigned, the two coders met to agree upon the cases to which they had each assigned a different score. We used the agreed-upon score as our *performance* value.

3.3.9 Control measures

We collected a further set of variables to explore alternative explanations for the clustering results. From the task, we recorded the total time spent solving the problem (*protocol duration*). We also asked participants to perform two further tasks to gauge their cognitive skills. Participants answered a 10-question Raven's Progressive Matrices test, which is correlated with abstract thinking (Laureiro-Martinez, 2014). Participants also solved a "Tower of Hanoi" task, which is known to measure planning and generativity skills (Laureiro-Martinez, 2014). We recorded the time it took them to finish the task (with longer times indicating worse planning). Finally, we added controls for individual characteristics: *age*, *gender* (female = 1, male = 0), and *profession* (entrepreneur = 1, manager = 0).

4. STUDY 1: RESULTS

In this section, we present the results obtained from the analysis of the participants' think-aloud protocols. We start with an introduction to the transition matrix of the full sample, and then explain the clustering procedure employed and characterize the different strategies that emerge from the clustering algorithm. We end by presenting an assessment of other possible explanations for the strategies and differences found.

4.1 Full sample transition matrix

Table 4 presents the average transition matrix for all 48 participants[4]. The participants' transition matrices allowed us to study their patterns of attention as they solved the "Karabayos" problem. In this study, we assess a participant's allocation of attention by examining the percentage of time they spend on each problem-solving phase, and the number of transitions they make to and from that phase. The participants differed greatly in how they allocated their attention to the different phases of problem-solving, and we use these differences to understand how they solved the "Karabayos" problem.

The last row of Table 4 presents the thinking time spent on each specific phase. These values show that participants spend more time in some phases than others. For instance, on average, the

[4] As the raters coded the protocols, they informed us that one protocol was quite different to the others in that the thoughts of the participant were mainly devoted to numerical calculations, based on assumptions and not information provided in the problem. After coding, we compared the protocol to the others and we decided to remove it from the sample. On average participants spent 68% of their time on the frame stating, direction setting, and evaluation phases, and 17.6% on the implementation, and implementation evaluation phases. This participant, instead was a clear outlier, who spent 17.3% of the time on the framing, direction setting and evaluation phases, and 63.8% on the implementation. The sample's median Mahalanobis distance to the average time spent on the problem-solving phases was 4.80 and the 75% percentile 6.96 (Mahalanobis, 1936). The removed protocol had a Mahalanobis distance of 21.94. On any measure of normality, the protocol was the least normal by a large margin (Rasmunssen, 1988). The observation by the raters and the quantitative measures led us to remove the protocol from our sample.

participants spent 25.4% of thinking time in the *direction setting* phase, and just 3.3% on making a *decision*.

Insert Table 4 about here.

The off-diagonal values present the transitions between the different phases of problem-solving. For instance, the most common transition is from *direction setting* to *evaluation*, which represented 16.5% of all transitions. Sixty-six percent of all transitions are generated between directly neighboring phases (e.g. *FS* → *FA, or DE* → *EV*), whereas longer jumps are less common. Second-order transitions such as *FA* → *EV* represent 17.4% of the total, and third- or higher-order transitions just 16.6%. These results help us replicate what one would expect from prior studies such as that of Mintzberg et al. (1976), who proposed a problem-solving model where transitions were complex and took place between *all* phases, not just adjacent ones.

4.2 Clustering

We input the participants' transition matrices into the partitioning around medoids – *pamk* – method. Each matrix has 49 variables: seven representing the thinking time spent on each phase, and 42 from the transitions between phases. Two clusters emerge from the *pamk* method: one comprising 20 participants and the other 28. In the appendix we show robustness checks on the clustering that indicate robust cluster assignment even upon removal of participants.

Each cluster represents an emerging pairing of the patterns of attention used by the participants in the study. We follow Ocasio and Joseph (2018) and refer to these emergent patterns of attention as the participants' "problem-solving strategies." From now on, therefore, we do not refer to clusters, but to problem-solving strategies.

4.3 Transition matrices per strategy

The first step to characterize a strategy is to understand its transition matrix. To do so, we generated the transition matrix for each strategy by averaging the transition matrices of the individuals who followed it. We called the strategy followed by the first 20 participants the *solution-focused* strategy, and that followed by the other 28 the *problem-focused* strategy, for reasons outlined below.

Tables 5 and 6 present the average of the transition matrices of the participants who followed the *solution-focused* and *problem-focused* strategies, respectively, showing how they differ in terms of the attention they allocate to four of the seven phases of problem-solving. Adherents of the *solution-focused* strategy attend more to the *implementation* and *implementation evaluation* phases; they spend longer on them, and transition to and from them more often too. Those adopting a *problem-focused* strategy, meanwhile, tend to favor the *frame stating* and *frame assuming* phases.

Insert Table 5 about here.

The differences in the four *frame* and *implementation* phases provide the strongest differences between the two groups (p-value < 0.001 for the four comparisons, shown in the last line of Table 6). Interestingly, both strategies allocate almost equal attention to *direction setting, evaluation,* and *decision*.

We call the first strategy *solution-focused* because it allocates more attention to the i*mplementation* and *implementation evaluation* phases. Examples of these phases can be seen in Table 2. For these two phases, the coding scheme asked raters to select passages where the participants designed sequences of actions that could unfold during the solution of the problem; anticipated how events would play out; or evaluated the feasibility of their solutions. These were situations where the participant was strongly *solution-focused*.

In contrast, the *problem-focused* strategy allocated more attention to the *frame stating* and *frame assuming* phases. For these phases, the coding scheme asked raters to identify verbalized thoughts that focused on empathizing to assess the situation; developing hypotheses or assumptions to gain an understanding of the problem; or analyzing the problem by recalling the available information. The thoughts coded in these phases relate strongly to *problem-focused* behavior.

Insert Table 6 about here.

Figure 3 shows visualizations of the transition matrices presented in Tables 5 and 6. Here, in contrast to the simple, linear problem-solving process depicted in Figure 2, the transitions processes are much more complex. We see that the strategies use their time unevenly, this is shown in Figure 3. The circle's diameter is proportional to the time each strategy spends on each phase. Additionally, since participants transition between any two phases, *any* two circles are linked (not just those that are adjacent in the linear model). Figure 3 shows that some transitions are more common than others, as the thickness of the lines are proportional to their use by the strategies. Figure 3 has a simplification, the lines represent the sum of the transitions between two phases in *both* directions – for example, *FS* → *DE* + *DE* → *FS* – because of this we replace the arrow heads of Figure 2 with lines.

Figure 3 shows that the strategies are most strongly differentiated by the phases they attend to the most—the *focus of attention*—and the number of transitions to and from this focus of attention. The *solution-focused* strategy took the *implementation* and *implementation evaluation* phases as its *focus of attention*, whereas the *problem-focused* strategy focused its attention on the *frame assuming* and *frame stating* phases.

Insert Figure 3 about here.

In Figure 1, we showed the problem-solving sequence of two sample participants who followed each strategy. Person A followed the *problem-focused* strategy, while Person B followed the *solution-focused* strategy. From Figure 1, one can observe how the differences in the transition matrices emerge, as people similar to Person B direct their attention towards *implementation* and *implementation evaluation*. In contrast, people similar to Person A attend more often to *frame stating* and *frame assuming*.

The eight row in Tables 5 and 6 present the thinking time spent in the different phases of problem-solving by each group. We calculate that the *solution-focused* strategy group devoted 3.5 times more attention to *implementation* and 5.3 times more attention to *implementation evaluation* than the *problem-focused* strategy group.

There are two possible reasons for the difference between the strategies in these two phases. Either the *solution-focused* strategy transitions into these phases just as often as the *problem-focused* strategy and then spends more time in them, or it transitions more often into these phases but spends a similar period there each time. By counting the number of instances of participants transitioning into the *implementation* phases, we corroborated the second option. We found that the *solution-focused* strategy transitions 3.7 times more often into *implementation,* and 6.2 times more frequently into *implementation evaluation,* than the *problem-focused* strategy does. Thus, what differentiates the two strategies is not that the periods of attention last longer, but that the relevant phases are attended to more frequently—that is, the two strategies pattern attention differently by transitioning more or less between phases.

