Decision-making between rationality and intuition: effectiveness conditions and solutions to enhance decision efficacy.

PHD Dissertation

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Thesis introduction

Disclaimer. This introduction is aimed at providing an outlook over the thesis content without forming part of the scientific articles therein contained.

We all make decisions every day. We all know that we cannot use the same approach for all our decisions. Buying the office building that meets the logistics needs of our enterprise, choosing the most suitable business partner, deciding when is the right time to drop a non-performing but promising project, are all examples of decisions that solicit our analytical and rational decision skills. We might decide to rely exclusively on analytical considerations or to follow our gut feeling no matter what. These polarized approaches in some cases might ensure an effective decision outcome while in other cases might lead to unsatisfactory epilogues due to excessively factious decision background. What is the right recipe then? How can we improve our capacity to deploy sound and rigorous analytical skills and refine the tacit skills that enable reliable intuitions? This research work starts from these queries to explore conditions and boundaries of the effectiveness of professional decisions and solutions to enhance decisions harmoniously inspired by intuition and analysis within organizations.

As per common practice, the thesis consists of three papers. The first paper is a multidisciplinary literature review of the decision-making theories from cognitive psychology, neuroscience, behavioural, heuristics and biases studies and the intuitive and naturalistic decision-making currents. The objective of the review is to isolate the most prominent contributions from diverse fields of scientific inquiry to management studies along two dimensions. The first one is an environmental dimension accounting for the characteristics and the constraints of the decision context. The second is a broader dimension encompassing cognitive dynamics, experience, expertise and individual characteristics of the decision-maker. With this review, we provide management scholars with a broad overview of the decision conditioning factors, mental mechanisms and implications of intuition and analysis in decision-making. Lastly, we draft a synopsis of the research approaches, investigation novelties, theorization, contribution and weaknesses of each of the already mentioned literature strands pointing out some research opportunities.

The second paper is a qualitative study investigating how individual and environmental factors interact and influence the effectiveness of strategic decisions through rational and intuitive dynamics. This investigation on decision effectiveness conditions is embedded in a setting where human cognition is conceived as the ensemble of both deliberate and tacit mental mechanisms. This framing responds to the choice to adopt a micro-founded approach to the study of decision-making processes underpinned by the cognitive science conception that even numerous higher-level cognitive operations originate in the non-conscious sphere of thought. The study builds on the effectiveness conditions already identified in former literature to investigate how the individual characteristics of the decision maker and the contextual features of the decision environment influence each other through cross-moderating effects and how this exerts an impact on decision effectiveness. Informants are forty three seasoned professionals from twelve job families operating in large organizations in executive and top management roles. Interviews are conducted through the critical incident approach adopting a person-situation interactionist framework to connect the situational and individual factors and to explore a number of dimensions

(individual preferences, role in organization, situation characteristics, organization style and team composition). Interviews were complemented with cognitive, personality and risk appetite psychometric tests. The patterns and recurrences emerged from the data analysis allowed to cluster the job families into three groups. These regularities were trended along the already mentioned dimensions that were eventually crystalized in a taxonomy. The analysis highlighted the existence of cross-moderating effects bridging different dimensions of the individual and environmental factors. We concluded defining five conditions and a multidimensional model of decision effectiveness.

The third paper is a field experiment consisting of a mentoring programme for the promotion of self-confidence in decision-making. The study was conducted at a United Nation organization based in Rome involving 20 mentoring couples in the treatment group and 20 couples in the control group over a nine month period. The treatment acts on cognitive awareness and expertise building and aims to validate a set of hypothesis:

> *Hypothesis 1a: A deeper understanding of how continuous learning leads to improved expertise-building increases self-confidence in decision making.*
>
> *Hypothesis 1b: A deeper understanding of how mindful teaching leads to improved expertise-building increases self-confidence in decision making.*
>
> *Hypothesis 2a: A deeper understanding of the deliberate cognitive mechanisms that regulate rational-analytical thinking increases self-confidence in decision making.*
>
> *Hypothesis 2b: A deeper understanding of the tacit cognitive mechanisms that regulate experiential-intuitive thinking increases self-confidence in decision making.*

The analysis was conducted applying both a one-way ANOVA (with post-estimation tests Bonferroni and Tukey) and the difference-in-differences regression technique to epurate the resuts from the effect of the counterfactual from the control group. The treatment had a positive significant effect on the self-confidence in decision making (dependent variable). We obtained sufficient evidences to support two hypothesis, limited evidences to support another one and no evidences to support the last one.

Decision-making, one process, many theories: a multidisciplinary literature review

Introduction

Decision theorists agree that there is not a single comprehensive theory that can explain all the many facets of the decision-making process. The complexity of this process requires separate framing and ad-hoc tools depending on the decision constraints and needs. For this reason, we assisted to the proliferation of research approaches and decision theories. In this review, we explore many of these approaches across different disciplines and through the lenses of the duality between intuition and rationality. In order to capture this distinction, we focused on the literature that defined the functioning of the tacit-unconscious and the explicit-conscious decision drivers. More specifically, we reviewed the contributions to decision-making that were provided by a wide range of sources such as behavioural decision theory, heuristics and biases tradition, cognitive psychology and neuroscience, intuitive decision tradition and the Naturalistic decision-making current. Our objective is to isolate the most prominent contributions from diverse fields of scientific inquiry to management studies along two dimensions. The first one is an environmental dimension accounting for the characteristics and the constraints of the decision context. The second is a broader dimension encompassing cognitive dynamics, experience, expertise and individual characteristics of the decision-maker. With this review, we provide management scholars with a broad overview of the decision conditioning factors, mental mechanisms and implications of intuition and analysis in decision-making. Lastly, we draft a synopsis of the research approaches, investigation novelties, theorization, contribution and weaknesses of each of the already mentioned literature stand pointing out some research opportunities.

Main strands of literature

This literature review encompass the work of scholars and researchers who contributed to the study of decision-making from a management and organization behaviour perspectives. For this reason, we limit the scope of this review only to some literatures that dealt with decision theory while only marginally treating some other theoretical positions. This does not represent an implicit declaration of irrelevance of the other literature

traditions, which remain prominent and influential in the decision-making domain. This choice is inspired by the principle of relevance for management studies, the need to focus on conscious and unconscious cognitive mechanisms and the relevant explicit and implicit decision drivers and last but not least the sake of brevity in the presentation.

Behavioural decision-making theory has its roots in Edwards' (1954) studies of probability revision, Meehl's (1954) analysis of clinical judgment, Luce and Raiffa's (1957) work on game theory and Simon's (1947, 1955) studies of organizational decision-making. In their attempt to reconcile the theorization of human decision-making to empirical evidences, Behavioural decision researchers soon realized that actual human behaviour deviates from the models inspired by full rationality and the optimal judgments. Even in the early 1960s, the view of human decision-making as maximization of subjective expected utility following the laws of probability, the axioms of expected utility theory or Bayesian statistics (Edwards, 1954; 1961) was considered unsuitable to explain real choices. From then onward, alternative explanations were proposed by behavioural decision theorists who investigated actual choices identifying numerous rule of thumb heuristics that often culminate into distortions such as availability, representativeness, confirmation biases and so on (Kahneman et al., 1982, Payne et al., 1993, Gilovich et al., 2002). Behavioural decision-making borrowed from Simon's pioneering treatises on bounded rationality written in the late 1940s and 1950s, and from the findings of Meehl's on the inaccuracies of expert clinical predictions (Meehl, 1954). A new promising season of this strand of literature was inaugurated by the collaboration between Kahneman and Tversky (Shapira, 2008) whose seminal work revolutionised research on judgement and decision-making (Gilovich and Griffin, 2002). The application of psychology to probability estimation and choice led Kahneman and Tversky to investigate the systematic biases deriving from automatic judgements and choices that result from fallacies and distorted appraisals inherent in human information processing (Kahneman and Tversky, 1973; Tversky and Kahneman, 1974). Within the 'Heuristics and Biases' programme, several research strands found space, namely judgement under uncertainty (Kahneman et al., 1982), prospect theory and framing in individual choice behavior (Kahneman and Tversky 1984). In this setting, analytical thinking was interpreted as the functioning of "System 2" cognitive mechanisms while intuition was defined as "thoughts and preferences that come to mind quickly and without much reflection" (Kahneman, 2002), as we will see in detail later. Their interpretation of intuition is in line with that of Gilovich and Griffin (2002), who see intuitive judgements as 'natural assessments' stemming from automatic perceptions in contrast with the deliberate operations of reasoning (Shapira, 2008). Evidence suggests that Heuristics is ubiquitous and that errors and biases, stemming from the intentional and unintentional, conscious and non-conscious application of rules of thumb, are inherent in human decision-making (Das and Teng, 1999; Hodgkinson et al., 1999; Highhouse, 2001; Neale et al., 2006; Hodgkinson and Sparrow, 2002). Tversky and Kahneman's position toward heuristics is essentially negative since their experimental results highlighted a

number of human computational deficiencies connected to bounded rationality (Bazerman, 1984; Schwenk, 1984, 1988; Bateman and Zeithaml, 1989).

The domain of *Cognitive Psychology* studies the underlying operating principles of the processing systems at the origin of thinking. Evidence regarding the attributes of cognitive systems generated within this discipline has led to the conclusion that human cognitive dynamics have a twofold structure: the experiential/intuitive system on one side and the rational/analytic system on the other side. The experiential/intuitive system—also known as System 1—operates by the rules that govern automatic learning from experience such as classical conditioning, operant conditioning, and observational learning based on association, contiguity, similarity and affective reinforcement. The rational/analytic system—System 2—is an explicit verbal reasoning system that relies on conscious rationality. These two information processing modalities translate into two models of the world, one consisting of implicit beliefs automatically acquired from experience and the other consisting of explicit beliefs derived from conscious reasoning (Epsten, 2003). These theories of reality are sometimes aligned, while at other times they diverge. When they diverge, they create cognitive conflicts within human mind. Both these models of the world determine feelings and behaviour still in very different ways and for different purposes. The experiential/intuitive system is used to direct judgements and behaviour in everyday life without effort and in a holistic way through involuntary associations (Bowers et al., 1990; Dijksterhuis, 2004; McMackin and Slovic, 2000). The rational/analytic system requires more effort and is used for abstract thinking and to solve problems by analytical reasoning (Pacini 2002).

