Cognitive Control Capabilities, Routinization Propensity and Decision-Making Performance

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Abstract

This paper examines the cognitive and behavioral foundations of decision-making at the individual level. It is based on a study conducted with 86 graduate students and a model that combines the highly mindful cognitive control capabilities and the less-mindful routinization propensity to explain decision-making performance.

The paper offers three contributions. First, I introduce and empirically observe cognitive control capabilities, i.e. the supervisory cognitive mechanisms through which individuals monitor and control their own attention processes. Second, I introduce and operationalize the concept of routinization propensity. This is an individual-difference variable capturing the tendency to develop and enact a behavioral repertoire of standard solutions. Third, I propose and test a model in which routinization propensity mediates the impact of cognitive control capabilities on decision-making performance. I show that both high and low levels of mindfulness are essential to maximize performance in strategic decision-making. Counterintuitively, however, higher cognitive control capabilities are connected to higher levels of routinization propensity, which in turn enhance performance. These findings contribute to the development of an integrated theory of cognition, decision-making, and learning.

Key words: cognitive control capabilities; attention; decision-making; strategy; microfoundations; routines; routinization propensity; cognition;

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1. Introduction

Recent years have seen several calls from strategy and organization scholars for a richer characterization of managerial decision-making, integrating both mindful and "less-mindful" perspectives (Argote 2006; Gavetti et al. 2007; Levinthal and Rerup 2006; Lubatkin et al. 2006; Weick and Sutcliffe 2006). Several important studies have also examined the role of learning and decision-making processes at different levels of intentionality and mindfulness (Narduzzo et al. 2000; Salvato 2009; Salvato and Rerup 2011; Tripsas and Gavetti 2003; Zollo and Winter 2002).

In particular, Levinthal and Rerup (2006) have argued that, at the performative level, mindful processes are underpinned by key elements of less-mindful ones, providing a first view of the interdependence between them. At the same time, scholars in cognitive neurosciences are making headway in understanding how more- and less-mindful processes interact at the neurological level, with important implications for our understanding of managerial decision-making and learning processes (Bechara and Damasio 2005; Cohen 2005). In an effort to bridge research in strategy and organization and recent developments in cognitive neurosciences, this paper proposes a microfounded explanation of how mindful and less-mindful processes interact when individuals make strategic decisions. Mindfulness is a nuanced concept; for the present purposes, I define a "mindful process" as "one carried out with full awareness and volition" and a "less-mindful process" as "one requiring little attention, intention, or thought".

This paper intends to contribute to the mindfulness debate in several ways. First, on the strength of recent research in cognitive psychology and neurosciences, I introduce the concept of Cognitive Control Capabilities (CCCs) to precisely define, and empirically observe, the mindful abilities behind decision-making. Second, to study the less mindful side of the phenomenon, I introduce *routinization propensity* as an individual-difference trait that captures the tendency to develop and enact a behavioral repertoire of standard solutions. Third, I propose two ways in which the less-mindful capabilities reflected by routinization propensity might interact with mindful capabilities to influence performance. The first way views routinization propensity as a moderating factor, enhancing the effectiveness of cognitive processes, roughly in line with theoretical arguments in the literature (Rerup and Levinthal 2006; Weick and Sutcliffe 2006). The second, alternative way views mindful processes influencing the degree of routinization propensity, which in turn positively affects performance. This view is consistent with the intuitions of some early thinkers in modern psychology (Dewey 1922; Whitehead 1911) as well as with the most recent advances in neuroscience on the pervasive role of neuroplasticity (Kolb and Whishaw 1998; Schwartz and Begley 2002). Fourth, I empirically test a framework in which both mindful and less-mindful elements interact to explain decision-making performance.

My study takes place at the individual level of analysis. Clearly, organizations are more than simple aggregations of individuals. Nevertheless, individuals still constitute the most concrete and essential foundation of an organization, and our understanding of organizations is founded on our understanding of the individuals that compose them (Gersick and Hackman 1990). “The behavior of an organization is, in a limited but important sense, reducible to the behavior of the individuals that are members of that organization. Regularities of individual behavior must therefore be expected to have consequences, if not counterparts, at the organizational level.” (Nelson and Winter 1982 p.72)

My argument proceeds as follows. First, I discuss the two analytical building blocks: mindful abilities (i.e. CCCs) and the less-mindful routinization propensity. Second, I present two hypotheses on these two abilities’ combined effects on decision-making performance. Third, I propose a multi-method approach for measuring cognitive control capabilities, routinization propensity, and decision-making performance. The method combines a strategic decision-making simulation and cognitive neurosciences tests. Finally, I present my main results and discuss their implications for both theory and practice.

2. The two sides of the coin: less-mindful and mindful processes in strategic decisions

There have been many calls for a richer characterization of strategic decision-making (Argote 2006; Eisenhardt et al. 2010; Eisenhardt and Zbaracki 1992; Gavetti et al. 2007; Levinthal and Rerup 2006; Lubatkin et al. 2006; Weick and Sutcliffe 2006). Strategic decisions have been defined as “important, in terms of the actions taken, the resources committed, or the precedents set” (Mintzberg et al. 1976, p.246). Furthermore, strategic decisions are genuine choices that make a real difference. “They are genuine in the sense they are neither random nor predetermined. […] They make a difference in the sense that today’s choice permanently affects future states of the world.” (Loasby 1976 p.5). In order to throw more light on this topic, I propose two individual-level characteristics that capture the mindful and less-mindful processes that underpin strategic decision-making.

2.1 Less-mindful processes: Routinization propensity

Routines are the cornerstones of the behavioral and evolutionary views of the firm (March and Simon 1958; Nelson and Winter 1982). I use the term “routines” to indicate recurring action patterns that act as standard solutions and are enacted in response to a signal that captures a state of the environment. A great deal of organizational activity follows recurring, stable, and relatively reliable patterns of action (Nelson and Winter 1982). All organizational and individuals’ activities are strongly regulated by routines (Forgas 1983); when taking decisions, we grossly simplify complex problems by applying and adapting routines as simple solutions (Loasby 1976). The constant use and adaptation of routines permeates decision-making to such an extent that seemingly “new” decisions are in fact recombinations and adaptations of old routines, or, as Loasby put it, “decision making becomes decision adapting” (Loasby 1976). During the past decade, decision-making researchers have become increasingly interested in the effects of routinization on decision-making, and the subsequent performance of the decisions made (Beach and Potter 1992; Betsch et al. 2004).

It is important to note that routines can be differentiated from a number of similar concepts. *Scripts* are rooted in culture, and thus shared by many individuals (Verplanken et al. 2005). *Habits* tend to be described as task-specific, while routines can be adapted to a range of tasks. Furthermore, habits are based on personal experience with the behavior, whereas a person who develops and implements routines does not necessarily need such experience (Betsch and Haberstroh 2005; Betsch et al. 2001; Verplanken et al. 2005).

The psychology literature has studied the individual propensity to develop and enact routines (Gersick and Hackman 1990; Weick 1979). The trait of routinization has been conceptualized as an individual approach to manage complexity by simplification. The simplification takes place through the development of standardized solutions that allow individuals to maintain control (Reich and Zautra 1991).

This literature supports the idea that individuals differ systematically in the extent to which they are dispositionally motivated to develop and/or enact standard behavioral solutions. Individuals who propend to routinize exhibit a disposition for developing abstract mental representations that serve as simplified solutions (Neuberg and Newsom 1993). Examples include schemata, prototypes, scripts, attitudes, and stereotypes. When implemented, these solutions require considerably less time and cognitive resources than exploring new and unknown solutions (Bazerman and Neale 1983; Carnevale and Pruitt 1992; Carroll and Payne 1991; Cavanagh et al. 2001; De Dreu 2003; Wershbale and Pleskac 2010).

This study aims to contribute to our understanding of a key learning mechanism. Routines capture lessons learned from previous experiences. Routinization promulgates learning from the individual level to the organizational level by allowing a process to be replicated by many individuals without “reinventing the wheel” (Levitt and March 1988) and facilitating relational coordination (Gittell 2002).

I define “routinization propensity” as *the individual tendency to develop and enact a behavioral repertoire that provides standard solutions (routines) for problems involving choice*.

This definition encompasses the repetition and execution of standard patterns of behavior while excluding coordinated and interdependent actions. Thus, my concept of routinization propensity is compatible with routinization at the organizational level as proposed in Feldman and Pentland (2003). It is important to emphasize that while I use the term “routine”, which is generally reserved for the organizational level in the management literature, my focus is on the roots of automatic behavior at the individual level, rather than the coordination of such behavior. While it is of course essential to study routines at the organizational level, it is also important to understand how routines are created and implemented by studying agency, the differences between individuals, and their impact on outcomes.

Studies have found that different degrees of routinization propensity are associated with different perceptions, at both the cognitive and behavioral levels. At the cognitive level, individuals with high routinization propensity might perceive higher control, order, and predictability in their actions. At the behavioral level, they would perceive, and potentially achieve, higher efficiency and actual control over events by maintaining standard solutions (Reich and Zautra 1991).

An individual’s routinization propensity can potentially have both negative and positive effects on decision-making performance. On the downside, the main argument is that a high routinization propensity will lead to inertia, as an individual might use routines as taken-for-granted notions of “the way things work here” and thus see less need or capacity for change. Given that individuals’ abilities permeate their behavior and can be transferred over different contexts and over time (Bransford et al. 1999), individuals who tend to rely on standardized action patterns will reduce their cognitive activity; their attention will repeatedly focus only on a few given, salient features. While this minimal cognitive processing may sometimes free up attention for other purposes, in other cases the decision-maker may perceive novel situations as normal in terms of those few salient features, failing to realize that the changing environmental circumstances necessitate a new approach (Langer 1989; Weiss and Ilgen 1985). A high routinization propensity will eventually lead to behavioral rigidity (Kastenbaum 1980; Zisberg et al. 2009).