A similar analysis shows that the *problem-focused* strategy attends 2.5 times longer to *frame stating* and twice as long to *frame assuming* as the *solution-focused strategy*. Conducting a deeper analysis, we observe the same reason as before, only reversed: the *problem-focused* strategy transitions twice as often into *frame stating* and 1.7 times more often into *frame assuming* than the *solution-focused strategy*. In this case, per occasion, those following the *problem-focused* strategy spent around 25% less time every time they attended to the *framing* phases than *solution-focused* participants did, but as they made the transition much more often, the cumulative attention they spent was greater.

In the rest of the document we will refer as the *problem-focused* strategy allocating more attention to the *framing* phases and the *solution-focused* strategy as allocating more attention to the *implementation* phases. We do this because of the finding that the amount of time spent on each phase is proportional to the amount of transitions to and from the phases.

4.4 Alternative explanations

Table 7 contains the descriptive statistics and zero-order correlations between the *strategy* categorical variable (1 for the *solution-focused* strategy, 0 for the *problem-focused* strategy), *protocol duration*, cognitive skills, and demographic characteristics of our participants. We find that the strategy followed by our participants is not significantly correlated to most variables. Interestingly, the *solution-focused* strategy is positively correlated to *performance*: participants who used this strategy performed about 14% (t-test p-value = 0.004) better than those who followed the *problem-focused* strategy. Similarly, *protocol duration* was correlated to *performance*. However, as *protocol duration* and *strategy* are uncorrelated, each might provide a separate avenue for higher *performance*.

Insert Table 7 about here.

Additionally, we found a marginal mean difference (t-test p-value = 0.08) between the *planning and generativity* skills of the participants of the two groups. Specifically, participants who followed the *problem-focused* strategy tended to be marginally better at *planning and generativity*. This difference could be due to the fact that the *problem-focused* strategy attends longer to the *framing* of the problem—a key skill within the task we used to measure *planning and generativity,* the "Tower of Hanoi" (Laureiro-Martinez, 2014).

4.5 Transition to Study 2

In Study 1, we find that managers solve strategic problems by following one of two alternative strategies. Note that this result is not obvious. We could have found that there were not enough similarities among the strategies to cluster them together, or alternatively, that there were as many different strategies as participants in the sample. We could have also found that there was a single, dominant process that described the strategies developed by most participants. Instead, we found two patterns that describe strategies that have enough commonalities within a cluster, but enough differences to fall into two clearly differentiated clusters.

These strategies appear to differ in terms of the amount of attention spent on the *framing* or *implementation* phases of problem-solving. However, beyond the descriptive finding, we do not know whether the allocation of attention is what *causes* such strategies to emerge, or whether the two strategies could be induced using a manipulation. In other words, with Study 1, we are able to describe the emergence of two different strategies under a controlled environment. With Study 2, we aim to explain the cause of the different strategies by inducing the different problem solving processes using a manipulation.

Specifically, in Study 2, we manipulate the attention participants pay to the *framing* or the *implementation* phases of problem-solving, and compare their behavioral changes to a control condition. To estimate the behavioral changes, we conduct a study in which each participant solves two problems, to compare how participants behave before and after the corresponding manipulation.

Three outcomes are possible from this experimental study. First, we might find that we cannot manipulate the allocation of attention, and thus there is no behavioral change between the two treatment conditions and the control condition. Second, we might find that the two manipulations do change the participants' behavior, but that the behavioral change is the same or indistinguishable in both conditions, thus failing to illuminate the cause of the two different strategies. Finally, we could find that each manipulation of attention affects each condition differently. This outcome, in turn, can be manifested with clearly differentiated strategies that correspond to what we can expect from the theorizing derived from the findings obtained on Study 1, or refute those expectations. Below, we develop our expectations from the results of Study 1.

We study strategic problems: those that are complex, ill-structured, and novel, involving high-stakes, irreversible outcomes. Study 1 suggests that the process that participants adopt corresponds to the way their attention is allocated. If so, requiring participants to focus their attention on either the framing of the problem or the implementation of the solution should translate into changes in their behavior.

Participants who pay more attention to the framing of the problem will notice that the problem is new to them and hard to comprehend due to its lack of structure. They will put more effort into understanding the various elements of the problem and their relations. While this deliberation effort is devoted to better framing the problem and its structure, multiple thoughts will appear, aimed at connecting the elements of the problem; creating and revising a hierarchy of goals and priorities; and, according to that evolving framework, thinking about the structure of the problem (Baer et al., 2013). The problem solving process might thus require a higher number of thoughts than the process of a participant in a control condition. Therefore, we can propose that:

Hypothesis 1: Increased attention to the framing of the problem will lead to a *problem-focused* strategy.

In contrast, participants who are asked to pay more attention to the implementation of the solution will focus on thinking about what is at stake, reflecting on how to minimize potential negative outcomes, and developing detailed thinking about possible contingencies and future consequences of potential solutions (Schacter, Benoit & Szpunar, 2017). By focusing more on the implementation of the solution to the problem, the participant might end up devoting more time and deliberation to each thought than a participant in a control condition. A solution-focused strategy will be associated with every thought requiring more time to be performed. Therefore, we can propose that:

Hypothesis 2: Increased attention to the implementation of the solution will lead to a *solution-focused* strategy.

Testing these two hypotheses requires a method where we can track the thinking process of problem-solving and decompose it into multiple thoughts. In addition, we need to do this twice: once before a manipulation takes place, and once afterwards. While think-aloud protocols would still be a very useful technique, the data analyses would prove very expensive—not just because the analyses must be done one by one, but also because they would have had to be performed twice per participant. For a sample size like the one needed to have a three by two mixed factorial design, like the one we will use in Study 2, it would mean collecting and analyzing near over 1000 protocols. Rank-based tasks combined with move analyses provide an excellent option for our needs, as they allow us to present a strategic problem and track the thinking of the participants as it unfolds in real time, using the computer to measure the movements of the mouse. While the thoughts are not verbalized in this case, mouse moves are used as a proxy for thoughts. In the next section, we present the two problems we employ to investigate the effect of manipulating the allocation of attention on strategic problem-solving.

5. STUDY 2: METHODS

In the previous study, we uncovered two types of strategies that managers employ when solving strategic problems. In this section, we present the methodology we used to investigate the causal antecedent of these strategies. We first introduce the tasks used, continue with data collection, and finally present the data analysis and results.

5.1 Strategic problems: "NASA survival" and "winter survival"

The "winter survival" problem by Johnson and Johnson (1982: 111) and the "NASA survival" problem by Hall and Watson (1970) are two tasks that allow us to observe the problem-solving processes of the participants who perform them. Additionally, the two tasks are commonly used in research and management education (Baker & Paulson, 1995; Joshi, et al., 2005; Lane et al., 1982; Yetton & Bottger, 1983). The tasks required participants to think as a leader who had to make decisions for a group they were responsible for. The "Winter problem" is placed in the mountains of Manitoba in Canada on a winter day minutes after a plane that carried the leader and his group crashed into a lake. The survivors have collected a list of 12 items that the leader needs to rank based on their importance to the group's survival. The "NASA problem" has a very similar structure, but it is set on the moon. The participant is asked to imagine that the ship that carried the crew was forced to land 300 kilometers away from its destination, a meeting point. Now, in order to survive, the participant needs to rank 15 items in terms of their importance in allowing the crew to reach the destination.

Both problems, despite their initial appearance as taking place in settings far from those of a manager, fulfill the requirements for being considered strategic problems. They are *complex* given the number of interrelated items that the participant needs to rank order. They are *ill-structured* as information is not clear about the exact means for achieving the goals. The list of items is not well related to survival, and some items are of very little use and it would be even better to leave them behind. The role of external agents is uncertain; it is not clear if help is coming or if the group is on its own. Both problems are *high-stakes* and also *irreversible*. After the leader has finalized a solution and moves on to implement it (e.g. the groups start to walk or start creating a fire), every choice will have a cost that cannot be taken back. An item ranked too low might be left behind and create problems along the way. At its core the problems share many commonalities with very difficult situations a manager or an entrepreneur might face when trying to make their business unit or their small firm survive despite facing a number of constraints. However, in these problems, the contexts are *novel* to the participants, which prevents them from directly taking past experience into account.