In the early 2000s, cognitive psychology was pervaded by the powerful tools adopted in *Neuroscience* that enable brain activity to be mapped. This allowed researchers to examine the neural bases of judgement and cognitive processes. For instance, in several studies on skin conductance responses (SCRs) (Bechara, XXX), electroencephalography techniques (EEG) (Gazzaniga et al., 2002) and brain-imaging techniques (fMRI) were used to identify brain regions associated with implicit and explicit thinking, in line with the dual-process theory (Jung- Beeman et al, 2004). Lieberman, a social cognitive neuroscientist, found that intentional explicit judgements in fields where individuals had little or no experience were associated with the activation of a 'reflective' system (C-system) while the implicit, intuitive, automatic judgements in fields where individuals had high experience were associated with the activation of the 'reflexive' system (X-system) (Lieberman, Jarcho, and Satpute, 2004).

The classical theory of decision-making was further challenged by the researchers belonging to the *Intuitive decision-making* strand of literature. Both practitioners and the academia (Vasconcelos, 2009; Salas et al., 2010; Kahneman and Klein, 2009) gradually and widely accepted the increasing importance of intuition in decision-making. Therefore, while rational analysis is still a norm in the decision-making processes in businesses, the

role of tacit knowledge and intuition in decision-making has been getting more attention in the management literature (e.g. Klienmutz, 1990; Brockman and Anthony, 1998; Elbanna, 2006). This branch of decision-making theorists capitalized the advances in cognitive neuroscience (Lieberman 2007) and managerial and organizational cognition (Sinclair and Ashkanasy 2005; Dane and Pratt 2007). Scholars of this strand of literature claimed that intuition is an innate ability and that all humans possess it. Bastick (1982) argued that intuition is 'a powerful human faculty and suggested that it may have a genetic component. Moir and Jessel (1989) considered the capability to intuit as an inherited 'unlearnt gift' while Myers (2002) explained social intuition evolutionary as an 'ancient biological wisdom' that supports humans in risky situations as 'meeting a stranger in a forest' in order to perform almost instant assessment of the potential danger (friend of foe). The ability to read accurately contextual and other people body signals such as facial expressions and other non-verbal cues translated into higher chances to survive and leave descendants. Among the numerous definitions of intuitions provided by the Intuitive decision-making researchers, we are inclined to adopt the widely accepted definition offered by Dane and Pratt (2007) who see intuitions as "affectively charged judgments that arise through rapid, non-conscious and holistic associations". These authors performed a comprehensive review and theorisation of intuition in managerial decision-making. They disaggregated intuitive outcomes into three types based on the 'nature of associations', 'intensity of affect', and 'level of incubation'. The first type is the problem-solving intuition conceived as the outcome of a process of pattern matching. This is in line with the concept of 'intuitive expertise' deriving from repeated training and practice that was adopted also by Kahneman and Klein (2009) and Salas, Rosen, and Diaz-Granados (2010). The second type is creative intuition seen as the "feeling that arises when knowledge is combined in novel ways" integrating knowledge across different domains in a slow incubation process that other researchers like Sadler Smith associated with insight rather than to intuition (Akinci and Sadler Smith, 2012; Hogarth, 2001). The third type is moral intuition (Hauser, 2006). During the 2000s, the Intuitive decision-making tradition derived impetus from the conceptual and theoretical advances in Behavioural and Naturalistic decision-making theories. Sadler-Smith and Shefy (2004), inspired by the work of Hogarth (2001) in the attempt to find a synthesis with the main concepts of the Naturalistic decision-making literature, developed two conceptualization of intuitions: 'intuition-as-affect' and 'intuition-as-expertise'. Simultaneously, Sinclair and Ashkanasy (2005) built a model of analytical and intuitive decision-making combining conjunctural characteristics with decision context, decision makers' position, conscious analytical and non-conscious intuitive processes, and including affect and gender as moderating variables. In their work, they defined intuition as a non-sequential information-processing mode working through cognitive and affective elements that allow decision makers to attain direct understanding without resorting to conscious reasoning. In the Intuitive decision-making current, intuition is not considered the opposite of rationality but rather the product of extensive experience in solving problems supported by both contextual analysis and gut feeling (Isenberg, 1984). In this view, intuition is positioned as being interdependent from rational analysis rather than

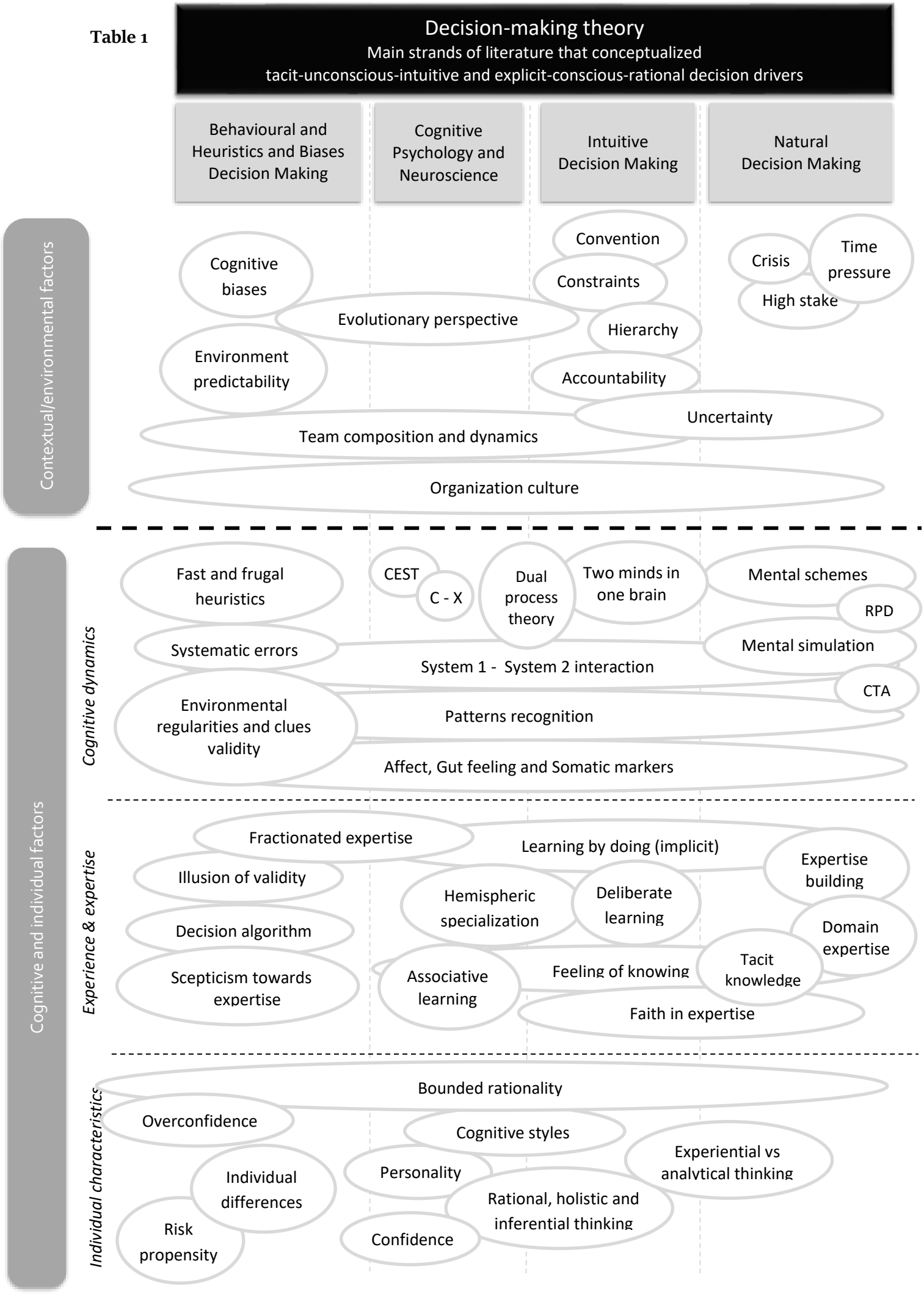
in opposition to it (Hodgkinson and Sadler-Smith, 2003). Rationality and intuition can co-exist as effective decision-making and creative problem-solving (Dane and Pratt, 2006; Sinclair and Ashkanasy, 2005), and have the potential to balance or reinforce each other in a hybrid powerful style that incorporates the best of both (Agor, 1989; Claxton, 1997, 2000; Khatri and Ng, 2000; Leonard and Straus, 1997; Parikh, 1994; Sadler-Smith and Shefy, 2004).