In contrast, several authors in management and psychology have been careful to avoid the image of routines as rigid, immutable patterns. They have emphasized the flexible aspects of routines which, through individuals’ enactment and reinforcement, can lead to change and adaptation (Feldman 2000; Ohly et al. 2006; Pentland et al. 2011; Pentland and Rueter 1994; Zisberg et al. 2009). An important feature of routines is that they encode the knowledge of past solutions and thus reduce the need for deliberative efforts, freeing up scarce cognitive resources to focus on complex problems (Levinthal and Rerup 2006). “… there is little basis in reality for the view that routinized decision processes are necessarily or typically information poor. The real situation is very nearly the opposite. Because rationality is bounded, it is not possible for individuals or organizations to improvise the effective use of large amounts of information. Such use is possible only as a result of prior investment in some sort of system (or skill, habit, routine, or program) that “‘mechanistically’ picks out, from the enormous range of possible processing activities, the actual processing that the information is to receive.” (Winter 1995 p.109). Another important feature, as Cohen et al. (1996) note, is that “routinized behaviors should […] be based on the absence or the reduction of active thinking” (p. 695). Routinization allows for the rapid processing of large amounts of information with little effort. Faster decision-making allows decision-makers to keep pace with changes in the environment, achieving superior adaptation and, ultimately, better performance (Eisenhardt 1989; Winter 1985). As summarized by (Winter 1985), “the fact that organizations make most of their ‘decisions’ without ‘thinking’ – without top management being involved in something it identifies as a decision situation – is not a flaw in organizational decision making. On the contrary, taking action ‘without thinking at all’ is often a symptom of high effectiveness, a characteristic of complex behavior patterns that are highly adapted to the environment in which they take place” (Winter 1985, p.108).

Decision-makers with a high routinization propensity will stabilize their expectations and perceptions of the environment. This might be suboptimal (Cohen and Bacdayan 1994), but in many cases the advantages in terms of encoding past solutions and saving cognitive resources and time will outweigh the disadvantages, leading to better decision-making performance.

2.2 Mindful processes: Cognitive Control Capabilities

While routinization propensity may be necessary for finding solutions and making decisions, it does not explain per se differential abilities in those areas. To do so, I need to introduce a second building block.

Mindfulness allows the direct apprehension of events as they occur without interposing any predetermined filters, thus overriding habits and routinized behavior (Brown et al. 2007). Thanks to mindfulness, “consciousness takes on a clarity and freshness that permits more flexible, more objectively informed psychological and behavioral responses” (Brown et al. 2007, p.212).

Different traditions emphasize certain characteristics of mindfulness more than others. One of the most recent and cited definitions of mindfulness was suggested by Brown and Ryan (2003) and cited again by Brown et al. in 2007. According to these authors, mindfulness involves “enhanced attention to and awareness of current experience or present reality. [A] core characteristic of mindfulness has been described as open or receptive awareness and attention which may be reflected in a more regular or sustained consciousness of ongoing events and experiences” (Brown and Ryan 2003, pp. 822–823). As highlighted by (Weick and Sutcliffe 2006), this definition blends traditional Western concepts of information processing with notions of awareness drawn from Buddhist psychology and Eastern traditions. For a recent review of different definitions of mindfulness, please see Dane (2011, p. 1000).

Preliminary evidence suggests that mindfulness is associated with the cognitive functions in charge of attention control (Raz and Buhle 2006). “...in its fullest expression the mindful mode of processing involves a voluntary, fluid regulation of states of attention and awareness" (Brown et al. 2007, p.213). In this paper I build upon the recent and growing neuroscience literature on the cognitive control mechanisms that supervise and direct our attention. These mechanisms are used when we perform such activities as purposefully paying attention, planning, organizing, forecasting, strategizing, abstracting, drawing analogies, and trying to overcome routinized behaviors (Bishop et al. 2004; Fernandez-Duque et al. 2000). They also enable us to carry out goal-directed behavior and to reflect on and inhibit inappropriate actions (Geenen et al. 2007; Norman and Shallice 1986; Shallice et al. 1994). Recent advances in cognitive psychology and neuroscience suggest that these functions are essential to motivate important volitional cognitions and behaviors, and to choose between competing behaviors (Black et al. 2011; Brown et al. 2007). In this paper, I term these functions Cognitive Control Capabilities (CCCs) and define them as "the supervisory cognitive mechanisms through which individuals monitor and control their own attention and cognitive processes".[1]

Over the last decade, CCCs have come to be fully appreciated by psychologists and neuroscientists (e.g. (Goldberg 2001; 2009) because of their impact on decision-making. By controlling and managing other cognitive processes, CCCs govern activities such as rule acquisition, abstract thinking, planning, initiation of appropriate actions and inhibition of inappropriate ones, and selection of relevant information (Loring 1999). The work of influential researchers in the field of cognitive control (Michael Posner, Joaquin Fuster, and Tim Shallice among others in the 1980s, and Trevor Robbins, Bob Knight, and Don Stuss more recently) has laid much of the groundwork for our understanding of CCCs. Different models to measure CCCs have been developed, and considerably refined thanks to brain imaging techniques (Knudsen 2007); a different function of CCCs is emphasized depending on the specific aim of each model (clinical or research). The most cited models in this literature all agree on four functional components – the names vary slightly according to the approach – that capture the main purposes of CCCs: *attention control, working memory, planning and generativity,* and *reflective capacity* (Barkley 2001; Barkley et al. 2007; Desimone and Duncan 1995; Knudsen 2007; Miller and Cohen 2001; Sohlberg and Mateer 2001). These four components are not neatly separable, but each one embodies a key function. *Attention control* is the ability to focus selectively on relevant information while avoiding distractors Attention control allows to maintain a consistent response during continuous and repetitive activity. *Working memory* is the ability to hold multiple pieces of information uppermost in the mind and process them. *Planning and generativity* is the ability to make causal relations, generate alternatives, and anticipate the consequences of plans. *Reflective capacity* is the ability to reflect before speaking, to resist reporting the

[1] CCCs have been referred to with a range of terms, including "executive functions", "executive system", "supervisory attentional system", and "cognitive control". In order to avoid confusion with the management literature over the word "executive", I adopt the term "cognitive control", first introduced by the influential psychologist Michael Posner in 1975.

first answer that comes to mind, to inhibit inappropriate actions, and sometimes to engage in abstract thinking to determine the appropriate action.

All these functions are intimately related to our abilities to learn, search, and make decisions. More specifically, CCCs allow people to adapt their cognitive and behavioral patterns to context. They serve to shift the control of behavior from the immediate context and the temporal *present* to broader representations and hypothetical futures, which is useful in winnowing out novel alternatives (Barkley 2001).

CCCs are essential, but they are also limited. They do not determine behavior, nor do they guarantee success in decision-making (Desimone and Duncan 1995). The number of stimuli we can attend to is limited, so cognition is bounded (Kahneman 1973; Pashler 1998; Robinson-Riegler and Robinson-Riegler 2004). The existence of such limits has been confirmed by psychological evidence focused on the depletion of cognitive resources (Baumeister et al. 1998; Muraven et al. 1998).

CCCs are particularly important in novel contexts, when the environment changes and routinized responses do not suffice (Helfat and Peteraf 2009 ; Norman and Shallice 2000). Since the environment can be unpredictable, CCCs are vital in paying attention to the varying signals it generates, recognizing new or unexpected situations, and taking proper decisions when unusual events arise. They allow decision-makers to evaluate a situation, self-monitor their decisions, and help their organizations respond to the changes in the environment by adapting their cognitive and behavioral patterns to the context.

2.3 Bridging the mindful and the less-mindful

> The more of the details of our daily life we can hand over to the effortless custody of automatism, the more our higher powers of mind will be set free for their own proper work.
>
> William James [1899: 114]

Different dimensions open up when we consider the influence of routinization propensity on CCCs. One argument is that individuals with high routinization propensity might rely on simple patterns to solve problems. By directing scarce cognitive resources towards standard solutions or rigid rules, high routinization propensity could have a negative moderation effect on CCCs, thus impairing decision-making (Gersick and Hackman 1990; Tripsas 2009). Therefore:

> Hypothesis 1a: The higher the level of routinization propensity, the weaker the effect of CCCs on decision-making performance.

On the other hand, by economizing on cognitive resources, a high routinization propensity will serve as the foundation for individuals' mindful processes to take place when necessary, boosting performance (Levinthal and Rerup 2006). Just as we have built labor-saving devices to free us from "mindless" chores such as washing clothes, so routines free our limited cognitive resources from tasks in which they are no longer needed. In this way, we can shift our attention, time, and energy to those tasks that require them (Bargh and Chartrand 1999; Kahneman 1973; Posner and Snyder 1975). So one could argue that individuals with a high routinization propensity will save cognitive resources, freeing them up for their CCCs and leading to superior decision-making performance. Therefore:

Hypothesis 1b: The higher the level of routinization propensity, the stronger the effect of CCCs on decision-making performance.

However, there might be another, hitherto unexplored link between the two factors. CCCs might allow decision-makers to develop cognitive frames about the problem at hand and design appropriate strategic responses in the form of patterns of actions, or "what to do when X happens". In other words, CCCs might be an antecedent of routinization.

How can CCCs explain the emergence and the adaptation of routines? As stated, CCCs are supervisory mechanisms that deal with the control of attention, which governs the narrowing of the number of issues that are focused on and the sustaining of attention on selected information (Posner and Petersen 1990). Also, CCCs are involved in abstract thinking and in developing representations and plans for hypothetical futures, keeping different pieces of information in mind, integrating seemingly disconnected issues and establishing cause-and-effect relationships (Cohen et al. 2004; Posner and Petersen 1990). So it may be that CCCs' supervisory role enables decision-makers to create and adapt routines to deal with the complexities of their environments – that is, that CCCs give decision-makers a higher routinization propensity. "Far from precluding effective monitoring, mechanistic decision making facilitates it by providing an operational definition of the objectives that sensors and processing routines are to serve, a role similar to the one that definite hypotheses, formulated in advance, play in a well-designed statistical study" (Winter 1995, p.110). In turn, and as per the arguments in section 2.1, a higher routinization propensity might mediate partly or fully between CCCs and decision-making performance, which might in turn enhance decision-making performance. Therefore:

Hypothesis 2: Routinization propensity mediates the impact of CCCs on decision-making performance.

Figure 1 summarizes the hypotheses. I intend to explain performance in decision-making as a function of the interplay between CCCs and routinization propensity. In the following, I explain how I operationalized these concepts and strategic decision-making through cognitive neurosciences tasks and a simulation.

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3. Method

3.1 Participants and Design

I designed an observational study, i.e. a natural experiment design. In contrast with controlled experiments, in this design participants were not previously assigned to treated groups. Instead, I aimed at capturing natural differences in decision-making performance. I did not use manipulations, but obtained laboratory measures of individuals' decision-making performance, their routinization propensity, and their CCCs. I refined the study design in two pilot sessions with 10 participants each. They underwent all the same screening and compensation conditions as the actual participants, but were not included in the study; nor did they have any contact with the actual participants. Prior to the study, all potential participants followed a rigorous screening procedure to comply with the guidelines of cognitive neurosciences studies. According to their results, participants were assigned to two of four scheduled sessions (see Appendix 6.1). All participants gave their written informed consent to take part in the study.