Participants are asked to rank a list of items by dragging them from a column on the left to a column on the right. In the interface of the problems, participants can and do reposition items on the right while they think of their solution. This interface allows us to explore the problem-solving process participants follow, in the form of drag-and-drop events and the time it takes them to carry out the movements (Fedor et al., 2015)—not just their overall reaction times and solutions (Yu et al., 2012). We can study the time they take to make each move, and how that move comes about. While we cannot record the thinking processes directly, the events we can observe provide a proxy for the problem-solving process of the participants (Öllinger et al., 2013).

By using the “NASA survival” and “winter survival” problems, we can operationalize our expectations on the increase of number of thoughts or their duration in specific ways. “Today it is relatively uncontroversial that thinking can be represented as a sequence of thoughts (relatively stable cognitive states) interspersed by periods of processing activity" (Ericsson & Simon 1998: 180). We capture chunks of thoughts as any drag-and-drop move that a participant performs before arriving at their finished solution. We count the thoughts and measure their duration as the time between the preceding move (or the start of the test for the first move) and the current one.

A *problem-focused* strategy will involve an effort to connect a multiplicity of problem elements as the participant tries to give the problem a structure and tries to define the goals and priorities. A *problem-focused* strategy will be associated with a higher number of thoughts, measured as the number of drag-and-drop moves.

A *solution-focused* strategy will involve an effort to reflect on developing and maturing the possible solution. A *solution-focused* strategy will be associated with a higher depth on each thought, measured as the time between moves.

5.2 Data collection: Online experiment

We performed an online experiment that studied the behavioral changes that develop as a consequence of manipulating the allocation of attention towards either the framing of the problem (*framing-focused*) or the implementation of the solution (*implementation-focused*), or allowing the task to unfold without intervention (*control* condition). By asking participants in different treatment conditions to focus on the problem or the solution, we can compare how their behavior changes in comparison to a control condition and infer why the two strategies exist in the first place.

We ran three pilot studies before the online experiment took place. The main benefit of these, besides refining the problems and the computer interface, were the debriefing interviews, which provided qualitative evidence about the problem-solving processes, complementing the quantitative measures obtained from the experiment.

Research design

We perform a three-conditions-by-two-tasks mixed factorial design experiment (Oehlert, 2000). The experimental procedure began with all participants performing the first task (the "winter survival" problem) without being manipulated. After this, the participants were split into three groups: one control group and two treatment groups (*control, framing-focused,* and *implementation-focused*). The two treatment groups were presented with manipulations that aimed at increasing participants' allocation of attention towards either the framing of the problem or the implementation of the solution.

After the manipulation, all participants performed the second task (the "NASA survival" problem). The mixed factorial design allows us to study the behavioral change of the participants as an effect of the treatment. In comparison to a between-subject design, we can use the participants' measures before the manipulation as a baseline for the treatment effect, thus reducing variation in the analyses. In contrast to a within-subject design, not all participants are exposed to every treatment, allowing us to separate treatment effects.

Manipulations: Framing-focused and implementation-focused

The manipulation was shown between the "NASA survival" and "winter survival" problems, so we could compare the groups before any change and study the behavioral change of every participant after the manipulation—for example, whether they spent longer on the task, or performed more moves.

We asked participants to direct their attention to do more of the behaviors associated with the different phases of problem solving characteristic of each type of strategy. The manipulations recommended participants to "spend more of their time thinking about" either "the framing of the problem" or "the implementation of the solution." In the framing-focused manipulation, we explained to participants that the framing of the problem involves the following mental activities:

- Analyze the problem by recalling the available information
- Empathizing to identify with the situation
- Develop hypotheses/assumptions to gain an understanding of the problem.

In the implementation-focused manipulation, we explained to participants that implementing a solution involves the following mental activities:

- Design the sequence of actions that could unfold during the solution of the problem
- Anticipate how events will play out
- Evaluate the feasibility of the solutions

Finally, the control condition was asked to solve the problem in whatever way felt natural to them. We took the mental activities that we asked participants to follow directly from the coding scheme of the "Karabayos" task, in order to minimize the over-interpretation of our findings. We include more detail on the manipulation and research procedure in the Appendix.

Sample

We conducted the behavioral experiment through the platform Prolific, as a way of recruiting participants to our study. Prolific is a dedicated research subject pool and recruiting platform, employed in multiple studies in recent years. For comparisons between Prolific and other online participant recruitment platforms, see Palan and Schitter (2018) and Peer et al. (2017).

In our study, we allowed participants with a broader background than just managers, but we did filter for participants' attributes in order to get homogenous behavior and a comparable sample. Specifically, we selected participants who had at least a bachelor degree, to generate a pool of participants with similar educational backgrounds. Secondly, we filtered for English as a first language, to recruit participants who could understand the task well. Finally, we selected participants aged 55 and under, as the task required interaction in a drag-and-drop setting and experience with computers is of benefit.

The experiment included 523 participants. We excluded 51 participants who had experience in survival training because we wanted to replicate the conditions of the "Karabayos" problem, where participants had neither experience of leading Amazonian tribes, nor access to feedback. The experiment included 472 participants 276 in the control condition, 97 in the framing-focused condition, and 99 in the implementation-focused condition.

Incentives

In order to ensure high commitment, we created a three-level incentive scheme. The base payment rate in Prolific is 5 British Pounds per hour. Our Study took on average 30 minutes in total, for a total base payment of 2.5 British Pounds. The top 25% of performers on both tasks received twice the hourly payoff of the platform, £5; the middle 50% received 1.5 times the hourly rate, £3.75; and the bottom 25% received the hourly rate, £2.5. As participants self-select to take part in the online platform, doubling the payoff for high performance is deemed an attractive way to increase the saliency of the task (Hertwig & Ortmann, 2001).

5.3 Data analysis

As in the "Karabayos" task, we focused on the processes that participants employed to solve the problem and find a solution. To uncover participants' thought sequences, we employed move analyses, a process-tracing method. Move analyses focus on isolating the moves as a way to proxy for the thoughts that unfold while solving a problem (Yu et al., 2012; Öllinger et al., 2013; Fedor et al., 2015). In addition, in this study's analyses, we compared the changes in behavior that resulted in the three different conditions.

Dependent variables

We measured three main variables that allowed us to infer differences in the way each participant thought while solving the problem. We based our measurements on studies of move analyses that aim at understanding the deliberation that takes place during real-time problem solving by measuring mouse movements, clicks, and drag-and-drop moves of elements while solving a problem. The assumption is that the moves represent steps involved in the deliberation process (Yu et al., 2012; Öllinger et al., 2013; Fedor et al., 2015; Ormerod et al., 2002).

The first measure is the *total time* spent. This variable includes the time reading the task, and the time moving the items to create the final ranking. Therefore, this measure reflects the total effort and attention the participants put into the task.

Second, we measure the *number of moves* each participant performs. There is a minimum number of moves the participant can make, imposed by the number of items that must be ranked. For the "NASA survival" problem this lower bound is 15 moves, and for the "winter survival" problem, 12 moves. Any additional move above this threshold represents the refinement or correction of a previous idea. Since the lower bound is the same for everyone, the total number of moves can be used as a proxy for the number of thoughts a participant engaged in during the problem-solving process.

Third, we calculate the time between the first and last move and divide it by the number of moves. The *time per move* is a measurement of the amount of deliberation involved in each thought. Some moves will involve more thought than others, and some processes will involve more or fewer moves. Putting the three variables together, we can explore the behavioral changes that arise from manipulating the *focus of attention* in strategic problem-solving.

We study these three variables because they provide us with a proxy for the participants' problem-solving process. By comparing their values before and after the manipulation, and how the changes compare to the control condition, we can find an answer to the research question of Study 2, namely: *Why are there two strategies for solving strategic problems?*

Finally, both tasks include an optimal ranking created by an expert (Hall & Watson, 1970; Johnson & Johnson, 1982). We estimate the performance of the solutions by calculating the distance of the participant's ranking from the optimum. For example, if the participant placed item A in the first position, and it is supposed to be in position 7, we add a distance of 6 to the first item. We sum the distance of all other items in the task to calculate a participant's *performance.*

Control measures

For each participant we use demographic variables as control variables—specifically, their *age, gender* (1 for female, 0 for male)*, postgraduate* education (1 if they have a master's degree or above, 0 if not), and whether they read more than twice a week, and are thus classified as a *reader* (1 if they do, 0 otherwise). We use these variables as control measures for the behavioral and performance metrics. Overall, the average age was 34.9 years (s.d. = 8.5 years); 269 of the 478 participants were female; 161 had a postgraduate degree; and 219 read more than twice a week.