The *Naturalistic decision-making* approach moved its first steps from the research on master chess players conducted by de Groot (1946/1978) and later by Chase and Simon (1973). De Groot observed that, after a decade of serious play, chess grand masters were able to identify the most promising or fruitless moves rapidly thanks to an unusual ability to appreciate the dynamics of complex positions. On the contrary, mediocre chess players were unable to visualize the best moves as they lack the perceptual skills to recognize complex patterns (Chase and Simon, 1973). The studies on chess grand masters estimated that they are able to recognize a repertoire of 50,000 to 100,000 patterns, thus being capable to identify a good move without the need to calculate all possible contingencies. The Naturalistic decision-making community built on the finding of the chess master empirical studies and embarked on a long series of field studies to describe how people make decisions in real-world settings rather than investigations that test "hypotheses drawn from mathematical and statistical theories" (Klein, 1998). They focused especially on contexts characterized by complexity, time pressure, high stakes, uncertainty, dynamic and unstable conditions and vague goals (Orasanu and Connolly, 1993). Recurrent informants of these empirical studies are navy commanders, jurors, nuclear power plant operators, army small unit leaders, anesthesiologists, airline pilots, nurses, and highway engineers (Zsambok and Klein, 1997). In 1989, a group of 30 researchers who studied decision-making in natural settings met for several days in an effort to find commonalities between the decision-making processes and to prepare a book on the perspective of this new decision-making current (Klein et al., 1993). The Naturalistic decision-making movement focused on field studies and adopted the perspective of the experts who are expected to be successful in attaining vaguely defined goals in the face of uncertainty, time pressure, high stakes, team and organizational constraints. Therefore, Naturalistic decision-making researchers focused on very specific decision dynamics such as shifting decision conditions and action feedback loops in which decision-makers are expected to manage disturbances while trying to diagnose them (Orasanu and Connolly, 1993). In the early 1990s, several researchers were still working in relative isolation from each other. Raanan Lipshitz (1993) identified around nine models of naturalistic decision-making developed simultaneously to describe the strategies used in field settings. It is worth recalling as main contributions the image theory (Beach, 1990), the search for dominance structures (Montgomery, 1993), and Hammond's cognitive continuum theory (Hammond, Hamm, Grassia, and Pearson, 1987) which asserts that decisions vary depending on the degree to which they rely on intuitive and analytical processes. Lastly and more prominently, Rasmussen's model of cognitive control (Rasmussen, 1983; 1986), which distinguished skill-

based, rule-based and knowledge-based behaviour operating within the context of a decision ladder, and the recognition-primed decision (RPD) model (Klein, 1989) that is discussed in more detail in the next sections. The main merit of Naturalistic decision-making is that it conceived human decision-making as a knowledge-based and domain-specific process in which experienced decision makers have a substantial advantage. In this process, decision makers synthesize prior experience to rapidly categorize, make sense of a situation and eventually formulate judgment and appropriate courses of action. This current rejected the notion of decisions as gambles; in their interpretation decision-makers are not passive actors awaiting the outcomes of their bets but rather active individuals who try to shape events. In the Naturalistic decision-making view, the decision process is not limited to choice from among given options but instead is expanded to include a prior stage of perception and recognition of situations, as well as the elaboration of appropriate responses. In addition, the Naturalistic decision-making tradition took advantage of the advances in cognitive psychology borrowing the knowledge representation concepts of scripts, schemas and mental models functional to contrast the behaviour of experts versus novices.

In this article, we conduct an in-depth review of the role of the environment, the decision makers' cognitive dynamics and individual preferences in the overall decision-making process. We present the position of each strand of literature vis-à-vis the role of contextual factors, the individual cognitive dynamics, the personal characteristics and the propensity for expertise building illustrating the constructs that are pivotal for the four literature currents. Table 1 provides a graphical representation of the main concepts we will be treating sorted by literature tradition and macro area of influencing factors. In this matrix, the 'Contextual and environmental' factors are presented separately from the 'Cognitive and individual' factors. The latter includes three sub-areas that are 'Cognitive dynamics', 'Experience and expertise' and 'Individual characteristics'.

Table 1


Decision-making theory
Main strands of literature that conceptualized
tacit-unconscious-intuitive and explicit-conscious-rational decision drivers
Behavioural and Heuristics and Biases Decision Making
Cognitive Psychology and Neuroscience
Intuitive Decision Making
Natural Decision Making
Contextual/environmental factors
Cognitive biases
Convention
Crisis
Time pressure
Constraints
High stake
Evolutionary perspective
Hierarchy
Environment predictability
Accountability
Uncertainty
Team composition and dynamics
Organization culture
Cognitive and individual factors
Cognitive dynamics
Fast and frugal heuristics
CEST
C - X
Dual process theory
Two minds in one brain
Mental schemes
RPD
Systematic errors
Mental simulation
System 1 - System 2 interaction
CTA
Environmental regularities and clues validity
Patterns recognition
Affect, Gut feeling and Somatic markers
Experience & expertise
Fractionated expertise
Learning by doing (implicit)
Expertise building
Illusion of validity
Hemispheric specialization
Deliberate learning
Domain expertise
Decision algorithm
Tacit knowledge
Scepticism towards expertise
Associative learning
Feeling of knowing
Faith in expertise
Individual characteristics
Bounded rationality
Overconfidence
Cognitive styles
Experiential vs analytical thinking
Personality
Individual differences
Rational, holistic and inferential thinking
Risk propensity
Confidence

Contextual and environmental factors

In this section, we provide an overview of the main contextual and environmental factors influencing decision dynamics as they were identified by the strands of literature considered in this review. We will start presenting the evolutionary perspective of human cognitive mechanisms and then we will proceed emphasizing the contribution of the most influential decision theorists to management studies. Subsequently, we will illustrate which are the dimensions of the organization environment to which the considered strands of literature contributed more significantly. These are organization culture, conventions, constraints, hierarchy, accountability, team composition and dynamics. Lastly, we will focus on environmental features such uncertainty and unpredictability and on the empirical works that explored decisions taken in critical situations characterized by time pressure and high stake.

The evolutionary perspective of human mind

The functioning mechanisms of human mind have always been a key and constantly hot topic for cognitive psychologists. The existence of more than one cognitive system was explored extensively until the theorization of a two-fold functioning of human mind based on two systems: System 1 and System The most salient characteristics of the two systems are conceived as the result of evolutionary selection and adaptation to the environment. The experiential/intuitive (System 1) is a rapid processing, holistic and immediate action-oriented system characterized by pleasure–pain orientation, codification of reality through concrete images, metaphors, and narratives, resistance to change that is produced only through repetitive or intense experience. System 1 works by encoding implicit beliefs in cognitive–affective network, and is mediated by feelings from experience that lead to a broad generalization gradient and are organized by context-specific representations and categorical thinking. Reality is experienced passively and preconsciously and becomes self-evidently valid since experiencing is equivalent to believing. The rational/analytic is a reality-oriented, analytic and logical system that functions through associative cause-and-effect relations that are processed comparatively slower than System 1. It is process-oriented and based on conscious beliefs encoded in affect-free cognitive networks and abstract symbols, words, and numbers. Behaviours are mediated by conscious appraisal of events and change occurs more readily. Thinking in system 2 is more nuanced, qualified, dimensional and organized by context-general principles. Reality is experienced actively and consciously as individuals feel in control of their conscious thoughts and are able to justify judgements through logic or evidence (Epstein, 1989).

The dual-process theorists in the Cognitive Psychology strand of literature have hypothesised that System 2 processing evolved 50,000-60,000 years ago (Evans, 2003) whereas System 1 processing dates back to more ancient times and is present also in non-human animals (Epstein, 1994, 2008). This hypothesis would be

confirmed by the fact that all the attributes of the experiential/intuitive system apply to the information processing of both humans and other higher non-human animals. Epstein (1994) suggested that that all human behaviours are influenced by both systems along a relative influence spectrum that spans from negligible to total influence. Indeed, this distinction was then gradually accepted by all the literatures we are considering and became a milestone for management community.

The echo of decision theories in management studies

Simon's influential book "Administrative behaviour" (1950) was a pioneer attempt to explore organizational decision-making and is repeatedly cited by decision theorists for his breakthrough contribution to the study of both rational and intuitive judgments. This author solicited the replacement of the classical models of rational choice with new models compatible with the restricted capacities of human cognition that do not allow individuals to act with perfect rationality. As a generalization of the individual level, human behaviour in the organizations is not wholly rational but rather "boundedly" rational (Simon, 1947). Based on the observation of how individuals make decisions in organizations, Simon depicted the concept of an "administrative man" in lieu of the "homo economicus" who makes decisions without maximizing but instead looking for a satisfactory option. These observations provided the basis for a behavioural theory of decision making in organisational contexts (Simon, 1955, 1967). The Behavioural and Heuristics and Biases traditions starting from the work of Kahneman and Tversky contributed to the conceptualization of bounded rationality posing the accent on the cognitive distortions and systematic errors that affect decisions and judgements (Kahneman and Tversky, 1973; Tversky and Kahneman, 1974).

Simon and Chase contributed also to the research on intuition-driven decisions. Due to their experiments with chess experts, they developed a pattern-recognition based theory of intuition that is defined as "analyses frozen into habit and the capacity for rapid response through recognition" (Simon, 1987) without the ability to explain the underlying mental passages (Simon, 1992). As we will see more in detail in later sections, Simon's view of intuition as domain-specific expertise based on tacit and explicit knowledge (Simon, 1983) is shared also by the Naturalistic decision-making current that considers intuitive judgments the outcome of rapid recognition of patterns and cues by experts (Klein 1998). On the same note, other authors adopted the 'intuition as expertise' view and contributed to management studies investigating the role of in managerial decision-making and possible solutions to nurture intuition among management students and practitioners.