Eighty-nine graduate students of management and economics of innovation (44 women and 45 men) volunteered to participate in two sessions (total time about 5.5 hours) for monetary compensation (mean €62, or approximately $75). Their mean age was 24 (SD = 2.289).

At the beginning of each session, participants were randomly assigned to a computer in the laboratory. General instructions were provided in oral and written form. In addition, specific on-screen instructions, including examples, were provided before the participant began each task. In the case of more complex tasks (such as the n-back) all participants played trial sessions before the session that was actually used to gauge their performance. I provided further explanation if required. The first session lasted for about 2.5 hours and the second session for three hours, including breaks, during which beverages and snacks were provided.

During the first session, participants completed a strategic decision-making task. They had 2.5 hours to read a case describing an organizational situation and then play the decision-making simulation. Consistent with the pilot results, all participants finished before the time was over. Following a 15-minute break (with refreshments), participants answered a personality questionnaire (Cloninger 1994) and were debriefed.

During the second session, participants completed a task aimed at capturing routinization propensity. The task consists of four sessions of 10 minutes each, separated by one-minute breaks. After the fourth session, participants answered one open question regarding the strategy they followed while playing. A compulsory 15-minute break followed the debriefing. Refreshments were offered. After the break, participants completed several cognitive tasks, described below under the heading 'CCCs tasks'. The tasks were automatically set by a computer program and presented in randomized order, separated by one-minute breaks. Unlimited time was given to read instructions, offering additional opportunities to rest when needed. After the CCCs tasks were done, participants had the option of a 15-minute break. In the final part of the second session participants filled out control questionnaires and were debriefed.

Participants were strongly urged not to discuss the content of the tasks with each other between sessions. They received two types of incentives. First, they were provided with a confidential, personalized booklet with detailed measures of their performance compared with the group average. I reported their scores on the various cognitive control measures (attention control, planning and generativity, reflective capacity, etc.), on their routinization propensity, and also on their performance in the decision-making simulation. In addition, the booklet also included their scores on the personality test and the stress and anxiety test (STAI). Second, all participants received a monetary incentive based on their performance with respect to the group average. Participants were given detailed instructions, including an explanation of how compensation would be calculated, in the recruitment sessions, and reminded before the start of the first experimental session. After the study, an average performance was calculated and normalized so that the best performer would earn €100 and the worst €25. In the end, due to consistently rounding up the amounts, the final average payment was €62 (instead of €60) with a standard deviation of 26.70. In no circumstances could the participants earn negative payments; all participants who attended the two sessions received at least €25. All participants signed a receipt for the payment they collected after the end of the second session of the experiment. All participants received via e-mail a file with the report of their performance. Three computer stations exhibited technical problems so the information for these participants was discarded. The anonymity of all participants was guaranteed at all stages of the study, including the payment procedure and the reporting of the results.

3.2 Tasks

I used different tasks to operationalize each of the key variables in the model. The tasks allowed me to assess each individual's performance through observed behavior, providing a more reliable and accurate assessment than, for example, self-reported measures. In addition, using a multiple-tasks design allowed me to minimize confounds that could arise from using a common method (Podsakoff et al. 2003). For a summary of the constructs and tasks presented in this section, and the measures presented in section 3.3, please see Table 1.

3.2.1 Strategic decision-making task. I looked for a realistic task that would simulate a dynamic organizational business scenario with enough information and complexity to exceed the decision-makers' cognitive limits. In particular, the scenario needed to force participants to consider a number of key business challenges concomitantly, including timing, uncertainty about market information, and levels of investment in real organizational settings. I opted for Christensen and Shih's online "Strategic Innovation Simulation" (2008). In this task the participant faces the innovator's dilemma: how to balance the trade-offs in R&D investment between sustaining investment in an existing business and investing in a new, potentially disruptive one. The objective for all participants is to maximize the cumulative profit. Participants manage R&D portfolios over eight simulated years (eight trials) and must decide which of several market opportunities to pursue, each offering varying levels of market intelligence and differing short- and long-term payoff prospects. After participants take each year's decisions, the simulation computes several variables and replicates a dynamic organizational context.

This game simulates an ideal decision-making setting for this research, since it incorporates fundamental features and complexities characteristic of the way strategic decisions related to innovation are taken in organizations. Throughout the simulation the participant is confronted with timing issues, levels of investment across both mature and new businesses, choices regarding market opportunities and inherent product performance characteristics, the need to meet constraining financial objectives, and constant trade-offs between investment options – all in the context of uncertain market information. It is important to note that while there are many factors in play, all participants are exposed to exactly the same initial business scenario. Also, the game is adaptive and provides detailed performance feedback after every trial. As the participant's decisions interact with simulated organizational and market variables, feedback on sales, market share, and profit (among others) was automatically calculated by the simulation software.

The suggested time for playing the game varies from 45 minutes to two hours. Participants were allowed to take as much time as they wanted, and had a mock session to familiarize themselves with the game before playing the session that was actually used to measure their performance. All of the participants finished the simulation well before 2 hours.

3.2.2 Routinization propensity task: The empirical literature on routinized behavior has proposed several ways to capture routines and routinization propensity at the individual and group levels (for example, see the review in Verplanken et al. 2005). A review of the empirical papers published since 1990 in the cognitive and management sciences reflects the variety of approaches that have been used, from asking how much one prefers repetitive and structured behaviors (Baba and Jamal 1991; Neuberg and Newsom 1993; Reich and Zautra 1991; Verplanken and Orbell 2003) to observing organizations documenting the content of routines (Feldman 2000) to using response time as an unobtrusive proxy for whether or not a routine was developed (De Dreu 2003) and used (Cavanagh et al. 2001; Wershbale and Pleskac 2010). It is also noteworthy that certain studies have been more concerned with capturing traits and behaviors at the individual level (Neuberg and Newsom 1993; Reich and Zautra 1991) and at the organizational level (Feldman 2000), while others instead have been more concerned with capturing the content of routines at both the individual and group levels (Birnholtz et al. 2007) or at the group level (Cohen and Bacdayan 1994; Feldman

2000; Pentland et al. 2010).

In order to measure routinization propensity in the context of individual decision-making, I selected the "four-armed bandit" gambling game as developed by (Daw et al. 2006). This structured and repetitive decision-making task is well suited to measuring inter-individual differences in routinization propensity, for three main reasons. First, because it provides an indirect and non-obtrusive measure of information processing, in contrast with self-reported measures (De Dreu 2003). Second, because it presents participants with very high exposure (300 trials) and a structured decision-making task with defined options that allows the decision-making process to be automatized, while revealing inter-individual differences (Betsch et al. 2001; Wershbale and Pleskac 2010). Third, because it imposes a time limit on the decision to be made in each trial. Time limitations may reduce motivation to process information systematically, and may increase the likelihood that responses capture an element of automaticity, and fosters routine maintenance (Betsch et al. 2004; De Dreu 2003; Kruglanski and Freund 1983; Verplanken et al. 1997).

In the "four-armed bandit" task, the participant must choose one of four slot machines 300 times, with the aim of maximizing the total cumulative payoff. The task is divided into four sessions of 75 trials each, separated by a one-minute break. On each trial, participants have to select one slot within 1.5 seconds; if no choice is entered during that interval, a large red X is displayed for 4.2 seconds to signal an invalid missed trial (after which a new trial is triggered)[2]. In this study, participants broached the time limit in less than 1% of the trials. In addition, participants answered well before the time limit in most cases, as was the case in a similar study using the same task. (In this study, participants answered in 0.3075 seconds on average, while in the study by Daw and colleagues (2006) participants answered in 0.4300 seconds on average. This confirms that the time limit acted as a ceiling but did not exert great pressure.)

After the participant selects one of the four options, the payoff of that slot only is revealed. Each slot pays points around one out of four different means[3].. The payout changes from trial to trial according to a predetermined sequence of 300 trials that was the same for all participants. Participants can only find information about the payoff of a slot through active sampling; they typically develop and enact action patterns in response to the results they achieve (Daw et al. 2006). Usually, participants use the first trials of each session to explore the different slots and identify the

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[2] On valid trials, the chosen slot machine was animated and, three seconds later, the number of points earned was displayed. These points were displayed for 1 second and then the screen was cleared. The trial sequence ended six seconds after trial onset, followed by a jittered intertrial interval using a discrete approximation of a Poisson distribution with a mean of two seconds, before the next trial was triggered.

[3] The payoff for choosing the *i*th slot machine on trial *t* was between 1 and 100 points, drawn from a Gaussian distribution (standard deviation σ_o = 4) around a mean $\mu_{i,t}$ and rounded to the nearest integer. At each timestep, the means diffused in a decaying Gaussian random walk, with $\mu_{i,t+1} = \lambda\mu_{i,t} + (1 - \lambda)\theta + \nu$ for each *i*. The decay parameter λ was 0.9836, the decay center θ was 50, and the diffusion noise ν was zero-mean Gaussian (standard deviation σ_d = 2.8). All participants were exposed to the same distribution of the payoffs.

one they think is best. They then continue to select that slot for a number of additional trials, but also develop procedures to decide when they should consider other slots again. Such procedures allow them to respond more quickly.

In pilot tests I observed 12 of the 20 participants and interviewed them about their approach afterwards. Their responses corroborated the notion that the task allows participants to show their disposition for creating and using simple and repetitive solutions. Most participants chose the same slot for as long as it continued to pay off around a certain expected value, only turning to explore the other slots if the payoff fell below this level. Participants had different procedures for exploring. Some started selecting slots in random order and stopped when they received a payoff above their previously expected value. Some turned to the slot that they thought was giving the second-best payoffs before. Some chose a machine they "liked" more. Finally, some reported moving on to the machine to the right of the one they were choosing before. While it is important to know that the task allowed individuals to develop repeating procedures, it is also important to emphasize that, in this study, I am not concerned with the specific content of the routines. Rather, I am concerned with the *inter-individual differences in their propensity to develop and use such routines*. Of the 12 pilot participants observed, only one said that they had no routine and chose randomly.

3.2.3 CCCs tasks: I chose five different tasks to observe the main facets of the four different functional components of CCCs described in section 2.2. Each task emphasizes a particular mechanism:

1) **Flanker Task:** this test (also called "Eriksen") assesses attention control: . Participants have to respond as quickly as possible to a centered and directed item (i.e. an arrow pointing either right or left) juxtaposed with distracting symbols. The distractors can be congruent (i.e., arrows pointing in the same direction as the focal arrow), incongruent (i.e., arrows pointing in the opposite direction) or neutral (i.e., no distractor).