Behavioral change

We estimated the behavioral and performance change of every participant due to the manipulation. As the two tasks have different numbers of items to rank, we could not directly compare the performance of behavioral variables, so we standardized our variables to study the changes in behavior between the two tasks. Specifically, we calculated the distance in units of standard deviation from the mean of the control condition after the manipulation, and subtracted the distance before. This is calculated using the following formula[5]:

$$Change\ Value(i) = \frac{Value_{NASA}(i) - Mean_{NASA}(control)}{Std.Dev._{NASA}\ (control)} - \frac{Value_{Winter}(i) - Mean_{Winter}(All)}{Std.Dev._{Winter}\ (All)}$$

For example, if a participant (i) took the average time to finish the "winter survival" problem, and, after the manipulation, their time in the "NASA survival" problem was 0.33 standard deviations

[5] We use the values from the control condition only to calculate the mean and standard deviation in the "NASA survival" exercise. We do this filtering to avoid diluting the effect of the manipulation through increased standard deviations or changed means. Therefore the mean and standard deviation used for standardization come from untreated participants.

higher than the average, we stored a change of +0.33 standard deviations. This analysis allows us to study in greater detail the behavioral changes that happen to every individual, and not just the entire group.

In the results section below, we present only changed variables, namely *total time, time per move*, *number of moves,* and *performance.* The control variables do not change and are presented in simple form.

6. STUDY 2: RESULTS

Table 8 presents the descriptive statistics of the four main variables of the study; a descriptive and first-order correlation table is included in the Appendix. From Table 8, we can observe that, on average, participants performed 66% more moves than the minimum number required for each task. Increases in the number of moves used allow us to explore the differences in the behavior of the participants. First, however, we present a short example of how the measure of behavioral change is calculated. From the results in Table 8, a participant who performed 20 moves in the "winter survival" problem and 33 in the "NASA survival" problem is stored as a behavioral change of 0.33 standard deviations. This is the equivalent of the example from the methods section.

Insert Table 8 about here.

Table 9 presents four ordinary least square regressions, we obtained the same results with robust regressions but show the model in Table 9 for simplicity. Each regression uses the same covariates, but focuses on a different dependent variable. Model 1 presents the change in *total time*. Both treatment conditions have beta values whose 95% confidence intervals are positive. That is, in both cases, the treatment led to participants spending more time on the task. The effect size of the change of *total time* between the control and treatment conditions (together) is small, with a Cohen's Delta of 0.269 with a confidence interval of [0.085, 0.454]. The η^2 value for the analysis of variance of the three conditions is 0.0174, again showing a small effect size. Participants in the treatment conditions spent longer after being given a hint about how to perform better. We can infer that the participants saw the manipulations as proxies for achieving higher performance.

Insert Table 9 about here.

Model 1 showed that the participants of both conditions spent more time overall on the problem after the manipulation. However, they used the time in different ways. Interestingly, when analyzing the time spent per move, Model 2 shows that the participants who were asked to focus on the solution spent longer *time per move*, whereas the framing-focused condition spent a similar amount of *time per move* as the control condition, thus supporting Hypothesis 1. Interestingly too, we found the opposite when analyzing the number of moves in Model 3. Framing-focused participants increased the *number of moves* when compared to the control condition. In contrast, the implementation-focused participants performed a similar number of moves as the control condition. The η^2 value for model 3 is 0.0141, and for Model 3 the value is 0.0111, giving support to Hypothesis 2. In both cases, the effect size qualifies as small. Finally, Model 4 focuses on the change in *performance* after the manipulation; focusing on the problem or the solution did not affect *performance*. However, behavioral changes were present.

Interestingly, while both manipulations led to an overall increase in deliberation effort (total time employed by the participants), each type of focus led to this additional deliberation being employed in two very different ways. Participants asked to focus on the framing of the problem spent their time engaging in more thoughts, represented by 3.81 more moves than the control and *implementation-focused* conditions. Each move was preceded with the same amount of deliberation as the moves of the control condition. In contrast, the participants who were asked to focus on the implementation of the solution conducted about 20% more deliberation before every move, but their total number of moves was similar to those in the control condition. Each thought took longer, but no additional thoughts were needed to solve the problem.

Combining the moves measures with debriefing interviews, we can infer that participants in the *framing-focused* condition restructured the way they defined the problem and adjusted their priorities more often than participants in the other conditions, probably due to a constant updating of their definition of the problem. An increase in the focus on the solution, meanwhile, led participants to perform the same number of thoughts as the control condition, but each thought involved more deliberation than in the other conditions. This might be because they delved deeper into their thoughts about how their solutions might unfold into the future.

7. DISCUSSION

In this paper, we study the micro-processes of strategic problem-solving. These micro-processes have often been treated as black boxes (as critically discussed in Langley et al., 1995; Posen et al., 2018) and at one remove from the theorizing of the problem-solving perspective (as highlighted in Baer et al., 2013). Using precise exploratory methods, we open the black box. Inside it, we discover two alternative strategies that reflect the way managers go about framing, analyzing, and ultimately solving strategic problems when they have neither experience nor feedback. Despite taking place in geographically distant contexts, the tasks we chose share the fundamental characteristics of strategic problems and have many parallels with the type of problems managers face in real-world organizational settings.

Our first contribution is to describe the emergence of these two strategies using exploratory methods. We used think-aloud protocols and a structured data analysis process to allow the two strategies to emerge from the data. Our methods did not pre-specify the number of strategies; we could have found any number of them, yet only two emerged. We found that the two strategies seem to differ in how they allocate their attention to different problem-solving phases: framing or implementation. Building on this finding, we developed a behavioral experiment to test whether and how shifts in attention focus affected the choice of problem-solving strategy. We found that by manipulating participants' focus of attention, we could indeed influence which strategy they adopt.

Our second contribution is to develop a theory that allows us to make predictions about how the allocation of attention will drive different processes to solve strategic problems. This contribution lies at the intersection of theories of organizations, in particular the Carnegie School (Gavetti, Levinthal, & Ocasio, 2007), the attention-based view (Ocasio, 1997; 2011; Ocasio & Joseph, 2018), and theories of managerial problem-solving and decision-making (Langley et al., 1995; Nickerson & Zenger, 2004; Klingebiel & De Meyer, 2013; Felin and Zenger, 2016).

The strategic problem-solving literature has focused on the organizational and meso-levels of analysis (Nickerson & Zenger, 2004). A microstructural approach to study organizational problems argues that by accumulating knowledge on the smallest organizational forms we can build organization science from the microstructures up (Puranam, 2018). We agree with this view and focus on the individuals. We use the attention-based view to conceptualize the processes that precede the formation of strategies. The attention-based view adopts a processual view, defining strategy as “a pattern of attention” rather than a set of actions (Ocasio & Joseph, 2018: 289).

Studying attention, allows us to contribute to the call to study how the process of solving managerially relevant problems unfolds beyond the mere linear sequences of decomposed phases, and capture the unfolding processes inside the black box of problem solving (Langley et al., 1995; Posen et al. 2018). Uncovering such processes is helpful tounderstand how managers solve problems and learn, even without the possibility of receiving feedback (March, Sproull, & Tamuz, 1991).