Organization culture and decision-making

In this review, we focus on organization culture as "something an organization is rather than something an organization has" (Smircich, 1983) as thus interpretation is the most suitable to reconcile the divergent positions of Behavioural, Intuitive and Natural decision-making strands of literature. In the Heuristics and Biases view, cultural assumptions are considered excessively vague and inconsistent to build reliable foundations to the discussion on decision-making. However, some authors consider culture as a possible influencing factor and see it as a limitation of decision rationality (Tse et al, 1988). Organization culture has been investigated extensively in management studies and numerous conceptualizations were developed to explain how workers shape the social environment within organizations and how these contextual feature influences decision-making. Sainsaulieu (1977) observed that workers throughout communities of occupations share rules, values and practices that help them manage relationships such as solidarity, mutual help, technical complementarity, dependence, authority, but also information and the capacity to exert control and perform appraisal aimed at taking decisions. Gregory (1983) studied professionals working in Silicon Valley and found "occupational communities" having distinctive cultures that are not simply subcultures, but crosscut organizational boundaries and provide employees with significant reference groups both inside and outside their companies that work as networks functional to inform decisions. Martin (2002) and Martin and Frost (1996) identified theoretical perspectives such as 'segmentation' that refers to the culture ambiguity, 'integration' that stresses the unifying power of culture (Schein, 1985) and 'differentiation' that focuses on inconsistencies, differences, and persistent subculture within organizations (Martin, 2002).

Convention, constraints, hierarchy and accountability

The Intuitive decision-making tradition explored how decision-making is influenced by contextual and environmental factors such as conventions, constraints, hierarchy, and accountability (Sadler-Smith, 2011). In his empirical studies, Sadler-Smith (2011) studied how organizational, social and contextual factors interact with intuitive judgements. This author emphasized that intuition sometimes need to be rationalised to demonstrate accountability to hierarchical superiors and to comply with norms and conventions. Respecting the conventional equilibrium of authority is crucial to have an eventual intuition-driven course of action and the consequent decision outcomes and behaviours endorsed within organizations. His findings resonates with the view expressed by Huff et al. (2006) confirming that a deep understanding of the organizational context is vital to validate intuitions. Sadler Smith (2011) hypothesised that norms, procedures, values, beliefs and attitudes gradually created over time convert into implicit rules and conventions and can contribute to "collective intuitions" (Sadler-Smith, 2008; Gomez and Jones, 2011).

Other researchers belonging to the Intuitive decision-making tradition conjectured that expertise-backed intuition might inform the creation of decision-making rules inspired by a process of organizational learning (Crossan et al., 1999) and contribute to a culture of collective intuition manifesting as taken-for-granted routines and conventions. Sadler-Smith (2011, 2013) insisted on the limitations and controls implied by organizational hierarchy, conventions and constraints exploring also the dynamics of the organizational upper echelons since these could hinder the development of intuitive judgments and the consequent decision-making process. Senior management is physiologically exposed to fewer hierarchical constraints; nonetheless, it remains subject to external limiting factors such as stakeholders' perceptions. These findings are largely in line with the results of Agor's (1989) survey of 200 US managers that revealed a widespread point of view among respondents who perceived intuition as connected with job level. Indeed, senior managers perceived themselves as more intuitive than those lower down in the hierarchy. Looking at the phenomenon from the perspective of executives and lower echelon employees, we see that they consider hierarchies as an obstacle for the development of their intuitive judgements. This finding was corroborated by subsequent studies (Sadler-Smith et al., 2000; Parikh et al., 1994; Burke and Miller, 1999).

A similar binding and restricting role was attributed to accountability and auditing requirements imposed by sectorial regulatory frameworks, policies or procedures that impede fast, intuitive decision-making in complex and highly regulated settings. Such an environment poses great pressure on individuals to provide tangible evidences and to justify intuitive judgements; however, it also works as a security net allowing the individuals to exercise caution and to reflect on the potential negative consequences. Sadler-Smith's research work (2002, 2006, 2011) expanded comprehension and knowledge of intuition in business and management through empirical evidences from executives on decision-making determinants and constraints deriving from contextual boundaries that favour the application of rational analysis tools and techniques and disadvantages the deployment of informed intuition both at individual and collective level.

Team composition and team dynamics

Team composition has been changing since the 1970s due to globalization and increasing organization complexity. This translated into the creation of cross-functional, global and culturally diverse teams with highly specialized professionals, more numerous women and people of differing ethnicities (Hambrick et al, 2001; (Milliken and Martins, 1996; Williams and O'Reilly, 1998; Jackson et al., 2003; van Knippenberg and Schippers, 2007). These changes solicited wider investigation of diversity in organizations driven by age, level and type of education, tenure, etc. (Tsui and Gutek, 1999). Management research community responded to this change of

scope analysing key aspects such as cohesiveness, influencing power of majorities and minorities and other contextual factors within organizations.

The original formulation of the theory of groupthink elaborated by Janis' (1972) proposed that group cohesiveness leads groups to attach deeper meaning and importance to the information that supports their thesis disregarding the information that does not. The self-categorization perspective (Williams and O'Reilly, 1998) observed that diverse professional groups reach inferior results since individuals prefer to interact with those who are considered similar to themselves or part of their in-group (Kramer 1991, Jehn et al. 1999). Relational demographers (e.g. Tsui et al. 1992, Chattopadhyay 1999) explored the conditions ensuring group cohesiveness despite the presence of dissimilar members. They identified a number of conditions such as the status of the individuals who dominate a group represented by characteristics such as gender (Chattopadhyay et al. 2004). Hultin and Szulkin (1999) found that males in the minority retained power even when the proportion of female managers increased. Moscovici (1985) and Nemeth et al (1990) studied the dynamics between majority and minority extensively and concluded that their influences were related to different subgroup goals.

Field studies conducted by Dovidio and Gaertner (1981, 1983) observed that low status subgroups are unable to influence the high status sub groups since the latter consider the former incompetent even when presented evidence to the contrary. Moreover, the relation between team composition, diversity and the decision-making dynamics was found correlated with contextual features. As we will see more in detail in the subsequent paragraphs, these are: time pressure, ambient noise, uncertainty, level of debate in the team, task complexity, team tenure and the extent to which the team has a climate that supports shared team objectives (Kruglanski and Webster, 1991; Keck, 1997; Harrison et al., 1998; Shah et al., 1998; Simons et al., 1999; Pelled et al. 1999; Carpenter and Fredrickson, 2001; West, 2002; Kruglanski et al., 2006).

The hallmark topics of the Heuristics and Biases tradition were resumed in management literature to explain information distortion and decision-making biases at the level of the team. Chattopadhyay et al. (1999) studied the predictability of executive beliefs starting from the similarities between members of the top management team and the functional background and position because of categorization and similarity biased judgments. Similar heuristics-driven categorizations were detected in other researches that revealed the inability of groups to identify the expertise level of team members (Libby et a. 1987), and that more often than men women are perceived by group members as non-experts (Thomas-Hunt and Phillips 2004). Status characteristics theory (Berger et al. 1966) provided valuable tools to explain such results by suggesting that categorization biases judgements to make abilities attributions in the absence of other information. According to this theory, status characteristics such as gender, race, or evaluations of competences are salient are used to infer status

information and to form beliefs and evaluation of group members (Cohen and Zhou, 1999). When beliefs and evaluations associated with status characteristics are found relevant in a particular context, then they are used to set expectations about performance. The importance of the attributions remain highly reliant on the characteristics of the context and the resulting importance attached to indicators of status (Balkwell and Berger, 1996; Foschi and Lapointe, 2002).

The Intuitive decision-making tradition built on the findings of management literature that found in group diversity a crucial factor capable to facilitate or hinder the ability of groups to process information from multiple sources such as information/decision-making perspective or the upper echelon perspective (Bantel and Jackson, 1989; Carpenter et al., 2004). Bunderson (2003) further investigated one of the central topics of Natural decision-making tradition, namely expertise. This author tested whether the social contexts matter in terms of how individuals make expertise attributions. This author found that gender and race are used to predict perceived expertise in centralized, shorter tenure teams, while other status indicators related to the group tasks are used to predict perceived expertise in decentralized, longer tenure teams. This conclusion builds on the fact that short tenure team members have less information to make attributions of expertise and use demographic and task related characteristics to infer individuals' expertise (Bunderson, 2003).

Environmental predictability and uncertainty

Behavioural decision-making dedicate a considerable attention to "environmental predictability" since this contextual feature plays a major role in the reliability of the conclusions reached through tacit perceptive thinking. In fact, the reliability of unconscious and automatic intuitions is higher when the decision makers operate in high-validity environments and have abundant and suitable opportunities to learn the rules of the environment in which they make choices. This is considered a binding condition for the reliability of automatic judgements; however, it remains often unmet in professional contexts. Kanemahan and Klein (2009) identified the motivations in the insufficient predictability of the environment or in the absence of opportunities to learn its rules. Consequently, intuitive judgments and decisions produced by System 1 are considered skilled, accurate and successful only given this condition and notwithstanding the hunches on the correctness of the automatic appraisal.

Among the peculiar features of the empirical studies conducted by Naturalistic decision-making researchers, there is definitely the need to cope with uncertainty and make decisions under stress (Orasanu and Connolly, 1993). The preferred unit of observation of these scholars is mainly expert professionals who developed abilities to deal with uncertain situations overtime. Lipshitz and colleagues defined uncertainty as a "sense of doubt that blocks or delays action" consistent with Dewey (1933) and accommodating the relevant features underlined by

the remaining strands of literature (inadequante understanding, insufficiently coherent situation awareness, incomplete, ambiguous or unreliable information, conflicting or insufficiently differentiated alternatives). These authors developed a heuristic model to explain how decision makers conceptualize uncertainty, how they copy with it and whether there are systematic relations between conceptualization and methods of copying with it. Lipshits and Strauss (1997) reported five strategies of copying with uncertainty: collecting additional information, assumption-based reasoning, weigning pros and cons forestalling, developing a response to anticipate contingencies, suppressing uncerrainty. Similar methods were suggested by Allaire and Firsirotu (1989), Janis and Mann (1977), Klein (1998) and Shapira (1995). The patter of contingent coping has a normative connotation as it begins with uncertainty reduction, use assumptions to fill understating gaps, compare competing alternatives, retain a back-up alternative in case of undesirable contingency and opt for uncertainty suppression only as last resort.