2) **N-back Task:** The N-back Task (Kirchner 1958) is used to assess working memory. Despite its name, working memory is actually a supervisory ability to keep different pieces of information in mind, ready to be used, manipulated, compared, or related (rather than passively stored). In the N-back Task, the participant is presented with a sequence of stimuli (i.e., letters of the alphabet) and has to indicate, under time pressure, when the current stimulus matches the one from *n* steps earlier in the sequence. The load factor *n* can be adjusted to make the task more or less demanding. For example, in the "two-back task", the participant has to compare the current letter with the one that was presented two steps earlier in the sequence, while also remembering it for comparison with the letter that will appear in two steps' time. I conducted trials using "two-back" and "three-back" variants.

3) **Tower of Hanoi:** The Tower of Hanoi task (devised by Edouard Lucas in 1883) measures planning and generativity abilities, considered a central part of CCCs. The participant is asked to generate causal relations and

anticipate consequences, and so create alternative paths of action. The task presents the participant with three rods and a number of disks of varying sizes that can be slid on to any rod. At the start, three disks are neatly stacked in order of size on the leftmost rod, the smallest at the top, forming a conical shape. The objective is to move the entire stack to the rightmost rod, obeying three rules. First, only one disk can be moved at a time. Second, each move must consist of taking the upper disk from one of the rods and sliding it onto another rod, on top of the other disks that may already be present on that rod. Third, no disk can be placed on top of a smaller disk. The goal is to transfer the disks to the rightmost rod in the smallest possible number of moves and the shortest time. Participants tend to move the disks without enough planning, which increases not only the number of moves but also the final response time.

4) **Cognitive Reflection Test (CRT):** This test measures emotional self-regulation or "cognitive reflection" – that is, the ability or disposition to resist reporting the response that first comes to mind (Frederick 2005). Like the Need for Cognition scale (Cacioppo and Petty 1982), this test relates to the individual propensity to engage in thinking. However, while the Need for Cognition scale relies on self-reported behavior, the CRT test measures observed behavior. Participants are presented with a series of simple problems of varying difficulty. The solutions are straightforward once explained, but reaching the correct answer often requires the rejection of an erroneous answer that springs immediately to mind. Answering correctly requires the ability to suppress the impulse to respond before thinking the answer through.

5) **Raven Matrices:** Raven's progressive matrices evaluate abstract thinking (Raven et al. 2003). The test presents a pattern of eight related images. The participant must identify the missing segment required to complete the larger pattern, in a multiple-choice format. The questions vary in difficulty, requiring different levels of abstract thinking.

3.3 Measures

3.3.1 Dependent variable: Decision-making performance

To measure decision-making performance, I used the cumulative profit over eight simulated years in the strategic decision-making task. This measure is suggested as comprehensive by the creators of the simulation (Christensen and Shih 2008). To achieve high performance, the participant needs to balance financial goals against the need to innovate, capitalize on new product/market opportunities, and guard against disruptive technologies. The participant must take into account resource requirements, product performance, investment timing, and end-market opportunities for a new technology in the context of nebulous market information and constraining financial performance criteria.

3.3.2 Independent variables: Routinization propensity

The speed of task performance has been identified as a principal indicator of routinization (Cohen and Bacdayan 1994; Weiss and Ilgen 1985). Cognitive psychologists and neuroscientists have long agreed that the creation of behavioral repertoires of standard solutions allows individuals to simplify their decision-making process and respond more quickly. The converse is also true: response time is longer if a decision requires complex calculation (Atkinson et al. 1969; Cavanagh et al. 2001; Neuberg and Newsom 1993; Shiffrin and Schneider 1977).

I measured the time it took participants to play each of the 300 trials in the “four-armed bandit” task. To exclude the very early trials in which participants were starting to play the game and had not yet had the chance to develop any routine, I calculated the average response time for each participant for the trials 5–75 of each of the four sessions. (For example, I calculated the average response time for the trials 5–75 for session 1, the average for trials 81–150 for session 2, and so on for sessions 3 and 4). I then averaged the four sessions to obtain a single measure. Very similar results were obtained across all trials.

This measure provides an indicator of speed, which past literature in management and in the cognitive sciences has associated with the creation and implementation of routines (Bazerman and Neale 1983; Carnevale and Pruitt 1992; Carroll and Payne 1991; Cavanagh et al. 2001; Cohen and Bacdayan 1994; De Dreu 2003; Eisenhardt 1989; Kovach et al. 2012; Wershbale and Pleskac 2010)

3.3.3 Independent variables: CCCs measures

I extracted several well-established measures for each of the tasks focused on the five different facets of CCCs.

1) Flanker Task measure: I used the average response time and the number of correct answers to the different distractor types (congruent, incongruent, and neutral). I also calculated an index of “net speed” by subtracting the congruent response time from the incongruent response time. This provided a pure measure of attention control: the lower the difference in the response time between incongruent and congruent trials, the higher the attention control.

2) N-back measures: I used the average response time and the number of correct answers to the “two-back” and “three-back” tasks.

3) Tower of Hanoi measures: I measured the total response time and the number of moves it took each participant to finish the task. If a participant did not finish, I took into account the number of moves they had made when their time elapsed.

4) Cognitive Reflection Test (CRT) measures: I used the three main questions from Frederick (2005) and added seven similar questions that I created and pre-tested in several pilot tests. I measured the average response time

and the number of correct answers to the three main questions and to the additional seven questions. The participants' performance was very correlated, but I kept the two sets of measures separate nonetheless.

5) Raven Matrices measures: I randomly chose ten questions from the broader set of questions in the original Raven test (Raven et al. 2003). I measured the total response time and the total number of correct answers.

3.3.4 Controls

I controlled for participants' gender and age. To comply rigorously with cognitive neurosciences studies, and since stress can interfere with the functioning of the attentive system and the type of cognitive abilities involved in CCCs, I also controlled for levels of stress and anxiety. I used the Stress and Trait Anxiety Inventory (STAI), a widely used test for measuring anxiety in adults. It differentiates between the temporary condition of "state" anxiety and the more general and long-standing condition of "trait" anxiety. Each condition has 20 items, each with four possible responses. In addition, I controlled for personality traits, measuring temperament and character with the TCI-56 (Cloninger 1994), though, for the sake of brevity, I do not report these results here. This personality inventory has 56 items on five-point scales (1=total disagreement, 5=total agreement). No differences were found in the variables of interest of this study.

Insert Table 1 about here
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4. Results

In this section, I first provide descriptive statistics on the different measures. Second, I present the results of the factor analysis carried out to summarize the five tests used to measure the CCCs. Third, I present the main correlations found between the measures of routinization propensity and CCCs. Finally, I summarize the regression models and bootstrapping approach aimed at testing the two hypotheses, and integrate the results.

4.1 Descriptive statistics

Table 2 presents the number of answers analyzed, means, standard deviations, and minimum and maximum values for each of the study measures.

Insert Table 2 about here

4.2 CCCs factor analysis

The five tests used to measure CCCs produced 18 variables. In order to group them under meaningful factors, I performed an exploratory factor analysis (Principal Component Analysis, varimax rotated solution, maximum iterations for convergence=50 and missing values excluded cases listwise; same results hold using Oblimin analyses). Each of the factors groups together variables that correspond to a functional component of the CCCs. Two functional components are represented by two factors each: one corresponding to measures related to performance, and another corresponding to measures related to speed of response. This leads to a total of six factors that group 17 variables[4] and account for 72.27% of the variance (please see Table 3 below).

Factor 1 (attention control) groups four measures that reflect the ability to focus on relevant information and maintain attention on selected information while avoiding being distracted. The four items are the speed in answering to the incongruent, congruent, and neutral stimuli in the flanker task, plus the net measure derived from subtracting the speed of response to congruent stimuli from the speed of response to incongruent stimuli. Factor 2 (reflective capacity) groups five measures related to participants' performance in different subsets of questions in the Cognitive Reflection Test, as well as their speed of response. Also included are the performance and speed measures in the Raven Matrices test. This factor reflects the ability to resist reporting the first thing that comes to mind, and instead engage in abstract thinking to determine the correct answer. Factor 3 (planning and generativity) groups two variables that measure the ability to make causal relations, generate alternatives, and anticipate the consequences of plans: the speed at which the participant solved the Tower of Hanoi problem, and the number of moves they required. Factor 4 (output of attention control) relates to Factor 1, but reflects the ability to answer questions that require attention control. This factor groups the variables that measured the number of correct answers to neutral and incongruent types of stimuli in the flanker task. Factor 5 (working memory speed) groups two variables that measured the response time of the correct answers provided to the "two-back" and "three-back" tests. Factor 6 (working memory performance) groups two variables that measure working memory performance by counting the number of correct answers to the "two-back" and "three-back" tests. It makes sense that the factor analysis found two different components underlying the variables related to working memory; the variables grouped under Factor 5 are somehow more "demanding", since they only measure the speed of response the participant achieved when answering correctly. Factor 6 instead captures the ability to correctly answer to the test, independently of time taken. A correct answer shows a better working memory capacity, which means the participant is better at holding multiple pieces of information uppermost in their mind. Also, as stated, working memory is not actually a type of memory, but the capability to keep different pieces of information in focus and process them. One's working memory is even better if, as captured by Factor 5, one is able to answer correctly and quickly. As these six factors capture different aspects of the CCCs, I shall use them as my proxy for the level of CCCs.

Insert Table 3 about here
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[4] I took out 1 of the 18 variables because of its low load. The excluded variable was the number of correct answers to the Flanker congruent stimuli (its load was 0.47 which was below the 0.5 threshold that I used).

4.3 Correlation analyses

Correlations between the independent, dependent, and control variables for the sample are reported in Table 4. It is interesting to note that routinization propensity (response time in the well-structured decision-making task) correlates strongly and negatively ($p<0.01$) with decision-making performance (cumulative profit in the strategic simulation). In addition, routinization propensity also correlates strongly and negatively ($p<0.05$) with average performance in the structured decision-making task (the average of points accumulated during the "four-armed bandit" game). Nor is decision-making performance significantly correlated with the CCCs factors.

Two factors constituting the CCCs are highly correlated with routinization propensity. First, the routinization propensity measure correlates strongly[5] with Factor 1 (attention control $p<0.01$). That is, the higher the attention control, the greater the routinization propensity. Second, routinization propensity correlates strongly and negatively[6] with Factor 6 (working memory performance, $p<0.01$): the better the working memory, the greater the routinization.