Although attention is a dynamic resource (Bansal, Kim, & Wood, 2018), “the traditional [attention-based view] is, however, not very well equipped to explain less-incremental forms of change and adaptation” (Ocasio, Laamanen, & Vaara, 2018: 156). Ocasio et al. (2018) proposed looking at communication channels as one possible avenue of making the attention-based view more dynamic. Our study illustrates another such avenue by studying the micro-processes of problem-solving. Like Bansal et al. (2018), we find that attention can be focused, but not spread too thinly: one can attend either to the problem itself or to its solutions—but not attend both at the same time. When we observe the emergence of the problem solving strategies in Study 1, we see that attention is naturally allocated to some phases more than others. This might be a reflection of the fact that we are bounded rational, and attention is a scarce resource, so it cannot be allocated to each and every phase of problem solving. “The accurate planning and performance of strategic actions and the speed of their execution require that individual and group decision-makers concentrate their energy, effort, and mindfulness on a limited number of issues and tasks.” (Ocasio 1997, p. 203). Such need for focus is evident again when we manipulate attention in Study 2. We observe that compared to the control condition, the total thinking time is higher in the two manipulated conditions. This might be reflecting the fact that, since attention is limited, the tendency is to conserve this scarce resource, thus deliberating less in the control condition than in the two manipulated conditions. Future studies should investigate how attention is focused under conditions of higher activity load (Castellaneta & Zollo 2014), when, for example, multiple the demands on attention might affect the strategies that emerge. Redefining strategies from how and where attention is focused (Ocasio, 2011; Ocasio & Joseph, 2018) allows us to illuminate the processes that precede actions, and thus understand where differences come from.

Complexity and uncertainty have canonical representations in the behavioral theory of the firm, the NK landscape for complexity (Levinthal, 1997; Billinger, Stieglitz, & Schumacher, 2013), and the "N-arm bandit" for uncertainty (Posen & Levinthal, 2012; Laureiro et al., 2015). Future studies could build on these representations and use think-aloud protocols to trace search processes. Process studies based on think-aloud protocols can potentially directly observe, validate, and refine the model proposed by Cyert and March (1963) when appropriate. Some steps in this direction have been taken by Reypens and Levine (2017), but should be extended to the environments of Billinger et al. (2013) and Laureiro et al. (2015) as they map to the canonical representations. Within the studies of microfoundations of strategy, recent studies show how individuals' specific traits are important in how they solve problems. More specifically, this stream of research has shown that cognitive flexibility (Laureiro & Brusoni, 2018), and strategic intelligence (Levine, Bernard, & Nagel, 2017) can be seen as antecedents of adaptive decision-making. Our study adds the concept of problem-solving strategies to this repertoire—but, in contrast to prior studies, we show that strategies can be changed by shifting the focus of attention. Future studies could investigate how managers change their problem-solving strategies in connection to shifts in attention, whether caused by the manager's own attention focus, and/or the way their attention is directed by organizational structures (Ocasio, 1997).

Our knowledge of how strategic problems are solved can serve as the foundation of research on the microstructure of organizations (Puranam, 2018). The microstructural approach argues that by accumulating knowledge on the smallest organizational forms—dyads and triads—we can build organization science from the microstructures up. We agree with this view—yet, as Felin and Foss (2005: 441) point out: "there is no organization without individuals." Often, individual-level heterogeneity is disregarded or acknowledged merely by controlling for variables such as gender, age, or level of education. In fact, as we show in this paper, individual heterogeneity in the way attention is allocated matters greatly. It leads to real differences in the way the most challenging problems are solved and ultimately engenders the strategies that leaders induce their organizations to follow. Only by understanding how the individual members of a dyad or triad solve problems can we make a judgment on how to organize them. Future studies could use our findings as a point of departure, and use the methods from Study 1 to investigate whether and how attention is allocated differently when a strategic problem is solved by two individuals working together. . This might result in a robust tool to answer "fundamental and universal problems of organizing (that relate to how they aggregate their members' efforts)" (Puranam, 2018: 1). How will a strategy emerge from the interaction of two different problem-solving processes? What would happen if within a dyad two different strategies emerge? Do contrasting decision-making strategies complement each other, or simply lead to conflict within the dyad? In a similar vein, the methods of Study 1 could be used in combination with, for example, the task from Cohen and Bacdayan (1994), who recorded the routine formation process of dyads who do not communicate. Future studies could employ think-aloud protocols and record the thinking processes that develop as two participants' strategy form, and how from those emergent strategies routinized patterns of actions unfold. The routines in Cohen and Bacdayan (1994) require cooperation between the agents. The concept of "routines as truce" is foundational to the evolutionary theory of economic change (Nelson & Winter, 1982) and the behavioral theory of the firm (Cyert & March, 1963), yet has not been studied as a micro-process. The methodology of Study 1 could enable future studies to investigate these processes.

Our third contribution is methodological. This paper builds upon and extends prior work on sequence analysis. For example, Salvato (2009) used sequence analysis to study the role of routine activities in the evolution of new product development (NPD) processes, to reveal a firm's capabilities. We take this approach to the micro level, and use sequence analysis to study the role of problem-solving phases in the crafting of solutions to strategic problems. Such solutions are the building blocks of the NPD capabilities that Salvato (2009) studied. As stated above, we think that this paper's combination of methods is a good example of the cycle of theory building and theory testing—methodologically complex, but foundational to the growth of scientific knowledge (Popper, 1962).

Our fourth and final contribution is to practice. Organizations put significant effort into managing their new product development (Salvato & Rerup, 2018). Our study can contribute to understanding why. As people focus either on the problem or on the solution, new product development methods could be seen as ways to manage attention in order to affect the way new products are developed. Some methods, for example Six Sigma and Lean product development, fix the attention to the problem (Liker & Morgan, 2006; Schroeder et al., 2008). These methods have a strong focus on finding sources of variation and waste and fix attention to the problem at the expense of the solution. Other new product development methods shift attention cyclically. For example, in Design Thinking participants first, focus attention to the problem, shift to attending the solutions, and cyclically continue the shifting of attention (Eisbach & Stigliani, 2018). The cyclical process allows for finding mistakes and creating new ideas. A shifting focus of attention is also present in the scientific approach to entrepreneurial decision-making advocated by Camuffo et al. (2019). In their approach, startups first attend to the problem by building key performance indicators, and then test their indicators, shifting their attention to the solution. After testing, new indicators are built, and the cycle continues. Our study allows us to understand the microfoundations of why new product development requires shifting or fixing the focus of attention. Attention is a limited resource; we see its scarceness in the two studies. When the clusters emerge without manipulation (Study 1) attention is given in higher amounts either to the problem or to the solution, not to both. We see that when we manipulate attention (Study 2), the control condition spends less attention than the two manipulated conditions. New product development methods guide people into shifting or fixing their attention to create the product the organization wants. However, our study also provides a warning notice. Since people use different strategies when solving problems, it might be that some methods work predictably better with some people and not others. Since these methods are widely used in organizations, future studies could investigate how to mix and match people and methods and how to help people shift their attention better between the problem and the solution.

In conclusion, this study broadens our understanding of how strategic problems are solved. Prior studies relied on distant analogies that only reflected certain characteristics of strategic problems. For example, Newell and Simon (1972) studied chess, which is admittedly complex, but far more structured than the problems managers typically face. With this study, we bring process-level data to tasks that, though apparently far-fetched in the contexts they involve, nevertheless require participants to grapple with problems that are ill-structured, complex, and novel, with high-stakes, irreversible outcomes. Thus, we show how people grapple with a type of problems that managers face under conditions that are representative of the complexities and fast change of their actual organizational lives.