Scholars of both the Intuitive and Naturalistic decision-making strands of literature agreed on the centrality of uncertainty in the functioning of both the implicit and explicit cognitive mechanisms that drive the decision-making process. In uncertain settings open to unexpected eventualities, the usual tendency to opt for objective and rational approaches characterized by exact, definitive and logical nature (Chia and Holt, 2008) might be unsuitable due to unavailable or inaccurate information, limited data, and unpredictable cause-effect relationship. In this circumstance, intuition can represent a valid alternative if it is based on deep understanding of the decision-making situation (Lagadec, 2007). Therefore, intuition builds on the decision maker's ability to draw from the reservoir of conscious and subconscious knowledge and experience (Scholz, 1983; Lipshitz and Strauss, 1997). Khatri and Ng (2000) observed that the implicit and tacit mechanisms behind intuition could be especially useful in organizations embedded in turbulent and uncertain environments. This finding resonates with the evidences of Hensman and Sadler-Smith's empirical study in the banking and finance sector (2011) which highlighted that people rely on intuition due to individual factors such as experience and confidence but also to contextual factors such as time and uncertainty.

Crisis, time pressure and high stake

The Naturalistic decision-making tradition focused on decisions taken in turbulent environments fraught with time pressures, complexity, stress, uncertainty, high stakes, vague goals and unstable conditions (Orasanu and Connolly, 1993) to complement and extend the scope of former empirical studies in fields like medicine (Elstein et al., 1978) and business (Isenberg, 1984). In any hazardous situation, successful response to crisis relies on a deep understanding of the professional domain and the capacity to dose perception-driven prompt responses and well thought rational solutions (Lipshits and Strauss, 2002). The relevance of these empirical settings for

intuition studies is confirmed by the work of numerous other authors. Indeed, intuition researchers converged in considering intuition as best-deployed in situations characterized by time shortage, uncertainty, unpredictability, limited clarity and little previous precedent (Kruglanski and Freund, 1983; Agor, 1989; Edland and Svenson, 1993; Kaplan, Wanshula and Zanna, 1993; Kaempf, Klein, Thordsen and Wolf, 1996; Abernathy and Hamm, 1995; Klein, 1998; Burke and Miller, 1999; Khatri and Ng, 2000; Hockey and Bdzola, 2000; Hayashi, 2001; Maule, Suri and Monroe, 2003; De Dreu, 2003).

Nonetheless, the study of professional environments qualified by high time pressure is not novel. Indeed, other management researchers conducted field studies in peculiar contexts like the movie industry. Since movie crews are temporary organizations that frequently operate in unknown terrains and unpredictable circumstances such as weather events, malfunctioning equipment, or unforeseen legal issues, directors are often forced to solve problems in high degrees of urgency (Bechky, 2006; Travis, 1999; Coget et al., 2009; Bart and Guber, 2002). In the movie industry, researchers observed that similarly to the fields investigated by the Naturalistic decision-making researchers, directors use intuition to diagnose and solve small issues (i.e. adjusting actors, choosing types of shots and coverage, or noticing when a special effect becomes dangerous). Furthermore, directors resort to intuition also for more crucial tasks namely to keep track of the big picture; abandon the original plan to accommodate changing conditions or to take advantage of unforeseen issues. In parallel, directors were observed to take rational decisions when confronting their crews and when they lack the expertise to make an effective intuitive decision quickly (Bart and Guber, 2002; Coget, 2004; Coget et al., 2009; Bart and Guber, 2002; Travis, 1999).

For their part, Naturalistic decision-making researchers focused on seasoned firefighters, army commanders, ER doctors, nurses and so on. These expert professionals made decisions with remarkable speed and accuracy by trusting their inferential intuition rather than adopting analytical strategies that were considered unable to improve the decision outcome in a setting with the abovementioned characteristics (Klein, 1998). One of the most researched category of respondents are unquestionably the ER hospital staff working in a turbulent environment characterized by incomplete information, overwhelming data, and overlapping processes besides high stakes, high stress and rapidity (Klein et al., 2006; Whittaker et al., 2004). ER doctors are expected to rapidly diagnose patients and treat them in a temporal succession that is not always straightforward and evident as the two actions can intersect in multiple feedback loops and treatment can precede full diagnosis (Coget and Keller, 2010; Groopman, 2007). Diagnosis is the core of the critical decision vortex and consists of interpreting information and reducing it to a pattern that can be acted upon. This process is the result of a synthetic effort to combine rational and intuitive decision-making with emotions (Bache et al., 2003; Groopman, 2007). We will provide further details on the interaction between rational and intuitive decision-making in the section dedicated to “Cognitive dynamics” later on in this review.

Decision-making, cognitive factors and individual characteristics

In the former section, we presented the main contributions of the strands of literature treated in this review in relation to the contextual and environmental factors that influence decision-making. In this section, we present how these strands of literature elaborated or adopted key concepts in relation to the basic cognitive mechanisms that regulate automatic and rational thinking. Subsequently, we will describe the techniques and the approaches to transform experience into expertise and, lastly, we will discuss how the literature on individual characteristics and personality features relates to decision-making.

Cognitive dynamics

The first subsection illustrates the main cognitive dynamics starting with Simon's metaphor of the human mind as a computer that dominated the cognitive sciences over the past 50 years (Newell and Simon 1956; Newell et al. 1958). This metaphor inspired the Behavioural decision-making researchers and led the way to the theorization the adoption by decision makers of simplified internal representations of problems that help them cope with their information-processing limitations (Porac and Thomas 1989). These mental representations thrived from the late 1980s to the early 1990s and numerous terms and concepts were borrowed from basic cognitive sciences to be adopted by management and organizational scientists including "mental models" (Johnson Laird 1983); "schemata" (Bartlett 1932); "scripts" (Schank and Abelson 1977); and "cognitive maps" (Tolman 1932). Nowadays, the understanding of the mental representations of decision makers is accurate and the study of mental models inspire the design of interventions to enhance decision processes, to stimulate more effective information processing and in some cases also cognitive change (e.g., Daniels et al. 1994; Hodgkinson and Johnson 1994; Eden and Ackermann 1998; Hodgkinson et al. 1999; van der Heijden et al. 2002).

As an evolution of the Heuristics and Biases tradition, Gigerenzer and his colleagues inaugurated the so-called *"Fast-and-Frugal Heuristics"* research programme to explore decision approaches adopted by decision makers in real-world settings under conditions of limited time and knowledge without computing probabilities and utilities (Gigerenzer and Todd, 1999; Gigerenzer, 2007). This research programme reposed on a fundamentally different conception of Simon's bounded rationality namely ecological rationality and identified alternative category of heuristics adapting to the informational structure and demands of the decision maker's environment.

The programme was aimed at designing simple heuristics models that ensure successful results, analysing the environmental structures under which such heuristics work well, testing their performance in real-world (as opposed to laboratory) environments, and determine if and under what conditions people use them (Gigerenzer and Todd, 1999). According to Gigerenzer and Todd (1999), people behave in an ecologically rational manner when they use heuristics that suit their environments. Fast-and-frugal heuristics requires minimal computational demands and was deemed to produce less error and bias than the heuristics identified by conventional Behavioural decision-making researchers. Kahneman (2000), who challenged the idea that fast-and-frugal heuristics do not introduce biases, criticized the expression 'heuristics that make us smart'.

In the Heuristics and Biases tradition, the intuitions originating from heuristics were not considered necessarily wrong. Tversky and Kahneman (1974) asserted, "these heuristics are quite useful, but sometimes they lead to severe and systematic errors" especially if they are not rooted in specific experiences. These authors pointed out that individuals usually are not aware of the origins of their thoughts and sometimes they experience confidence over their judgments that is neither sufficiently correlated with their accuracy nor a good indication of validity (Arkes, 2001; Griffin and Tversky, 1992; Einhorn and Hogarth, 1978). In order to evaluate the probable accuracy of a judgment, decision makers should assess the validity of the environment in which the judgment was made and make an effort to performer a rational check of the intuitive judgement.

Several researchers investigated the systematic errors determined by hyper-optimism and motivational biases in large engineering projects that often end up in time and costs overruns. The puzzle of why companies and governments continue to fund projects based on inaccurate estimates in competitive bidding for fixed price design contracts is intriguing (Hudgins and Lavalle 1995). Careful due diligence and high fines could be used as disincentive mechanisms, however, a possible way to neutralize overconfidence is to counterbalanced it through the rotation of different "champions" who take on the lead role in different periods of an engineering grand scale project (initiator, construction, maintenance). The outside perspective that each champion adopts vis-à-vis the work of the other champions (Shapira and Berndt, 1997; Kahneman and Lovallo, 1993; March and Shapira, 1992) counterbalances the negative effects of overconfidence.