Insert Table 4 about here

4.4 Regressions results: routinization propensity mediates CCCs' relationship with performance

Table 5 summarizes the results of the OLS estimates from multiple regression analyses. First, I specify a model with three control variables: gender, state of stress and anxiety, and trait of stress and anxiety, as these variables may influence cognitive abilities (Controls model in Table 5). I include these four control variables in all the models that follow. For the sake of brevity, I do not include the variables related to personality in the regressions, as they have no effect on any of the variables of interest.[7] Second, to analyze the impact of routinization propensity on decision-making performance, I specify model 1. I find that the higher the routinization propensity (the lower the response time), the better the decision-making performance. Third, to analyze the impact of CCCs on decision-making performance, I specify model 2 with the control variables and the six factors that represent the different aspects of the CCCs. Factor 3, "planning and generativity", and Factor 6, "working memory performance", show significant correlations with the dependent variable: decision-making ability. This suggests that the stronger the decision-maker's CCCs, the better the decision-making performance. First, the "planning and generativity" ability – i.e. the ability to make causal relations, imagine alternatives, plan an optimal sequence of actions, and implement it – turns out to have a direct impact on decision-making performance. Also, working memory performance – i.e., the ability to have

[5] Please note that the interpretation of the correlation coefficient is direct, since both measures of routinization and of attention control are response times.

[6] Please note that the interpretation of the sign of the correlation coefficient for routinization propensity is the opposite from when we talk about response time: a high routinization propensity implies a low response time.

[7] There are strong gender differences in the dependent variable. Men routinized more and did better than women in the managerial decision-making simulation. This is a puzzling result I discuss in appendix 6.2.

different pieces of information under the scope of attention and be able to actively relate them – appears to be related to the performance obtained in the decision-making task.

To test Hypotheses 1a and 1b (the higher the routinization propensity of individual decision-making, the weaker/stronger is the link between CCCs and decision-making performance), I create six interaction terms, each corresponding to the product of one of the six CCCs factors multiplied by the routinization propensity measure (Baron and Kenny 1986). Model 3 tests the same model as Model 2, and adds the routinization propensity measure and the six interaction terms. Only the routinization propensity measure and one of the six interaction terms is significant: "working memory output", signaling that the interaction between routinization propensity and working memory has a positive effect on decision-making performance. None of the CCCs has a direct effect on decision-making performance. This evidence appears as weak evidence in support for Hypothesis 1b.

Insert Table 5 about here

Finally, to test Hypothesis 2 (routinization propensity mediates the impact that CCCs have on decision-making performance) I specify models 4 and 5 to test for a mediation effect (Baron and Kenny 1986; Zhao et al. 2010). In model 4, the dependent variable is routinization propensity. I keep the same independent variables as in model 2: the control variables and the six factors representing the CCCs. Interestingly, "working memory performance" and "planning and generativity" are again significant. In addition, Factor 1, "attention control", also significantly predicts routinization propensity. In model 5, the dependent variable is decision-making performance and the independent variables are the control variables, the six CCCs factors, and the variable measuring routinization propensity. Crucially, adding routinization propensity not only impacts the effect of the CCCs on the dependent variable, as predicted by Hypothesis 2, but completely eliminates it. This result can be interpreted as strong evidence in favor of Hypothesis 2, i.e. there is a full mediation effect: the ability to routinize completely mediates the effect that CCCs have on decision-making performance.

Apart from using the criteria prescribed by Baron and Kenny (1986), I also evaluated the significance of the mediated effect using both a Sobel test and a bootstrapping approach (Zhao et al. 2010). The Sobel test has problems in small samples. Its two-tailed p value is based on the assumption that the distribution of the indirect effects follows a normal distribution under the null hypothesis. This assumption has been seriously questioned. Not only is the distribution not necessarily normal, it is often not even symmetrical, especially in small samples (Bollen and Stine 1990; Zhao et al. 2010). Because the distribution of products is usually positively skewed, the symmetric confidence interval based on the assumption of normality will typically yield underpowered tests of mediation. If access to raw data is possible, a recommended approach is to bootstrap the sampling distribution of the indirect effects and derive a confidence interval with the empirically derived bootstrapped sampling distribution (Zhao et al. 2010).

Insert Table 6 about here

I used the Preacher And Hayes (Preacher and Hayes 2008) bootstrapping SPSS macro for estimating indirect effects in mediation models to estimate the confidence intervals for each of the three CCCs factors (attention control, working memory, planning and generativity) that affect the dependent variable (decision-making performance). Preacher And Hayes' (2008) macro allows covariates to be included, so I included the same variables as in the regressions (i.e. on each case the other five CCCs factors, and the control variables age, gender, state of stress and anxiety, and trait of stress and anxiety). The 95% bias-corrected bootstrap confidence intervals were obtained using 5000 bootstrap samples.

Table 6 presents the Sobel test and bootstrap results, which are highly consistent. The Sobel test underpowered the evidence of a mediation from factor 3. Since zero is not in any of the 95% confidence intervals, I can conclude that the indirect effects of the three CCCs – attention control, working memory, and planning and generativity – are indeed significantly different from zero at $p<0.05$ (two-tailed). This is a crucial finding, as it shows how CCCs (and what kind of CCCs in particular) are associated with routinization propensity. Figure 2 depicts the findings.

Insert Figure 2 about here

4.5 Routinization or CCCs?

To gain additional insight, I assigned participants to one of four conditions depending on their routinization propensity and their scores on the two CCCs that were highly correlated with decision-making performance. To simulate the four conditions, I first created a new measure by adding up each individual's scores in the two factors that had a significant impact on decision-making performance: "planning and generativity" and "working memory performance". I then split the sample into two, based on whether each participant's score in the new measure was above or below the mean, and subdivided each of these groups based on whether each participant's measure of routinization propensity was above or below the mean.

I thus obtained four possible conditions according to whether the participant ranked below or above the mean on (a) the two significant CCCs and (b) on the routinization propensity variable. The first group clustered the participants who had low scores in Factors 3 and 6 and low routinization ability. The second group clustered those participants who had high scores in Factors 3 and 6 and low routinization propensity. The third group clustered those who had low scores in Factors 3 and 6 and high routinization propensity. The fourth group clustered those who had high scores in Factors 3 and 6 and high routinization propensity.

I then calculated the mean in the decision-making task for each group. The differences in the means are significant (p=0.006). Figure 3 shows the average profit obtained in the decision-making task for each of four groups. This result further corroborates the discussion about Hypothesis 2. CCCs per se do not explain superior performance: participants with high routinization propensity but low CCCs (Factors 3 and 6) actually outperform participants with high CCCs (Factors 3 and 6) but low routinization propensity. CCCs per se have a weak direct effect on performance, which is consistent with the logic behind Hypothesis 2 (and models 4 and 5).

The direct effect of the CCCs embedded in "working memory" and "planning and generativity" disappears when routinization propensity is taken into account. Why? Because it is captured in the individual's ability to create standard solutions. As stressed by Nelson and Winter (1982), routines are the solution to problems solved in the past (i.e. plans), and are a powerful memory tool (i.e. for keeping important elements under attention, like working memory). Once introduced in the model, the propensity to create and implement such routines crowds out the "working memory performance" and "planning and generativity" factors. Why should it be that those individuals who have high CCCs (Factors 3 and 6), but do not tend to routinize, are worse off than those with low CCCs who tend to routinize? Cognitive scientists would expect individuals with a higher ability to select the relevant stimuli to be better at developing standard solutions (Atkinson et al. 1969; Cavanagh et al. 2001; Neuberg and Newsom 1993; Shiffrin and Schneider 1977). Therefore, a plausible explanation is that without "attention control" (the factor that appeared to be highly correlated to routinization, but not directly to decision-making performance), decision-makers with high CCCs (Factors 3 and 6) could not cope with the complexity of decisions, as they were unable to focus and subsequently sustain their attention on relevant pieces of information. In other words, they had cognitive breadth, but not depth. They could see all the elements of the decision-making task, but not selectively focus their attention on the few, crucial variables. Hence, their overall performance was relatively low.

Insert Figure 3 about here

4.6 Control checks

Following the arguments that I presented in section 2.1 on the negative effects of routinization, one might think that, beyond a certain point, an excessively high routinization propensity would have negative effects on performance. If routinization propensity positively affected performance up to a certain level, but became negative thereafter, one would expect routinization to have a parabolic form. I therefore controlled for the possibility that the model that has routinization propensity as a dependent variable (model 4) was not correctly specified. I performed the Ramsey test to further check the right specification of the model. I tested the possibility that Routinization can have a parabolic form or any greater power. The null hypothesis of the test is that the model was correctly specified – i.e. there are no quadratic, cubic, or greater powers of the dependent variable in the model. The results for the possibility that Routinization has a quadratic power have a p-value of 0.5814; including a cubic power too gives a p-value of 0.6598, while including a fourth power leads to a p-value of 0.8335. These p-values discredit the possibility that powers of two, three, or four should be integrated into the model.

As a reliability check of the findings, I analyzed the data concerning the response time evolution while participants played the routinization propensity task in more detail. I ranked participants according to their performance on the dependent variable: decision-making performance. Then I divided the sample into three groups. The first clustered the best 29 participants in the decision-making task, the second clustered the 29 average performers and the third the 28 worst performers. Instead of calculating a single routinization propensity measure for each participant (average of their response time from the 5^{th} till 75^{th} trial on each of the four sessions) I calculated their response times in a more fine-grained way by grouping the response times of a few rounds at a time. In figure 4 below, I show routinization propensity on the vertical axis. On the horizontal axis, the evolution of the routinization propensity can be seen for the 300 trials divided into twenty sessions: first 1–15, second 16–30 and so on until 20th 286–300. The same results are obtained by grouping fewer trials at a time. I also calculated the response-time gap between the worst and best performers.

In line with the fact that most participants routinize, I observe that, on average, response time diminishes during the game (see figure 4). The analyses show that while the best performers start routinizing early on, it is not until after the 30^{th} trial that the differences among the groups become statistically significant. It is interesting to note that not only do the differences become significant, but also the response time gap is positive for the 20 sessions and increases among groups in the majority of the trials (it did not increase on four out of 20 sessions). This might show how individuals who propend more towards routinization not only develop those routines early on, but continue to use them as the game goes on. This finding could be interpreted as supporting evidence for Hypothesis 2.

Insert Figure 4 about here

Finally, the speed of task performance or response time is an essential part of most measures derived from cognitive neurosciences tasks. Even when tasks may have "ceiling effect" problems, response times are used as a more subtle way to capture inter-individual differences in performance. In the present study most measures for the CCCs and the routinization propensity rely on response times. This might be a concern, in the sense that all measures could be related to a single underlying variable associated simply with speed. While I cannot fully disprove this, I can gain some confidence that the different tasks capture different underlying constructs by analyzing how different response time measures correlate among themselves and with the performance in their respective tasks. Interestingly, for example, the two variables related to the speed with which participants answered the Raven Matrices and the Tower of Hanoi correlate with their respective performance measures in opposite ways. Those who answered the Raven Matrices quickly did better on the test measuring abstract thinking, while those who took more time to answer to solve the Tower of Hanoi made more incorrect moves.