REFERENCES

Andrews, K. R. (1971). *The concept of corporate strategy*. New York.
Baer, M., Dirks, K. T., & Nickerson, J. A. (2013). Microfoundations of strategic problem formulation. *Strategic Management Journal*, 34(2): 197-214.
Baker, H. E., & Paulson, S. K. (1995). *Experiential exercises in organization theory*. Prentice Hall.
Bansal, P., Kim, A., & Wood, M. O. (2018). Hidden in plain sight: The importance of scale in organizations' attention to issues. *Academy of Management Review*, 43(2), 217-241.
Billinger, S., Stieglitz, N., & Schumacher, T. R. (2013). Search on rugged landscapes: An experimental study. *Organization Science*, 25(1), 93-108.
Brightman, H. J. (1978). Differences in ill-structured problem-solving along the organizational hierarchy. *Decision Sciences*, 9(1): 1-18.
Camuffo, A., Cordova, A., Gambardella, A., & Spina, C. (2019). A scientific approach to entrepreneurial decision making: Evidence from a randomized control trial. *Management Science.*
Castellaneta, F., & Zollo, M. (2014). The dimensions of experiential learning in the management of activity load. *Organization Science*, 26(1), 140-157.
Cohen, M. D., & Bacdayan, P. (1994). Organizational routines are stored as procedural memory: Evidence from a laboratory study. *Organization science*, 5(4), 554-568.
Csaszar, F. A. (2013). An efficient frontier in organization design: Organizational structure as a determinant of exploration and exploitation. Organization Science, 24(4), 1083-1101.
Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. *Englewood Cliffs, NJ*, *2*(4), 169-187.
Dewey J. (1910). *How we think*. Boston. MA: DC Heath.
Dong, J., March, J. G., & Workiewicz, M. (2017). On organizing: an interview with James G. March. *Journal of Organization Design*, 6(1), 14.
Einstein A, Infeld L. (1938). *The Evolution of Physics.* Simon and Schuster: New York.
Elsbach, K. D., & Stigliani, I. (2018). Design thinking and organizational culture: A review and framework for future research. *Journal of Management*, 44(6), 2274-2306
Eisenhardt, K. M., & Bourgeois III, L. J. (1988). Politics of strategic decision making in high-velocity environments: Toward a midrange theory. *Academy of Management Journal*, 31(4), 737-770.
Ericsson, K. A. (2003). Valid and non-reactive verbalization of thoughts during performance of tasks towards a solution to the central problems of introspection as a source of scientific data. *Journal of Consciousness Studies*, 10(9-10): 1-18.
Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, 87(3): 215.
Ericsson, K. A., & Simon, H. A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. *Mind, Culture, and Activity*, 5(3): 178-186.
Fedor, A., Szathmáry, E., & Öllinger, M. (2015). Problem solving stages in the five square problem. *Frontiers in psychology*, *6*, 1050.
Felin, T., & Foss, N. J. (2005). Strategic organization: A field in search of micro-foundations. Strategic Organization. 3(4), 441-455
Felin, T., & Zenger, T. R. (2015). CROSSROADS—Strategy, Problems, and a Theory for the Firm. *Organization Science*, 27(1), 222-231.
Fernandes, R., & Simon, H. A. (1999). A study of how individuals solve complex and ill-structured problems. *Policy Sciences*, 32(3): 225-245.
Fox, M. C., Ericsson, K. A., & Best, R. (2011). Do procedures for verbal reporting of thinking have to be reactive? A meta-analysis and recommendations for best reporting methods. *Psychological Bulletin*, 137(2), 316.
Gavetti, G., & Levinthal, D. (2000). Looking forward and looking backward: Cognitive and experiential search. *Administrative Science Quarterly*, 45(1): 113-137.
Gavetti, G., Levinthal, D., & Ocasio, W. (2007). Perspective—Neo-Carnegie: The Carnegie school's past, present, and reconstructing for the future. *Organization Science*, 18(3), 523-536.
Gavetti, G., Levinthal, D., & Rivkin, J. W. (2005). Strategy making in novel and complex worlds: The power of analogy. *Strategic Management Journal*, 26(8): 691-712.
Ghemawat, P. (1991). *Commitment*. Simon and Schuster.
Gibbs, A. J., Dale, M. B., Kinns, H. R., & MacKenzie, H. G. (1971). The transition matrix method for comparing sequences; its use in describing and classifying proteins by their amino acid sequences. *Systematic Biology*, 20(4): 417-425.
Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: models of bounded rationality. *Psychological Review*, 103(4): 650.
Grégoire D. A., Barr P. S., Shepherd D. A. (2010). Cognitive processes of opportunity recognition: The role of structural alignment. *Organization Science* 21(2): 413-431.
Hall, J., & Watson, W. H. (1970). The effects of a normative intervention on group decision-making performance. *Human relations*, *23*(4), 299-317.

Hennig, C. (2015). *fpc: Flexible Procedures For Clustering*. R Package Version 2.1-6.
Hertwig, R., & Ortmann, A. (2001). Experimental practices in economics: A methodological challenge for psychologists?. *Behavioral and Brain Sciences*, 24(3), 383-403.
Isenberg D. J. (1986). Thinking and managing: A verbal protocol analysis of managerial problem-solving. *Academy of Management Journal* 29(4): 775-788.
Johnson, D. W., & Johnson, F. P. (1982). *Joining together* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall. 111-116
Joseph, J., & Wilson, A. J. (2018). The growth of the firm: An attention-based view. *Strategic Management Journal*, 39(6), 1779-1800.
Joshi, M. P., Davis, E. B., Kathuria, R., & Weidner, C. K. (2005). Experiential learning process: Exploring teaching and learning of strategic management framework through the winter survival exercise. *Journal of Management Education*, *29*(5), 672-695.
Kaufman L, Rousseeuw P. J. (1990). Partitioning around medoids (program pam). *Finding groups in data: an introduction to cluster analysis*: 68-125.
Klein, G. (1997). The recognition-primed decision (RPD) model: *Looking back, looking forward. Naturalistic decision making*: 285-292.
Klingebiel, R., & De Meyer, A. (2013). Becoming aware of the unknown: decision making during the implementation of a strategic initiative. *Organization Science*, 24(1): 133-153.
Krippendorff K. (2012). *Content analysis: An introduction to its methodology*. Sage.
Kuusela, H., & Paul, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. *The American Journal of Psychology*, 113: 3.
Lane, I. M., Mathews, R. C., Chaney, C. M., Effmeyer, R. C., Reber, R. A., & Teddlie, C. B. (1982). Making the goals of acceptance and quality explicit: Effects on group decisions. *Small Group Behavior*, 13(4), 542-554.
Langley, A., Mintzberg, H., Pitcher, P., Posada, E., & Saint-Macary, J. (1995). Opening up decision making: The view from the black stool. *Organization Science*, 6(3): 260-279.
Laureiro-Martinez, D. (2014). Cognitive control capabilities, routinization propensity, and decision-making performance. *Organization Science*, 25(4): 1111-1133.
Laureiro-Martínez, D., & Brusoni, S. (2018). Cognitive flexibility and adaptive decision-making: Evidence from a laboratory study of expert decision makers. *Strategic Management Journal*, 39(4), 1031-1058.
Laureiro-Martínez, D., Brusoni, S., Canessa, N., & Zollo, M. (2015). Understanding the exploration–exploitation dilemma: An fMRI study of attention control and decision-making performance. *Strategic Management Journal*, 36(3), 319-338.
Levine, S. S., Bernard, M., & Nagel, R. (2017). Strategic intelligence: The cognitive capability to anticipate competitor behavior. Strategic Management Journal, 38(12), 2390-2423.
Levinthal, D. A. (1997). Adaptation on rugged landscapes. *Management Science*, 43(7), 934-950.
Levitt, B., & March, J. G. (1988). Organizational learning. *Annual review of sociology*, 14(1), 319-338.
Liker, J. K., & Morgan, J. M. (2006). The Toyota way in services: the case of lean product development. *Academy of management perspectives*, 20(2), 5-20.
Lipshitz, R., & Bar-Ilan, O. (1996). How problems are solved: Reconsidering the phase theorem. *Organizational Behavior and Human Decision Processes*, 65(1): 48-60.
Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content analysis in mass communication: Assessment and reporting of intercoder reliability. *Human communica*
Mahalanobis, P. C. (1936). On the generalized distance in statistics. *Proceedings of National Institute of Science of India*. 12, 49-55
March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization science*, 2(1), 71-87.
March, J. G., Sproull, L. S., & Tamuz, M. (1991). Learning from samples of one or fewer. *Organization science*, 2(1), 1-13.
Mintzberg, H., Raisinghani, D., & Theoret, A. (1976). The structure of "unstructured" decision processes. *Administrative Science Quarterly*, 21(2): 246-275.
Nelson, R., & Winter, S. (1982). *An Evolutionary Theory of Economic Change*, Harvard Univ. Pres, Cambridge.
Neuendorf, K. A. (2002). *The content analysis guidebook*. Sage.
Newell, A., & Simon, H. A. (1972). *Human problem solving* (Vol. 104, No. 9). Englewood Cliffs, NJ: Prentice-Hall.
Nickerson, J. A., & Zenger, T. R. (2004). A knowledge-based theory of the firm—The problem-solving perspective. *Organization Science*, 15(6): 617-632.
Nickerson, J. A., Silverman, B. S., & Zenger, T. R. (2007). The problem of creating and capturing value. *Strategic Organization*, 5(3), 211-225.
Ocasio, W. (1997). Towards an attention-based view of the firm. S*trategic Management Journal*, 18(S1), 187-206.
Ocasio, W. (2011). Attention to attention. *Organization Science*, 22(5), 1286-1296.