The reliance of decision makers on the intuitive judgements suggested by System 1 is considered problematic by the Behavioural and Heuristics and Biases tradition especially when they did not have chance to acquire true skills and to reach mastery due to environmental irregularity or insufficient practice (Kahneman and Kelin, 2009). The heuristics and biases researchers resorted mainly to laboratory experiments to study faulty judgments. This methodological choice reduce the opportunities to observe decision processes that entail domain specific knowledge and skills that cannot be reproduced in the laboratory. Their work showed that both valid and flawed intuitions arise from the operations of memory that in the latter case generate errors caused by

misleading and over simplistic mental representations. Frederick (2005) has used computation puzzles eliciting straightforward and tempting shortcuts as the famous problem of the ball and the bat price. The author found that surprisingly many graduated from top schools (MIT, Princeton, Harvard) adopted the intuitively compelling response without checking it. Another study in which a bias in the operations of memory misled intuitive judgements is the problem of the price of German cars in which researchers asked participants whether the average price was above or below $100,000. Eventually, they posed to a subset of the participants an additional anchoring question in which they were requested to reflect on a hypothetical average market price of $30,000. The anchoring question was used to mislead the estimation of the average market price (Jacowitz and Kahneman, 1995). Through the mechanism of anchoring the researchers brought to the minds of the participants expensive cars such as Mercedes, BMW, Audi in one case and cheaper cars such as the Volkswagen beetle in the other case. This experiment aims to bias the average market price estimation that is a deliberate System 2 operation by introducing a bias in the automatic phase of retrieving instances from memory when the sample of cars considered for the estimate is distorted. The participants are typically confident of their answers and do not realize the ongoing anchoring manipulation (Mussweiler and Strack, 2000; Kahneman and Kelin, 2009). An additional famous experiment was based on the following question: "Julie is a graduating senior. She read fluently at age 4. What is your best guess of her GPA [grade point average]?" The immediate intuitive impressions reported by the participants were the result of attribute substitution – in this case a misinterpretation of the correlation between her impressive precocity in reading and her school results measured by the GPA (Frederick, 2005). These findings contrapose the literature on successful strategic decisions based on gut feelings and intuitions that are considered by the Heuristics and Biases scholars largely the consequence of luck rather than of genius (Rosenzweig, 2007).

At this point, we emphasize that all the stands of literature considered in this review formulated assumptions, hypothesis and theorizations on the interaction between the experiential/intuitive (System 1) and the rational/analytic (System 2) cognitive mechanisms.

The Behavioural and Heuristics and Biases literatures looked with extreme caution to intuitive judgements. This cautious approach is rooted in the explanations that these authors give of intuition that is considered the output of a fragile mental process susceptible of distortions. These alterations intervene during the automatic phase of information processing when unconscious mechanism interfere with the rational-analytic cognitive processes. These raids of the unconscious into the conscious may jeopardize the whole process and distort the judgement validity (Jacowitz and Kahneman, 1995; Frederick, 2005; Rosenzweig, 2007).

Cognitive Psychology is the discipline that contributed most significantly to shed light on the System 1 – System 2 interaction mechanisms. The experiential/intuitive system builds through the empirical learning that is

implicit in experience whereas the rational/analytic system builds through reasoning (Pacini et al., 1998; Pacini and Epstein, 1999). Epstein and Pacini (1999) claimed that the interaction between experiential and rational processing could be sequential or simultaneous depending on situational factors and individual cognitive preferences (Epstein et al., 1996; Pacini and Epstein, 1999). In sequential interaction, nonconscious, automatic processing can influence conscious reasoning as witnessed by studies of priming (Epstein and Pacini, 1999). Another possible interaction mechanism works contrariwise when thoughts that occur in the rational system trigger associations in the experiential system or rather when the slower-acting rational system acts in a corrective fashion toward the more rapid experiential system. The simultaneous operation of the two systems can manifest as direct reports of conflicts of reasons and feelings ('head-versus-heart' dilemmas) or compromises between the two forms of processing (Epstein and Pacini, 1999). Even when a person attempts to be completely rational, the fast-acting and autonomous experiential system continues to influence thoughts and behavior in a compelling, often affectively charged, way. Even if it were possible to be completely rational, this "would not be desirable," since some of the advantageous outcomes of experiential processing (such as creativity and wisdom) would be lost (Epstein and Pacini, 1999). The coexistence and exchanges between these two systems is vital for human life because they play a central role in establishing an accurate working model of the environment that allows for effective adaptation. The 'ideal state' is a high level of functioning in both the experiential (intuitive) and rational (analytical) processing modes (Epstein and Pacini, 1999; Hodgkinson and Clarke, 2007; Louis and Sutton, 1991).

The researchers of the Intuitive decision-making current examined the implication of intuition in organizational decision-making (Sadler-Smith and Sparrow, 2006, 2018) and portrayed it as an expression of tacit knowledge in which cognitive and affective processes operate below the level of conscious awareness. This tradition conceives the experiential/intuitive and the rational/analytic systems as two different facets of information processing that can operate in parallel or interact contingently depending on factors such as expertise, nature of the task and social setting (Isenberg, 1984). Hodgkinson and Sadler-Smith (2006) observed that there are some salient and significant point of difference between the precepts of CEST and the default-interventionist models championed by Evans and colleagues and attempted to recompose this discrepancy. Sadler-Smith and Burke (2009) proposed an iterative process passing through several rounds of recurrent validation to refine intuitive skills from analysis to intuition and vice versa. These authors proposed to "use affectively charged judgments to sense problems, develop an integrated picture of the entire situation, weigh the value of alternatives, and conduct a gut feel check on their choice". Contextually, rational processes are considered useful to "analyse situations, generate alternatives, evaluate alternatives, and monitor decision outcomes". The "switching structures" based on the interplay of rationality and intuition that was imagined by Sadler-Smith and Burke (2009) shares some common points with the 'spiralling' process defied by Woiceshyn (2009) who

suggested a three-loop 'spiralling' (zooming-out/zooming-in, analysis-by-principles, testing the tentative decision) in which intuition and rational analysis alternate to guide the resolution of complex situations.

The position of Naturalistic decision-making literature toward System 1 – System 2 interaction was elaborated starting from the field studies conducted with ER doctors, firefighters and army commanders. In the theoretical frame of the Recognition Primed Decision (RPD) theory that will present afterwards, rational decision-making is considered the pole of the critical decision vortex especially for novices (Groopman, 2007; Bache et al., 2003) who develop their intuitive decision-making abilities only gradually with experience (Greenhalgh, 2002). All the cases treated by a given professional contribute to the creation of a broad and detailed mental repertoire of situation typologies stored in memory. The actual capacity to formulate wise intuitive judgments is connected with the gradual improvement of this repertoire of mental schemes and the capacity to detect deviations of the patterns and signals of a given new case from these mental schemes. Anomalies can be detected since intuitive thinking interacts with rational thinking to spot subtle cues in complex, urgent situations or when the available information is overwhelming. In turn, decision makers resort to rational thinking to assess the reliability of their intuitions and to confirm hunches and gut feeling through tests and analysis (Klein, 2008; Coget and Keller, 2010).

According to all the literature strands considered in this review, the conceptualization of System 1 - System 2 interaction is closely connected with the mental dynamics that regulate patterns recognition.

In Simon's (1992) words, intuition is "nothing more and nothing less than recognition" view shared also by Kahneman and Klein (2009) who acknowledged the great merit of this interpretation that contributed to demystify intuition. In the Heuristics and Biases tradition (Goldstein and Gigerenzer, 1999), pattern recognition is conceived as a special-purpose rule of thumb thus diverging from the skilled pattern recognition process described in the RPD model of the Naturalistic decision-making tradition. For the researchers belonging to the latter, there are two conditions that should be respected to have a genuinely skilled intuitive judgment namely, sufficient experience reached by decision makers and valid and specifiable cues provided by the environment. Experience is preconditional to have a deep understanding of the situational dynamics while high validity describes the causal and statistical structure of the relevant environment (Ericsson, Charness, Hoffman and Feltovich, 2006). These conditions lead to another implicit contextual requirement that is the existence of sufficient regularity in the environment (Brunswik, 1957; Hertwig, Hoffrage, and Martingnon, 1999).

The emotional and affective components of decision-making constitute another challenge to rational theories to the point that some researchers stated that individuals in organization are constraint by "bounded rationality (Mumby and Putnam, 1992). Nonetheless, scholars treated the topic of affect and emotions in organization only

very reluctantly possibly due to the high degree of complexity and ambiguity that surrounds it (Ashkanasy and Ashton-James, 2005). The strands of literature treated in this review have all speculated on the role of affect, gut feeling and body signals in decision-making albeit from different perspectives and with different levels of depth.

Since the origins to the mid-1990s, both Behavioural decision-making and Heuristics and Biases researchers emphasised cognition over affect while only in the early 2000s acknowledged the role of affect in decisions still without recognising or accounting for the role of automaticity and affect in intuitive judgements (Simon, 1987; Slovic, Finucane, Peters, and MacGregor, 2002). Slovic and his colleagues (2002) granted a space to affect in the Heuristics and Biases theory using the expression 'affect heuristic' to refer to the phenomenon of affectively-tagged images already in the affect pool that are used as inputs to the decision process. These researchers emphasized that there are strong elements of rationality in both the experiential and the rational-analytic system and created theoretical connections between affect heuristic, dual-process theories, and CEST (Slovic et al, 2004). This kind of heuristics relying on the experiential mode of thinking was considered an ancient mechanism to detect and assess risks throughout Homo sapiens' evolution (Slovic et al, 2002; 2004).

Cognitive psychology provided decision researchers with an explanation of the neurophysiological mechanisms that lead affect to pervade human judgement and decision-making. The breakthrough work of Damasio, Bechara, and colleagues, who studied patients with lesions of the ventro-medial pre-frontal cortex (VMPC), revealed that these individuals could maintain normal intellectual faculties but at the same time showing impairments in judgment and decision-making (Eslinger and Damasio, 1985). Damasio and colleagues formulated the somatic marker hypothesis (SMH) studying clinical cases (e.g. 'frontal lobe syndrome' suffered by railway worker Phineas Gage), assessing the galvanic skin conductance response (SCR) and applying the electroencephalography (EEG) technique. The SCR is detected through measuring changes in the electrical activity that arise from the functioning of the autonomic nervous system through. The high-risk 'Iowa Gambling Task' experiments with normal participants and patients whose VMPC was damaged was the most famous SCR study (Bechara, Damasio, Tranel, and Damasio, 1997). This research programme revealed that when the VMPC is intact, decision-making is guided by autonomic responses associated with intuitions that are based upon previous experience and influence higher-order thinking processes both consciously and unconsciously (Dunn, Dalgleish and Lawrence, 2006). These authors concluded that the VMPC plays a vital role as it is the neural substrate that triggers neurophysiological signals that work as affect-loaded 'somatic markers' thus guiding decision choices. Another group of researchers, Gazzaniga and colleagues, utilized the EEG technique to appreciate the electrical signals produced by a large population of simultaneously active neurons measured by electrodes placed on the scalp (Gazzaniga et al., 2002). As observed by Jung-Beeman et al. (2004), the electrodes pick up alpha waves that are associated with a quiescent, meditative state, whereas its dissipation is associated

with attention and arousal. These signals operate in advance of conscious awareness and in a certain sense introduce a bias in decision-making.