5. Discussion

> Just as philosophical traditions have struggled with the relationship between mind and body (Descartes [1641] 1931), the organizations literature has struggled with an analogous tension between cognitive and behavioral perspectives on action. (Levinthal and Rerup 2006 p.502).

This paper focuses on the combined role played by CCCs and routinization propensity in explaining decision-making performance. Its initial finding is encouraging but not surprising: both are important. Some other findings, however, reveal novel evidence on how the two individual characteristics influence each other. Even though the debate in the literature has thus far focused on the moderating role of routinization in enhancing the effectiveness of CCCs (Cohen et al. 1996; Levinthal and Rerup 2006), my analyses show minor support for this idea, and rather support the idea that routinization propensity acts as a full mediator between CCCs and performance. This result is somewhat at odds with Weick and Sutcliffe's (2006) suggestion that stability and vividness of attention lead to mindfulness. They argue that when unexpected events arise, the ability to sustain attention is interrupted, leading to poor performance – essentially, a positive moderating effect of routinization on the effectiveness of higher cognitive capacity (Hypothesis 1b). In the data, "attention control" does not have a direct impact on performance, neither a role in the moderation analyses, but is highly correlated with the ability to develop and adapt routines. In addition, my evidence affords more precision about the specific dimensions of mindfulness that are most important in the chain linking CCCs to decision-making performance via routinization propensity. I find, in fact, that "planning and generativity" and "working memory" have a direct impact on decision-making performance in the absence of routinization, and that they are fully mediated by the role of routinized behavior, once this latter factor is integrated into the model.

The tension between different ways to conceptualize the relationship between cognition and behavior, represented in Hypotheses 1 (a and b) and 2, has long been a subject of discussion (Gavetti and Levinthal 2004). The full mediation role of routinization propensity between cognitive capacity and performance offers a novel way to understand the role of less-mindful processes in complex decision-making contexts. This view is consistent with intuitions by some of the early thinkers of modern psychology (Whitehead, 1911; Dewey, 1922) as well as with the most recent advances in neuroscience on the pervasive role of neuroplasticity (Goldberg 2001).

As early as 1911, Whitehead anticipated what psychological research discovered many years later: the limitations of self-regulatory capabilities (Baumeister et al. 1998).

> It is a profoundly erroneous truism, repeated by all copy-books and by eminent people making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of operations which we can perform without thinking about them. Operations of thought are like cavalry charges in a battle—they are strictly limited in number, they require fresh horses, and must only be made at decisive moments. (Whitehead 1911, p.61).

This is precisely what I find in this study: decision-makers who propend towards routinization outperform those who do not. Moreover, routinization propensity is not the product of shallow rationality, as is often implied in debates on the pros and cons of automatic behavior. On the contrary, it is the product of higher cognitive capabilities. Decision-makers with strong CCCs tend to be faster in developing and applying routines, which gives them a double advantage in both simple and complex decision settings. Not only are they more likely to frame the problem more quickly than their peers with lower CCCs levels, but they can translate their superior clarity of mind into better and faster routinized behavior, thus compounding the advantages of both factors.

The implications of this evidence for evolutionary theories of organizations and learning could be profound. First, the virtuous role of routinization in decision-making, one of the fundamental tenets of evolutionary economics (Nelson and Winter 1982), is empirically validated at the individual level. Second, the conceptual and empirical inquiry is carried out at the individual level of analysis, contributing to the development of micro-foundations for the standard claims at the group or organizational levels. Third, the fact that the full mediation of routinization on the effectiveness of CCCs was found to be a better description than a moderating role means that the benefits of routinization propensity might extend even further than originally conceived in Nelson and Winter's (1982) formulation of the theory on routines. When routinization propensity is entered into the model, the quality of CCCs loses its relevance as an antecedent of strategic decision-making performance, which can be interpreted to mean that there is a significant component of rationality and cognitive capacity in the selection and enactment of routinized behavior. At the same time, the fact that CCCs are at the origins of routinization propensity lends credit to the claims of the “mindfulness” school (Brown et al. 2007; Langer 1989; Rerup 2009; Weick and Sutcliffe 2006; Weick et al. 2005) on the role of attention-control capacity in the generation and mapping of appropriate solutions, in simple and complex and ambiguous decision-making contexts. Whereas Whitehead’s quote emphasizes the need to routinize, the consequences of routinizing in inappropriate situations can be disastrous (Gersick and Hackman 1990; Levinthal and Rerup 2006).

The evidence examined suggests, therefore, that a crucial challenge for managers and their organizations is the ability to blend together mindful and less-mindful behaviors. Individuals may differ in their propensity to create and enact routines, and also in their CCCs. It is the interplay of mindful, cognitive abilities with the less-mindful propensity to routinize that affects behavior and therefore decision-making performance. In Levinthal and Rerup (2006)’s words, “learning is a mindful exercise of appropriately mapping routines to a context”. The interplay between the two processes can be described from several perspectives. First, as supervisory mechanisms, CCCs are responsible for the non-automatic components of the decision related to the creation and mapping of routines according to the environment. They help people “shift gear” from offline to online learning (Gavetti and Levinthal 2000) or from contemplation to action (Louis and Sutton 1991). Also, CCCs might influence the choice of whether to develop or change an automatic behavior, based on the framing and cognitive representation of the problem. Second, when an automatic response is triggered, CCCs might play a role in directing the enactment of the automatic behavior in the most appropriate way: higher CCCs might make the difference between a normal execution of a behavior and an excellent one. Finally, CCCs might facilitate better-quality inferences from the performance feedback obtained from automatic behavior implementation, and thus guide the learning and adaptation processes that constantly shape the evolution of organizational routines through marginal adjustments and trial-and-error processes (Rerup 2009; Rerup and Feldman 2010).

This study may have important implications for the management of teams. For example, it suggests that managers creating teams should account for individuals’ strengths in CCCs and routinization propensity in order to get the most from their abilities. It may be important to select individuals who offer both high levels of CCCs and routinization propensity, or else to team those who are more prone to routinization with those who have strong CCCs. Research has found that routinization propensity tends to become more pronounced with age (Kastenbaum 1980), implying that a high-performing team may need a diverse age profile.

We are still, unfortunately, “a long way from having an authoritative textbook for students in professional training who want to know how to create effective organizational routines, or how to modify them when they could be still better” (Cohen 2007). It is therefore important to highlight some of this study’s key limitations and suggest some avenues for future research. We should be cautious in interpreting and generalizing from this study given the characteristics of its sample, the study design, and the pattern of observed findings. First, the use of a single indicator to measure complex decision-making performance might be a limitation, especially since it is generated by a simulation game. Although this is a thorough measure, more reliable and accurate than self-reported ones, the use of a single task to measure performance remains a weakness to be considered. Another possible limitation is the single context for decision-making. It would be interesting to study how these results might change in a less innovative context than the one presented in the simulation, where one might expect routinization to become even more important. Conversely, in a purely creative context, CCCs might acquire more importance, with routinization playing a moderating role (as per Hypotheses 1a and 1b).

A second limitation of this study is the use of a sample composed entirely of graduate students. Another direction would be to replicate it with managerially experienced participants (Carnevale et al. 2011). This would strengthen confidence in the robustness of the results. A particularly interesting follow-up would be to examine how individuals differ in the *efficiency of the routines they create*, rather than their ability to create routines in the first place. For example, taking a cue from Daw et al. (2006), one could explore whether the routines that individuals create for a particular task correspond to 1-greedy, the softmax strategy, or the awarding bonus strategy. It may be that individuals differ not only in their propensity to routinize but also in the efficiency of the routines they create and implement, depending on their experience or area of expertise.

I present results based on a cross-section. This study had an observational design, aimed at uncovering the different relationships between mindful and less-mindful abilities. I did not use manipulations, since my objective was to measure individual variation along the various abilities’ dimensions, and their combined impact on performance. Future research could design treated experimental studies to test the causality dynamics behind these findings. While it might be difficult to create a multiple-task design that also includes manipulations in some of the variables, using different tasks to measure the dependent and independent variables offers the advantage of helping to minimize common-method biases (Podsakoff et al. 2003).

This study contributes at the individual level of analysis, but this focus constitutes another limitation. While this is definitely a first step, and “firms ultimately consist of people whose performance can widely vary” (Mollick 2012), it would be important to explore how individuals’ CCCs and routinization propensity impact performance under interactive conditions. What happens when individuals' CCCs and routinization propensity interact with cognition and routinization at the organizational level? While much is known about how routines in task-performing groups tend to persist and act as a source of inertia and resistance to organizational change (Gersick and Hackman 1990), it would be very interesting to understand how individuals' routinization propensity and cognitive control capabilities react to changing environments in a setting that allows them to interact. How is an individual's routinization propensity strengthened or weakened when they work in a group characterized by different levels of mindful and less-mindful abilities?

There are various interesting possibilities for experimental studies using manipulations that would be helpful in testing the boundary conditions for the findings of this study. Individuals who develop routines tend to do so in different contexts (Singley and Anderson 1989), and it seems unlikely that this would be positive in every setting. While recent and ongoing research in both social and cognitive neurosciences tends to argue that any negative effects are the outcome of rather specific circumstances, and that routinization propensity might actually be a necessary condition for change and adaptation, there might be conditions under which routinization propensity is negative. One interesting study would be to create a decision-making simulation with extreme levels of uncertainty, so that individuals who routinize no longer outperform those who do not. Another possibility would be to alter the time pressure in the routinization propensity task or in the complex decision-making simulation. Since time pressure reduces motivation to process information systematically and fosters routine maintenance (Betsch et al. 2004; De Dreu 2003; Kruglanski and Freund 1983; Verplanken et al. 1997), this might induce individuals to routinize more. Could this artificially generated propensity to routinize improve their performance?

Finally, I believe that an important avenue for future research is to bring emotions into the picture of the less-mindful/mindful debate. Rationality requires emotional input, but emotions also guide (or bias) behavior and decision-making (Bechara and Damasio 2005). In fact, both Simon and Dewey included emotions as the third element of decision-making, in addition to cognition and routines (or automatic behavior, or habits). Future research should also account for emotions as an essential part of strategic decision-making, especially if the ultimate aim is to complete the microfoundations of our theories on organizational learning and change.