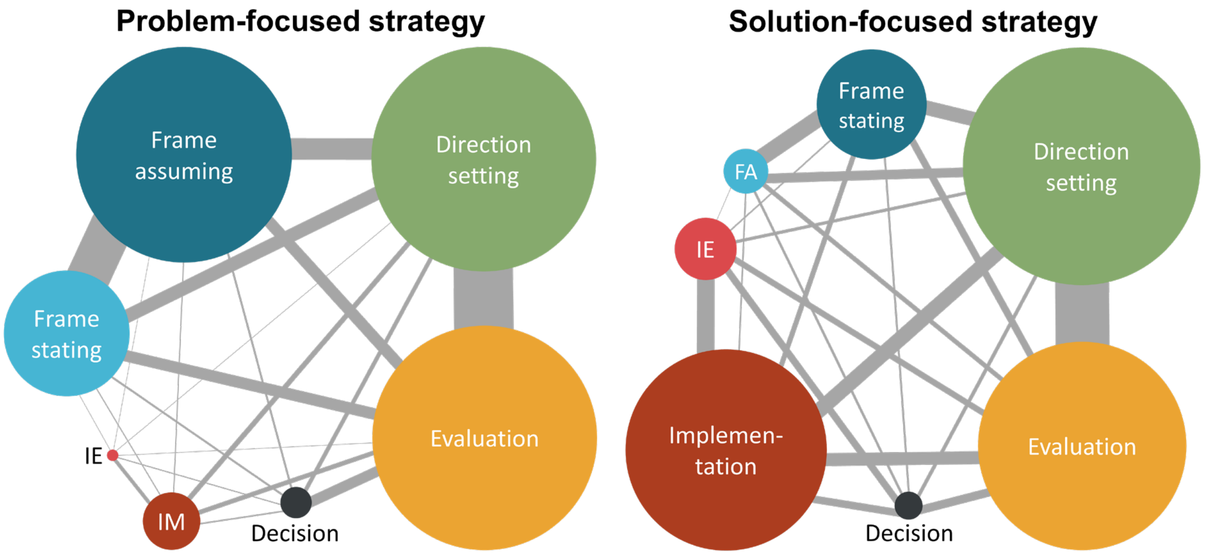
Ocasio, W., & Joseph, J. (2005). An attention-based theory of strategy formulation: Linking micro-and Macroperspectives in strategy processes. In *Strategy Process* (pp. 39-61). Emerald Group Publishing Limited.
Ocasio, W., & Joseph, J. (2018). The attention-based view of great strategies. *Strategy Science*, 3(1), 289-294.
Ocasio, W., Laamanen, T., & Vaara, E. (2018). Communication and attention dynamics: An attention-based view of strategic change. *Strategic Management Journal*, *39*(1), 155-167.
Oehlert, G. W. (2000). *A first course in design and analysis of experiments.* W. H. Freeman
Öllinger, M., Jones, G., Faber, A. H., & Knoblich, G. (2013). Cognitive mechanisms of insight: the role of heuristics and representational change in solving the eight-coin problem. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 39(3), 931.
Ormerod, T. C., MacGregor, J. N., & Chronicle, E. P. (2002). Dynamics and constraints in insight problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28(4), 791.
Palan, S., & Schitter, C. (2018). Prolific. ac—A subject pool for online experiments. *Journal of Behavioral and Experimental Finance*, 17, 22-27.
Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. J*ournal of Experimental Social Psychology*, 70, 153-163.
Popper, K. R. (1963). Conjectures and Refutations. Routledge and Kegan Paul.
Posen, H. E., Keil, T., Kim, S., & Meissner, F. D. (2018). Renewing Research on Problemistic Search—A Review and Research Agenda. *Academy of Management Annals*, 12(1), 208-251.
Posen, H. E., & Levinthal, D. A. (2012). Chasing a moving target: Exploitation and exploration in dynamic environments. *Management Science*, 58(3), 587-601.
Posner, M. I. (2004). *Cognitive Neuroscience of Attention*. Guilford Press, New York.
Puranam, P. (2018). *The microstructure of organizations*. Oxford University Press.
Rangel, A., Camerer, C., & Montague, P. R. (2008). A framework for studying the neurobiology of value-based decision making. *Nature Reviews Neuroscience*, 9(7): 545-556.
Rasmussen, J. L. (1988). Evaluating outlier identification tests: Mahalanobis D squared and Comrey Dk. *Multivariate Behavioral Research*, 23(2), 189-202.
Ratcliff, R., & McKoon, G. (2008). The diffusion decision model: theory and data for two-choice decision tasks. *Neural computation*, 20(4): 873-922.
Reypens, C., & Levine, S. S. (2017). To grasp cognition in action, combine behavioral experiments with protocol analysis. In Methodological challenges and advances in managerial and organizational cognition (pp. 123-146). Emerald Publishing Limited.
Reypens, C., & Levine, S. S. (2018). Behavior in Behavioral Strategy: Capturing, Measuring, Analyzing', *Behavioral Strategy in Perspective* (Advances in Strategic Management, Volume 39).
Salvato, C. (2009). Capabilities unveiled: The role of ordinary activities in the evolution of product development processes. *Organization Science*, 20(2): 384-409.
Salvato, C., & Rerup, C. (2018). Routine regulation: Balancing conflicting goals in organizational routines. *Administrative Science Quarterly*, 63(1), 170-209.
Sarasvathy, S. D., Simon H. A., & Lave L. (1998). Perceiving and managing business risks: Differences between entrepreneurs and bankers. *Journal of Economic Behavior & Organization* 33(2): 207-225.
Schacter, D. L., Benoit, R. G., & Szpunar, K. K. (2017). Episodic future thinking: Mechanisms and functions. *Current opinion in behavioral sciences*, 17, 41-50.
Schroeder, R. G., Linderman, K., Liedtke, C., & Choo, A. S. (2008). Six Sigma: Definition and underlying theory. *Journal of operations Management*, 26(4), 536-554.
Schwenk, C. R. (1985). The use of participant recollection in the modeling of organizational decision process. *Academy of Management Review*, 10(3): 496-503.
Simon, H. A. (1962). The architecture of complexity, *Proceedings of the American Philosophical Society*, 106(6), 467-482.
Simon, H. A. (1965). *Administrative behavior* (Vol. 4). New York: Free Press.
Snyder, R. C., & Paige, G. D. (1958). The United States decision to resist aggression in Korea: The application of an analytical scheme. *Administrative Science Quarterly*, 341-378.
Tversky, A., & Kahneman, D. (1975). Judgment under uncertainty: Heuristics and biases. In *Utility, probability, and human decision making*. Springer Netherlands.
Wollersheim, J., K.H. Heimeriks. 2016. Dynamic capabilities and their characteristic qualities: insights from a lab experiment. *Organization Science* 27(2) 233-248
Yetton, P., & Bottger, P. (1983). The relationships among group size, member ability, social decision schemes, and performance. *Organizational Behavior and Human Performance*, *32*(2), 145-159.
Yu, Z., Wang, F., Wang, D., & Bastin, M. (2012). Beyond reaction times: Incorporating mouse-tracking measures into the implicit association test to examine its underlying process. *Social Cognition*, 30(3), 289-306.