The investigation on the role of emotion by the Intuitive decision-making scholars benefited greatly from the advances in cognitive neuroscience (Phelps, 2006) and seminal works were initiated to shed light on the pathway of how emotional traits and states influence the extent to which decision makers rely on conscious or automatic processing (Daniels et al, 2004). Starting from Hogarth's (2001) findings, Sadler-Smith and Shefy (2004) emphasized the affective facets of intuition ('intuition-as-affect') formulating recommendations to executives on how to develop better intuitive judgement skills. Daniels and colleagues (2004) explored the influence of cognition on emotions and moods, and vice versa, and concluded the affect has both positive and negative dimensions and reflects social contagion and situational influences. This author inferred that affect is both a determinant and a consequence of cognition and can contribute to decision effectiveness at individual level. Around the mid-2000s, some researchers adopted hypothetico-deductive methods to capture subjective experiences and inductive methodologies to gain retrospective accounts of intuition. An example is the study conducted by Lipshitz and Shulimovitz (2007) with loan officers of a large Israeli commercial bank who revealed to have been integrating 'hard' financial data with 'soft' impressions and gut feelings in rating the credibility of loan applicants. Surprisingly, the interviewed loan officers considered feelings as more reliable indicators of credit worthiness than financial data. A differentiated analysis by Glöckner and Witteman's (2010) reported that in the decision-making processes affect is considered both as an important input and an important output ('gut feel') in line with the "affect heuristic" view and the definition of intuition as "affectively-charged judgments" (Dane and Pratt, 2007). More recent studies postulated an automatic and affective reflexive (X-system) corroborates the controlled operations of a reflective system responsible for higher forms of cognition as logical reasoning, planning and hypothetical thinking (Lieberman, 2007; Hodgkinson and Healey, 2013). Hodgkinson and Healey (2008) highlighted the need to consider recursive processes used by affectively informed appraisals shape cognition both within discrete episodes and over time.

In the Naturalistic decision-making current, the role of strong manifestation of affect was considered counterproductive due to the risk to blur judgement or paralyze action (Janis and Mann, 1977). On the contrary, moderate emotions were acknowledged and praised for enabling those judgments that can provide information and initiate intuitive and rational decision-making. In risky and high stake environments, emotions can contribute to maintain focus and the capacity to prioritize especially (Coget and Keller, 2010).

In Cognitive Psychology, one of the most widely accepted theories to explain the duality of a 'rational (i.e. analytical) system' and an 'experiential (i.e. intuitive) system' is the Cognitive-Experiential Self- Theory (CEST) developed by Epstein (Epstein 1985, 1994; Epstein, Pacini, Denes-Raj, and Heier, 1996; Epstein, 2008). This

theory accord primacy to affect (i.e. 'gut feel', 'hunch', 'vibe', etc.) still providing a rigorous and balanced explanation of the cognitive mechansims behind the two systems. CEST is based on the dichotomy between two information-processing systems with different rules and attributes. The first system is experiential, holistic, automatic and rapid in motion, effortless and immediate, affective, associationistic, resistant to change that is triggered by repetitive experience and mediated by "vibes" from: past events, concrete images, metaphors, narratives. The second system is rational, analytic, intentional, effortful, logical, slower and resulting in delayed action, rapidly changeable in response to strong arguments and evidence, mediated by conscious appraisal of events, abstract symbols, words or numbers (Epstein 1994, 1996, 2008). The experiential system is an automatic learning system that humans share with other higher-order animals whilst the rational/analytic system is a verbal reasoning system unique to humans. It is worth to clarify that the experiential system encompasses a domain more extensive than intuition (i.e. superstitious thinking, irrational fears, unusual beliefs, and religious beliefs). The operating rules and attributes of the experiential system are identical with intuitive thinking.

During the 2000s neuroscientists obtained evidences that holistic and analytic processing rely on different neural systems (Lieberman, 2007, 2009; Volz and von Cramon, 2006; Jung-Beeman et al., 2004). Lieberman (2004, 2007, 2009) defined two systems regulating human behaviour articulated in two processing modes: the reflexive or 'X' system and the reflective or 'C' systems. The two systems operate independently and activation in one system is uncorrelated (or negatively correlated) with activation in the other. In the first phase of the skill acquisition process, brain activates a domain-general control network to direct the attention to the novelties of the task. This control network is intrinsically associated with the C system. As the subject reaches a good level of familiarity and the overall process starts being automated, the activation in the control network decreases while the activation in areas required for task performance (e.g. motor areas, modality-specific regions) remains comparable across all stages of skill acquisition (Chein and Schneider, 2005 as cited in Hill and Schneider, 2006). The latest generation of neuroimaging tools (e.g. functional Magnetic Resonance Imaging - fMRI) marked a turing point in neuroscientific research. Such tools showed that activation in the basal ganglia and the ventromedial prefrontal cortex associated with implicit learning is related to non-conscious acquisition of knowledge ('X' system). Similarly, activation in the lateral prefrontal cortex associated with working memory and in the rostral anterior cingulate cortex are related to effortful, serial and consciously overriding automatic processing ('C' system). Studies on teams made of both experts and novices showed that in order to complete a task the former recruited more specific, focused areas of relevant neural systems whereas the latter recruit broader brain areas. These findings confirmed the assumption that inferential and holistic intuition on one side and rational analysis on the other side rely on distinct mechanisms. Furthermore, the neural processing associated with inferential intuition of less experienced individuals should be more focused than holistic or analytical processing.

During the 2000s, the researchers of the Intuitive decision-making current adopted CEST as theoretical background for their Dual-Process Theory and the Rational Experiential Inventory (REI) as an instrument for assessing individual differences in the preferred information processing approach. There are essentially two approaches: one is driven by independent rationality ('need for cognition') whilst the other is driven by experientiality ('faith in intuition' - Hodgkinson and Clarke, 2007; Hodgkinson et al, 2009; Leybourne and Sadler-Smith, 2006; Sinclair and Ashkanasy, 2005). These scholars embedded intuition into the dual process-theory (Chaiken and Trope 1999; Gilovich et al 2002; Evans 2007, 2008) and emphasized its importance in different disciplines such as education to management (Hodgkinson et al. 2008). The Dual-Process Theory is essentially the story of "Two Minds in One Brain", namely the natural and the analytical cognitive systems (Evans, 2003). In this theory, both the automatic unconscious processing mode and the analytic conscious mode are equally necessary and supported by psychometric evidences (Hodgkinson and Sadler-Smith, 2003; Sadler-Smith and Shafy, 2007; Sinclair and Ashkanasy, 2005). The former allows decision makers to make sense of vast quantity of information rapidly while the latter enables to perform detailed analysis. The automatic unconscious processing mode is essentially contextually dependent, automatic, largely unconscious, associative, intuitive, implicit, and fast. The analytic conscious processing mode is contextually- independent, analytic, rule-based, explicit, and relatively slow (Chaiken and Trope, 1999; Stanovich and West, 2000; Evans, 2008).

In addition, the Dual-Process Theory provided ground for the psychological micro-foundations of strategic management research (Hodgkinson and Healey, 2013).

The Naturalistic decision-making current was dominated by the influential studies of Klein (xxxx) who developed the recognition-primed decision (RPD) model in 1989 postulating that experts can take good decisions without extensive, multi-attribute analyses as they are capable of employing their experience to recognise problems as similar to previously encountered and categorized ones (Klein, 1989; Klein, 1998). This model was born from an attempt to describe and analyse the decision-making of fireground commanders who are required to make decisions under conditions of uncertainty and time pressure that preclude the evaluation of sets of options (Klein, Calderwood, and Clinton-Cirocco, 1986). In Klein's view, the "decision-making process was expanded to include a prior stage of perception and recognition of situations, as well as generation of appropriate responses, not just choice from among given options". In the fieldwork with firefighters, this author described how seasoned commanders use their experiences in the form of a repertoire of patterns to anticipate how flames were likely to spread through a building, to notice signs that a house was likely to collapse, to judge when to call for additional support (Klein et al., 1986). In Klein's own words: "patterns describe the primary causal factors operating in the situation and highlight the most relevant cues, provide expectancies, identify plausible goals, and suggest typical types of reactions in that situation typology. Klein borrowed from cognitive psychology some knowledge representation concepts such as scripts, schemas and mental models shaped through knowledge-

based domain-dependent approaches in order to contrast expert versus novice behaviour (Klein, 2007). Mental schemas make sense of the causal factors operating in a situation while patterns highlight the most relevant cues, provide expectancies, identify plausible goals, and suggest typical reactions in that situation typology. When decision makers need to make a decision, they can match the situation to the patterns stored in their memory, classify it as familiar-prototypical or unknown and then define the most suitable course of action. The contextual categorization is performed through a subconscious recognition of patterns made possible by an automatic comparison between the mental representation or schema that the decision maker has of a given situation and the actual cues and signals in a situation. In case of a perfect match, they can carry out the most typical course of action and decide very rapidly. In case of an imperfect match, decision makers engage in metal simulations, namely imaging whether a given course of action would work in the present situation —a process that de Groot (1946, 1978) had described as progressive deepening. If the course of action seems appropriate, the decision maker can implement it. If it had shortcomings, they would modify it or else consider the next most plausible option and run through the same procedure until an acceptable course of action was found. Often decision makers are unable to explain what they actually noticed, or how they judged a situation as typical or atypical as the patterns in real-life situations are often subtle. In the RPD model, options are generated and evaluated serially rather than simultaneously and concurrently and decision makers look for the first workable option rather than searching for the best possible one (Simon, 1997).