Mindful and less-mindful processes intertwine, and are both required for achieving superior outcomes. The nature of the intertwining, however, is rather complex, somewhat surprising, and awaits a significant empirical effort from the community of interested scholars to couple the important theoretical debate with solid evidence of correlation and (more importantly) causation. I hope that this study has shed some light on the path towards more complete microfoundations of the field.

6. Appendices

Appendix 6.1. Methods – Screening procedure subsection

In order to comply rigorously with the requirements of a cognitive neurosciences study, all potential participants filled out a questionnaire for excluding neurological disorders and the use of drugs or any psycho stimulant before joining the laboratory sessions.

Also, participants filled out the Circadian Rhythm Questionnaire (Horne and Ostberg 1976) to determine their circadian typologies and diurnal preferences. According to their circadian rhythm, participants were assigned to either a morning or an evening session so that they could deliver their best cognitive performance. Two groups were formed. The first group, composed of 38 participants, joined the sessions on two consecutive Wednesday mornings. The second group (51 participants) attended two consecutive Friday evening sessions. The Wednesday and Friday sessions only differed in the time of the day at which they took place. All participants were asked not to consume any alcohol in the 24 hours preceding each of the sessions. No differences were found between the two groups in any of the study variables.

Appendix 6.2 Gender differences

I conducted additional analyses to further check my main findings. I did not find any significant gender differences in terms of CCCs, or in risk or temporal preferences. Different hypotheses may arise. In the first place, psychologists often find that while both men and women are overconfident about their relative performance, men tend to be more overconfident than women (Niederle and Vesterlund 2007). This may lead them to feel the task at hand is under control and so tend to routinize more, diminishing the time required to answer to the task and improving performance. I could hypothesize that men tend to show more overconfidence, and so have a higher routinization propensity in the gambling game and improve their performance in the decision-making task.

Another reason to acknowledge superior performance for men in the decision-making task might be differences in motivation. While all participants were very involved in the simulation game and were playing for the same monetary reward, it may be that men derived superior motivation from the task itself. Some studies argue that the reason why some studies do not find gender differences is because their tasks are not in the masculine domain (Lundeberg et al. 1994; Niederle and Vesterlund 2007). Some recent research in the neurosciences has found that men show greater activation and functional connectivity compared to females in the mesocorticolimbic system, which may be the reason for higher motivational states in males when playing video games (Hoeft et al. 2007). These gender differences may help explain why males are more attracted to, and more likely to be motivated to play, computer and video games than females. This phenomenon may also be reflected in my task setting, where the decision-making simulation and routinization propensity task shared many features of computer and video games. I am currently trying to clarify these issues.

7. References

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Table 1: Summary of constructs, tasks and measures

	Construct	Task	Measure
Dependent variable			
Performance	Decision-making performance	Strategic decision-making simulation	▪ Total accumulated profit over 8 years
Independent variables			
Less-mindful	Routinization propensity	Four-armed bandit task	▪ Average response time (not taking into account first 4 trials of each session)
Mindful	CCCs – Attention control	Flanker Task	▪ Number of correct responses in each condition. ▪ Average response time in each condition. ▪ Net speed (response time in incongruent trials minus response time in congruent trials)
	CCCs – Working memory	N-back Task (versions 2-back and 3-back)	▪ Correct responses ▪ Average response time for good responses
	CCCs – Planning and generativity	Tower of Hanoi	▪ Number of moves ▪ Total response time
	CCCs – Reflective capacity (self-regulation)	Cognitive reflection test (CRT)	▪ Correct responses (two separated measures, one for the first 3 and another for the last 7 questions) ▪ Total response time (two separated measures, one for the first 3 and another for the last 7 questions)
	CCCs – Reflective capacity (abstract thinking)	Raven Matrices	▪ Correct responses ▪ Total response time

Table 2: Descriptive Statistics

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Strategic decision-making performance	86	-476.5	471.2	69.55	168.38
Routinization propensity	86	1160.537	4934.974	3075.02	731.76
2back performance	83	13	35	28.95	5.38
2back Response Time in good trials	83	4553.97	14484.55	8745.52	1902.86
3back performance	84	7	35	28.81	5.22
3back Response Time in good trials	84	5162.70	15737.60	9512.39	2220.26
CRT good trials	86	0	10	6.53	2.51
CRT good answers in first 3 questions	86	0	3	1.47	1.20
CRT good answers in last 7 questions	86	0	7	5.07	1.74
CRT Response Time (seconds)	86	0.00	1372.88	496.82	296.51
Flanker good answers in congruent trials	85	14	32	31.55	2.04
Flanker Response Time in congruent trials	85	3942.00	7492.00	5393.62	772.11
Flanker good answers in incongruent trials	83	2	32	29.47	5.15
Flanker Response Time in incongruent trials	85	4428.91	10905.33	6617.05	1074.64
Flanker good answers in neutral trials	85	29	32	31.80	0.59
Flanker Response Time in neutral trials	85	3807.50	8362.13	5298.97	784.30
Flanker net speed (incongruent minus congruent)	85	216.63	3413.27	1223.47	570.08
Raven Matrices performance	86	0	9	7.06	1.70
Raven Matrices Response Time (seconds)	85	136.00	1766.00	585.87	263.83
Tower of Hanoi number of moves	86	31	326	80.15	46.42
Tower of Hanoi Response Time (seconds)	86	47.00	600.00	289.53	159.20
*Response times are expressed in tenths of miliseconds unless stated differently.					

Table 3: Factor analysis

Rotated Component Matrix	Component					
	1	2	3	4	5	6
Eigen value	3.96	2.34	1.93	1.60	1.40	1.05
% of Variance	23.28	13.74	11.38	9.42	8.26	6.20
Cumulative %	23.28	37.02	48.40	57.82	66.07	72.27
Variables and their loads:	1	2	3	4	5	6
Flanker Response Time in congruent trials	0.931					
Flanker Response Time in incongruent trials	0.959					
Flanker Response Time in neutral trials	0.911					
Flanker net speed (incongruent minus congruent trials)	0.549					
CRT Response Time		0.562				
CRT good answers in first 3 questions		0.640				
CRT good answers in last 7 questions		0.585				
Raven Matrices performance		0.731				
Raven Matrices Response Time		0.679				
Tower of Hanoi number of moves			0.897			
Tower of Hanoi Response Time			0.908			
Flanker good answers in incongruent trials				0.850		
Flanker good answers in neutral trials				0.656		
2back Response Time in good trials					0.869	
3back Response Time in good trials					0.889	
2back performance						0.835
3back performance						0.710

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 6 iterations.

Table 4: Correlations between the dependent variables, the factors and the control variables

		Routinization propensity	Strategic Decision-Making Performance	Average gambling performance	FAC1_Attention control	FAC2_Reflective Capacity	FAC3_Planning and Generativity	FAC4_Output of attention control	FAC5_Working memory Speed	FAC6_Working memory performance	control_Year of Birth	control_Gender	control_Anxiety as Trait	control_Anxiety as State
Routinization propensity	Spearman Correlation	1	-0.3374**	-0.2573*	0.3833**	-0.0776	-0.1268	-0.1007	0.0272	-0.356**	-0.0874	-0.2418*	-0.0262	-0.1241
	Sig.		0.0015	0.0168	0.0005	0.4966	0.2654	0.3773	0.8121	0.0013	0.4237	0.0249	0.8109	0.2548
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
Strategic Decision-Making Performance	Spearman Correlation	-0.3374**	1	0.1199	-0.0256	0.2067 †	0.1237	0.0743	-0.0520	0.1485	0.1468	0.3645	0.0111	-0.0957
	Sig.	0.0015		0.2715	0.8229	0.0675	0.2776	0.515	0.6489	0.1916	0.1773	0.0006	0.919	0.3807
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
Average gambling performance	Spearman Correlation	-0.2573*	0.1199	1	-0.0511	0.1539	-0.1128	0.1559	-0.0366	0.1972 †	-0.0477	0.2211	-0.0046	0.0419
	Sig.	0.0168	0.2715		0.6547	0.1758	0.3224	0.1701	0.7487	0.0816	0.6629	0.0407	0.9668	0.7014
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
FAC1_Attention control	Spearman Correlation	0.3833**	-0.0256	-0.0511	1	0.0192	-0.0023	0.0044	0.0241	0.0086	-0.0973	0.0448	-0.1533	-0.1795
	Sig. (2-tailed)	0.0005	0.8229	0.6547		0.8666	0.9836	0.9692	0.8329	0.9402	0.3934	0.6953	0.1773	0.1135
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
FAC2_Reflective Capacity	Spearman Correlation	-0.0776	0.2067 †	0.1539	0.0192	1	-0.0189	-0.0021	-0.0029	0.0046	0.0199	0.0962	-0.0489	0.0181
	Sig. (2-tailed)	0.4966	0.0675	0.1758	0.8666		0.8688	0.9855	0.98	0.9682	0.862	0.3989	0.6687	0.8742
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
FAC3_Planning and Generativity	Spearman Correlation	-0.1268	0.1237	-0.1128	-0.0023	-0.0189	1	0.0009	0.0199	0.0168	0.0586	-0.0659	0.215†	0.0763
	Sig. (2-tailed)	0.2654	0.2776	0.3224	0.9836	0.8688		0.9936	0.8621	0.8834	0.6078	0.5639	0.057	0.504
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
FAC4_Output of attention control	Spearman Correlation	-0.1007	0.0743	0.1559	0.0044	-0.0021	0.0009	1	-0.0034	-0.0014	-0.0355	0.036	-0.2666*	-0.0062
	Sig. (2-tailed)	0.3773	0.515	0.1701	0.9692	0.9855	0.9936		0.9764	0.9904	0.7562	0.7531	0.0176	0.9568
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
FAC5_Working memory Speed	Spearman Correlation	0.0272	-0.052	-0.0366	0.0241	-0.0029	0.0199	-0.0034	1	-0.0144	0.0071	0.1095	-0.0005	-0.006
	Sig. (2-tailed)	0.8121	0.6489	0.7487	0.8329	0.98	0.8621	0.9764		0.9	0.9508	0.3367	0.9966	0.9578
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
FAC6_Working memory Performance	Spearman Correlation	-0.356**	0.1485	0.1972 †	0.0086	0.0046	0.0168	-0.0014	-0.0144	1	0.1494	0.2231*	0.0254	-0.0431
	Sig. (2-tailed)	0.0013	0.1916	0.0816	0.9402	0.9682	0.8834	0.9904	0.9		0.1887	0.0481	0.824	0.7061
	N	79	79	79	79	79	79	79	79	79	79	79	79	79
control_Year of Birth	Spearman Correlation	-0.0874	0.1468	-0.0477	-0.0973	0.0199	0.0586	-0.0355	0.0071	0.1494	1	-0.0269	-0.0576	-0.0534
	Sig. (2-tailed)	0.4237	0.1773	0.6629	0.3934	0.862	0.6078	0.7562	0.9508	0.1887		0.806	0.598	0.6251
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
control_Gender	Spearman Correlation	-0.2418*	0.3645	0.2211	0.0448	0.0962	-0.0659	0.036	0.1095	0.2231*	-0.0269	1	-0.0272	-0.1177
	Sig. (2-tailed)	0.0249	0.0006	0.0407	0.6953	0.3989	0.5639	0.7531	0.3367	0.0481	0.806		0.8037	0.2804
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
control_Anxiety as Trait	Spearman Correlation	-0.0262	0.0111	-0.0046	-0.1533	-0.0489	0.215†	-0.2666*	-0.0005	0.0254	-0.0576	-0.0272	1	0.7048
	Sig. (2-tailed)	0.8109	0.919	0.9668	0.1773	0.6687	0.057	0.0176	0.9966	0.824	0.598	0.8037		0
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
control_Anxiety as State	Spearman Correlation	-0.1241	-0.0957	0.0419	-0.1795	0.0181	0.0763	-0.0062	-0.006	-0.0431	-0.0534	-0.1177	0.7048	1
	Sig. (2-tailed)	0.2548	0.3807	0.7014	0.1135	0.8742	0.504	0.9568	0.9578	0.7061	0.6251	0.2804	0	
	N	86	86	86	79	79	79	79	79	79	86	86	86	86
	**	Correlation is significant at the 0.01 level (2-tailed).												
	*	Correlation is significant at the 0.05 level (2-tailed).												
	†	Correlation is significant at the 0.10 level (2-tailed).												