FIGURES

Figure 1: Example of problem-solving sequences of two individuals

Figure 2: Visualization of a linear model transition matrix

Figure 3: Visualizations of the problem- and solution-focused strategy transition matrices



TABLES

Table 1: Comparison of different problem-solving models and their phases

Prior Management Models		Combined problem-solving model	Neuroscience model
Simon (1965)	**Schwenk (1985)**		**Rangel et al. (2008)**
Intelligence Gathering	Goal formulation and Problem identification	*Frame stating (FS)*	Representation
		Frame assuming (FA)	
Design	Strategic alternative generation	*Direction setting (DS)*	
Choice	Evaluation and selection	*Evaluation (EV)*	Valuation
		Decision (DE)	Action Selection
NA	Implementation	*Implementation (IM)*	NA
NA	NA	*Implementation evaluation (IE)*	Outcome Evaluation

Table 2: Problem-solving phase coding definitions

Problem-solving phases	Description	Examples of verbalized thoughts (transcribed verbatim)
Frame stating (FS)	Repeating the data mentioned in the text of the problem	"…so our area want to be left alone we are vulnerable that we have understood for a good reason … *I* mean here *I do* no*t* have other information problems diseases a very small zone lack of food…"
Frame assuming (FA)	Development of hypotheses not mentioned in the problem	"… for millennia and before me, my father, my grandfather, and all the others one after the other without having to face things that were more difficult go hunting sometimes or collect fruit…"
Direction setting (DS)	Defining a general path of actions to be followed and generating proposals about what should be done	"… we can also be a means for, a means to attract, for your region, we can, we can make people, we can, we can help you make I do not know a museum something we can make lessons to teach city kids how to love the forest…"
Evaluation (EV)	Evaluating and judging the proposal and considered their strategy without evaluating specific details	"… sending two or three people can be interesting… even though most likely those two or three won't return…"
Decision (DE)	Making an explicit choice about what intended actions	"…however I will try to dialogue this for sure I will try three key points dialogue with another civilization support from my group and away and an alternative in case of failure of dialogue…"
Implementation (IM)	Designing a sequence of actions required to carry on the proposed actions	"…slow calm we arrive in front of a representative we try with presents with kids with women and with men with those most intelligent to craft a speech even with gestures drawing we ask for help and we see if they help if not we try alone we do not explain where we are because if we explain because if we have to try at least they don't know where we are… we return…"

Implementation evaluation (IE)	Evaluating the possible actions' outcomes	"…is clear that it is not easy because probably out the jungle a someone some member of my tribe will hardly survive but is an endeavor to try…" "…if the two people [that were sent away before] should not return however 46 people will still be alive if instead return with a positive answer we have solved at least for some time long enough the problem…"

Table 3: Transition matrix for a flat and linear sequence

Flat & Linear	→ FS	→ FA	→ DS	→ EV	→ DE	→ IM	→ IE
FS →		16.67	0.00	0.00	0.00	0.00	0.00
FA →	0.00		16.67	0.00	0.00	0.00	0.00
DS →	0.00	0.00		16.67	0.00	0.00	0.00
EV →	0.00	0.00	0.00		16.67	0.00	0.00
DE →	0.00	0.00	0.00	0.00		16.67	0.00
IM →	0.00	0.00	0.00	0.00	0.00		16.67
IE →	0.00	0.00	0.00	0.00	0.00	0.00	
% of thinking time	14.3	14.3	14.3	14.3	14.3	14.3	14.3

Table 4: Full-sample transition matrix

Full sample	→ FS	→ FA	→ DS	→ EV	→ DE	→ IM	→ IE
FS →		9.07	3.90	1.49	0.41	0.31	0.07
FA →	7.27		6.61	2.12	0.53	0.66	0.11
DS →	1.87	2.71		16.47	1.17	3.03	0.20
EV →	2.77	2.66	11.64		3.10	2.27	0.43
DE →	0.75	0.39	0.68	1.84		1.04	1.03
IM →	0.42	0.79	1.66	1.65	0.99		3.09
IE →	0.32	0.39	0.60	0.99	0.72	1.77	
% of thinking time	10.8	19.1	25.4	24.2	3.3	13.2	4.0

Table 5: Solution-focused strategy transition matrix

Solution-focused	→ FS	→ FA	→ DS	→ EV	→ DE	→ IM	→ IE
FS →		5.32	2.97	1.02	0.26	0.13	0.00
FA →	3.06		5.06	1.95	0.78	1.25	0.13
DS →	1.69	2.31		14.88	1.11	4.98	0.35
EV →	1.10	1.64	12.10		2.37	4.21	0.84
DE →	0.94	0.13	0.51	1.94		1.63	2.23
IM →	0.62	1.19	2.66	2.32	2.27		5.37
IE →	0.23	0.75	1.23	2.08	1.22	3.15	
% of thinking time	5.7	12.2	26.4	23.2	3.1	22.4	6.9

Table 6: Problem-focused strategy transition matrix

Problem-focused	→ FS	→ FA	→ DS	→ EV	→ DE	→ IM	→ IE
FS →		11.61	4.70	1.81	0.47	0.34	0.07
FA →	10.21		7.77	2.21	0.36	0.16	0.07
DS →	2.12	3.04		18.09	1.24	1.60	0.08
EV →	3.93	3.42	11.71		3.63	0.99	0.16
DE →	0.57	0.58	0.83	1.82		0.59	0.16
IM →	0.23	0.43	0.96	1.21	0.08		1.11
IE →	0.20	0.13	0.20	0.19	0.39	0.54	
% of thinking time	14.2	24.0	25.3	25.5	3.5	6.3	1.3
t-test p-value	0.000	0.001	0.786	0.553	0.681	0.000	0.001

Table 7: Descriptive statistics for the "Karabayos" problem

	1.	2.	3.	4.	5.	6.	7.	8.
1. Performance	1							
2. Solution-focused strategy	0.358 (0.013)	1						
3. Protocol duration (min.)	0.315 (0.029)	0.114 (0.44)	1					
4. Planning & generativity (s)	0.164 (0.287)	0.270 (0.076)	0.091 (0.558)	1				
5. Abstract thinking	0.237 (0.117)	-0.066 (0.667)	-0.090 (0.555)	-0.217 (0.158)	1			
6. Age (years)	0.088 (0.551)	0.120 (0.416)	-0.109 (0.461)	-0.140 (0.364)	0.024 (0.875)	1		
7. Gender: Female	-0.082 (0.578)	0.027 (0.855)	-0.176 (0.231)	-0.214 (0.163)	-0.140 (0.36)	-0.268 (0.065)	1	
8. Profession: Entrepreneur	-0.060 (0.687)	0.068 (0.644)	0.252 (0.084)	0.109 (0.481)	-0.030 (0.847)	-0.095 (0.52)	-0.094 (0.527)	1
M	6.089	0.417	12.49	286.0	7.333	35.60	0.188	0.312
SD	1.013	0.498	9.34	172.0	1.610	6.72	0.394	0.468

Note: p-value of pairwise correlations shown in parenthesis

Table 8: Descriptive statistics for the "NASA survival" and "winter survival" problems

Task		Total time	Time per move	# of moves	Performance
"Winter survival" problem	M	324.5	10.17	20.05	45.13
	SD	287.2	11.37	7.37	9.54
"NASA survival" problem	M	363.0	8.85	28.92	49.34
	SD	208.8	5.92	12.31	15.48

Table 9: OLS Regression of performance and behavioral change

	Dependent variable:			
	Total time (1)	**Time per move** (2)	**# of moves** (3)	**Performance** (4)
Problem-focused	0.282	0.084	0.31	-0.084
	(0.046, 0.517)	(-0.175, 0.344)	(0.061, 0.559)	(-0.368, 0.201)
Solution-focused	0.281	0.353	0.031	-0.074
	(0.048, 0.514)	(0.097, 0.610)	(-0.215, 0.277)	(-0.355, 0.207)
Gender	-0.228	-0.153	-0.046	-0.033
	(-0.415, -0.041)	(-0.359, 0.053)	(-0.243, 0.152)	(-0.259, 0.192)
Age	0.002	0.002	-0.008	0.012
	(-0.009, 0.013)	(-0.010, 0.014)	(-0.020, 0.003)	(-0.001, 0.026)
Post Graduate	-0.253	-0.126	-0.07	0.087
	(-0.451, -0.054)	(-0.345, 0.092)	(-0.279, 0.140)	(-0.153, 0.326)
Reader	-0.037	-0.168	0.224	-0.101
	(-0.230, 0.156)	(-0.381, 0.044)	(0.019, 0.428)	(-0.334, 0.132)
Constant	0.06	0.061	0.169	-0.376
	(-0.354, 0.473)	(-0.395, 0.516)	(-0.269, 0.606)	(-0.875, 0.123)
Observations	472	472	472	472
R2	0.043	0.029	0.023	0.009
Adjusted R2	0.031	0.017	0.01	-0.003
Residual Std. Error	1.013 (df = 6; 465)	1.117 (df = 6; 465)	1.072 (df = 6; 465)	1.223 (df = 6; 465)
F Statistic	3.484 (df = 6; 465)	2.32 (df = 6; 465)	1.833 (df = 6; 465)	0.737 (df = 6; 465)
Note:		95% confidence intervals shown in parenthesis		