Table 5: Regression models

Variables	Controls model	Model 1	Model 2	Model 3	Model 4	Model 5
Dependent variable	**Dec.Mak.Perf.**	**Dec.Mak.Perf.**	**Dec.Mak.Perf.**	**Dec.Mak.Perf.**	**Rout.Propens.**	**Dec.Mak.Perf.**
Constant	-0.295(0.437)	-0.089(0.424)	0.013(0.456)	0.156(0.452)	0.188(0.417)	0.0736(0.439)
Gender	0.732**(0.205)	0.593**(0.201)	0.661**(0.214)	0.522*(0.210)	-0.427*(0.195)	0.517*(0.213)
Anxiety as State	-0.014(0.015)	-0.011(0.014)	-0.026(0.016)	-0.032†(0.016)	0.021(0.015)	-0.019(0.016)
Anxiety as Trait	0.010(0.014)	0.005(0.013)	0.015(0.015)	0.021(0.015)	-0.017(0.014)	0.010(0.014)
Routinization propensity		-0.306**(0.105)		-0.332*(0.133)		-0.325*(0.127)
Factor1 Attention control			-0.016(0.105)	0.164(0.115)	0.393 ***(0.096)	0.111(0.112)
Factor2 Reflective Capacity			0.11(0.103)	0.046(0.103)	-0.052(0.094)	0.094(0.099)
Factor3 Planning and Generativity			0.211 †(0.107)	0.175(0.105)	-0.166 †(0.098)	0.158(0.105)
Factor4 Output of attention control			0.000(0.110)	-0.069(0.132)	-0.039(0.100)	-0.015(0.106)
Factor5 Working memory Speed			-0.090(0.104)	-0.153(0.105)	0.038(0.095)	-0.079(0.0997)
Factor6 Working memory performance			0.182 †(0.105)	-0.003(0.115)	-0.313 **(0.96)	0.078(0.109)
Routinization propensity x Attention control				0.114(0.112)		
Rout. Propens.x Reflective capacity				0.083(0.120)		
Rout. Propens.x Planning & Generat.				-0.019(0.099)		
Rout. Propens.x Output attention control				-0.015(0.097)		
Rout. Propens.x Working memory speed				0.022(0.091)		
Rout. Propens. x Working memory perf.				0.335**(0.106)		
R^2	0.155	0.2347	0.255	0.422	0.376	0.3201
Adjusted R^2	0.124	0.1969	0.158	0.273	0.294	0.2201
F statistic	5.01**	6.21**	2.63*	2.84**	4.61**	3.20**
Mean VIF	1.73	1.6	1.36	1.66	1.36	1.45
White Test	0.413	0.299	0.087	0.447	0.475	0.1957

Notes: standardized coefficients are reported

† p<0.10 * p<0.05; ** p<0,01; *** p<0,001

Table 6: Sobel estimates and bootstrap confidence intervals for indirect effects on decision-making performance

Antecedents	Mediator	Sobel estimates	Bias Corrected and Accelerated Confidence Intervals 95%
FAC1 Attention control	Routinization propensity	-1.79*	[-0.289 -0.19]
FAC3 Planning and Generativity	Routinization propensity	1.36†	[0.0066 0.1730]
FAC6 Working memory performance	Routinization propensity	1.69*	[0.0191 0.2465]

Notes: † p<0.10; * p=<0.05; Statistical controls included: gender, age, stress as trait, stress as state, and the remaining 5 CCC factors apart from the one being considered as antecedent on each of the analyses.

Figure 1: Hypotheses on Cognitive control capabilities, routinization propensity and decision-making performance

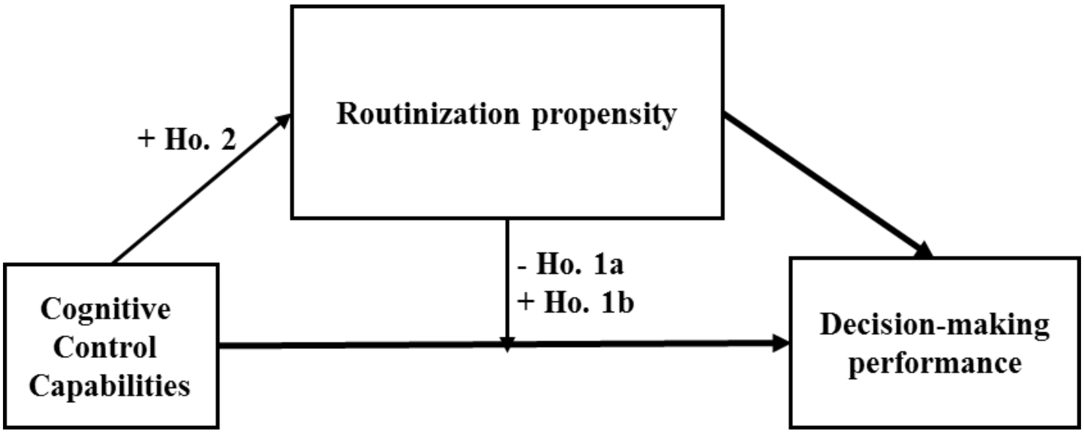

Figure 2: Results Cognitive control capabilities, routinization propensity and decision-making performance

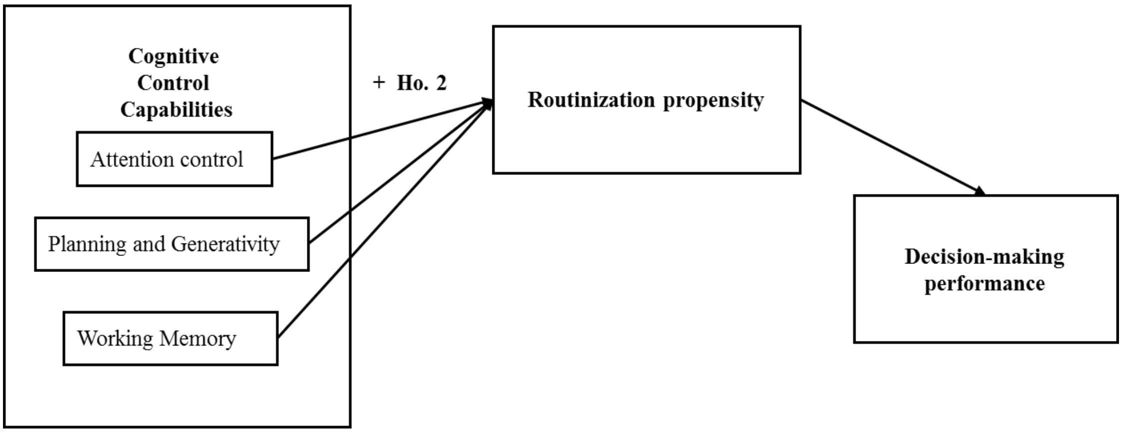

Figure 3: Combined effect of Cognitive control capabilities and routinization propensity on decision-making performance

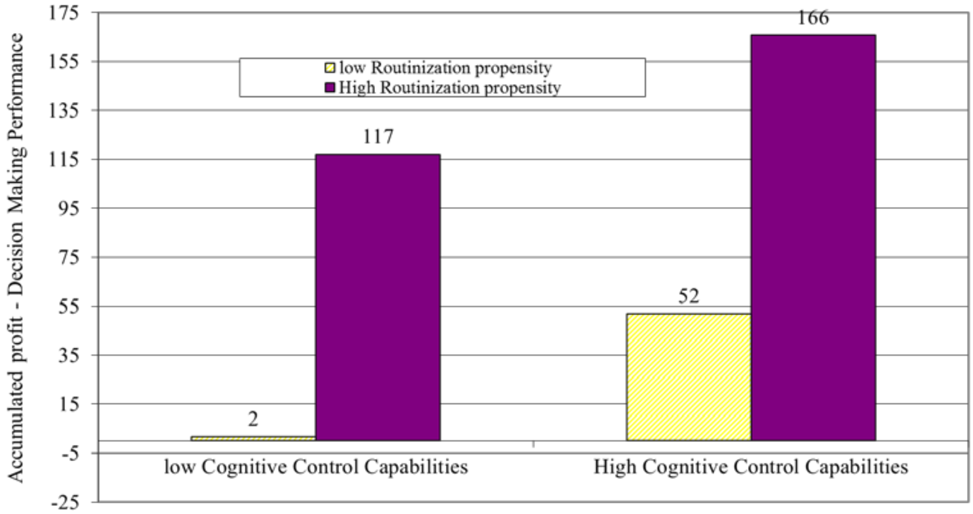

Figure 4: Routinization propensity according to best, average and worst performers

Legend to figure 4: the lines show the response time averages for the participants throughout the trials of the routinization propensity task. The x-marked line shows all participants together. The other lines show the participants divided into groups according to their performance on the dependent variable (the decision-making task): the 28 worst performers (diamonds-marked line), the 29 average performers (the squared-marked line), and the best 29 participants (triangles-marked).