Einhorn and Hogarth (1981) originally introduced the concept of mental simulation in decision-making. These authors assumed that individuals use mental simulation to find a synthesis between their experience and a new situation. Based on the new situation, individuals imagine various configurations of events and combine what they know to be true with what might be true. In addition, the research on anchoring and adjustment strategies referred to mental simulation while more traditional decision research referred to mental envisioning. Kahneman and Tversky (1982) used the concept of simulation heuristic to explain how individuals run mental models of a situation to define a course of action. In the studies of chess players, de Groot (1965) used the concept of progressive deepening to illustrate the process followed by players to set their moves. This author observed that grand masters identify relatively few plausible moves, then simulate the counter-moves of their opponents and eventually their own moves in reaction to those. These findings indicate that experts use their detailed mental models and their understanding of a situation to run simulations of how the situation is going to develop in the future. This dynamic mental process allow them to elaborate predictions and expectations. The Naturalistic decision-making researchers resumed the concept of mental simulation and Klein (1998) provided numerous evidences of its functioning. The field studies conducted with firefighters highlighted that experienced commanders are able to prefigure the events ongoing inside a burning building before entering it. They could use cues such as smoke and flames size and orientation to derive information on the fire location. A careful

observation of the external configuration of the building was enough for them to envision stairways, elevator shafts, and roof supports. Starting from these premises, commanders were able to project into the future running mental simulations of how a fire is likely to burn and spread. Mental simulation is, therefore, the result of a bend of intuition and analysis in which pattern matching is the intuitive part (System 1 - fast and unconscious) and mental simulation is the conscious, deliberate and analytical part (System 2 - slow and deliberate) (Epstein, 1994; Kahneman, 2003). The RPD model is consistent with the work of de Groot (1946/1978) and Simon (1992) and has been replicated in multiple domains, including system design, military command and control, and management of offshore oil installations (Klein, 1998).

Experience and expertise

The strands of literature examined in this review tackled a number of constructs connected with expertise building such as experience, learning and knowledge. The definition of expertise varies among the different traditions. The Heuristics and Biases community defined expertise based on a set of optimality criteria such as standardized performance measures. For example, the performance ratings of chess players was estimated based on their record of wins and losses against other rated players. Meehl (1954) assessed expert performance comparing the accuracy of decisions made by experts with the accuracy of the optimal linear combinations. This optimality criterion is more stringent than the criteria used by Naturalistic decision-making that evaluates expertise based on histories of successful outcomes. Naturalistic decision-making researchers compare the performance of professionals with that of the most successful experts in their field using peer judgments rather than quantitative performance measures. The use of peer judgments is a subjective way that allows distinguishing highly competent decision makers from mediocre ones from novices. This definition of expertise lays on the assumption that there is consensus on how successful performance is intended and that there is sufficient comparability to use the performance of the best practitioners as a benchmark. The definition of expertise provided by Shanteau (1992) effectively encapsulates all these features: “experts are operationally defined as those who have been recognized within their profession as having the necessary skills and abilities to perform at the highest level”.

Behavioural decision-making and the Heuristics and Biases approach explored primarily the conditions for the development of sound decision abilities. In line with Hogarth’s work (2001), also Kahneman and Klein (2009) affirmed the importance a regular environment and an adequate opportunity to learn it while Ericsson and colleagues (Ericsson, 2006; Ericsson et al., 2006) focused on attitude, motivation, talent, and deliberate practice as crucial to skill development. Shanteau (1992) investigated the actual chances to achieve a high degree of

expertise and observed that not all the professional occupation perform equally, then this author searched for task characteristics that distinguish these domains an found that the most favourable factors to achieve expertise are: predictability of outcomes, amount of experience, availability of good feedback, and static stimuli. The professionals of some occupation clusters (nurses, physicians, and auditors) exhibited genuine expertise in some of their activities but not in others. These mixed grades are defined "fractionated expertise" and are deemed the rule rather than an exception since in the vast majority of professions; individuals regularly encounter brand new tasks that they never master due to lack of practice (Stewart, Roebber, and Bosart, 1997). When experts have performed a given task long enough to master it, they should be able to recognize that a situation is anomalous when they encounter unfamiliar situational characteristics (Gawande, 2002; Groopman, 2007), however, they might also misinterpret their perception of familiarity and resort to knowledge that turns to be unsuitable.

This view of expertise fractionation leads to the concept of illusion of validity experienced by those decision makers who feel overconfident about their perceived skills and competences that are indeed inadequate due to sparse, ambiguous or delayed post-failure feedback.

Strong subjective confidence in judgments is not a reliable indicator of valid judgments. As emerged from Meehl's (1954) study on the accuracy of human judges, often individuals are unable to recognize anomalies using judgments of typicality and familiarity that allow them to detect violations of patterns in the environment. This might happen also to expert when they are not sufficiently skilled in detecting patterns in the internal situation in order to identify the basis for their judgments. Some professional occupations might be less susceptible to overconfidence due to high level of direct personal risk and because there is more awareness of which are the boundaries of one's own professional competence.

The Heuristics and Biases approach favours a sceptical attitude toward expertise and expert judgment in line with Meehl's (1954) study on the predictions of clinical psychologists versus the predictions elaborated through simple statistical models and Goldberg's (1970) study on the "bootstrapping effect". Meehl's (1973) study revealed that statistical predictions were more accurate than human predictions of clinical judgments due to systematic errors. Meehl returned to discuss the tendency of clinicians to rely uncritically on intuition and their failure to adopt statistical tools. The scepticism toward expertise of Heuristics and Biases scholars is motivated also by the inconsistency of informal judgment emerging when individuals reach different conclusions using the same information but on separate occasions. Goldberg's (1970) study proved the inconsistency on the validity of diagnostic judgments of clinicians due to the noise intrinsic in human judgments that impairs their validity. In 1971, Tversky and Kahneman affirmed that following intuitions, scientists are more prone to reach incorrect conclusions and make inferior choices and, despite training and actual experience, faulty statistical intuitions

remain pervasive. Karelaia and Hogart's (2008) meta-analysis of judgment studies supported the generality of the bootstrap effect while other authors (Gilovich et al., 2002; Kahneman, 2000) remarked that the sources of errors in intuitive judgement are traceable to the weighting biases. These biases accrue when particular sources of information (e.g. availability or representativeness bias) are overweighted; while others are neglected (e.g. base rates or probability laws).

Since the Heuristics and Biases tradition tends to focus on flaws in human cognitive performance rather than on the existence of skill and expertise, its researchers recommend the replacement of informal judgment by algorithms whenever possible. Indeed, a meta-analysis by Grove, Zald, Lebow, Snitz, and Nelson (2000) indicated that under certain conditions mechanical and analytical judgments outperform human judgment. In this analysis, the accuracy of clinical and mechanical judgments favoured the adoption of algorithms since in half of the cases the "mechanical" judgments were superior, in the other half was indifferent and only in very few cases, the performance of clinical judgments was superior. Experienced individuals who received enough rapid feedback in an environment characterized by simple and valid cues perform as well as the algorithms. On the contrary, in low-validity environments where available cues are weak, uncertain, only slack regularities can be detected, and maintaining consistency of judgment is difficult, individuals perform worse than algorithms. Indeed, besides the low validity environments, algorithms are superior also in high-validity and high-predictability environments. In this latter case, algorithms can compute accurate predictions where there are possible ceiling effects and accidental human mistakes (e.g. personal loans appraisal). The meta-analysis performed by Karelaia and Hogarth (2008) showed that consistency accounted for much of the advantage of algorithms over humans. Therefore, the conditions for the construction and use of an algorithm include: (a) confidence in the adequacy of the list of variables that will be used, (b) a reliable and measurable criterion, (c) a body of similar cases, (d) a cost/benefit ratio that warrants the investment in the algorithmic approach, and (e) a low likelihood that changing conditions will render the algorithm obsolete. Any algorithm should remain under human supervision to ensure continuous performance monitoring and adaptation to eventual changes in the environment. Those in charge of monitoring should resist to the tendency to become more passive and less vigilant when algorithms are in charge — "automation bias" (Skitka, Mosier and Burdick, 1999, 2000).

Over the 1980s, the studies on hemispheric differences conducted by cognitive psychologists and neuroscientists inspired the development of the "Hemispheric specialization" view the in management studies (Taggart and Robey, 1981; Agor, 1986). This specialization was proposed based on the dual nature of human information processing and provided a stereotyped characterization of the two brain hemispheres. On one hand, the left hemisphere was defined as logical, diurnal, sequential, objective, causal, deductive, and analytic. On the other hand, the right hemisphere was defined as non-logical, nocturnal, simultaneous, subjective, acausal, inductive and synthetic. This view was labelled as "hemisphere mythology" by another faction of scholars (Simon, 1987)

because the supposed dichotomy between left and right brain sides is not suitable to express the complexity of human mind and represents a mere convenient metaphor for two different modes of thinking.

The speculations to shed light on the functioning of the two information-processing systems continued following the path of studies on learning. The centrality of learning is not limited to its clear importance to explain the role of experience and expertise but extends also to the genesis of the two cognitive systems. For this reason, cognitive psychologists investigated learning mechanisms in depth focusing on the behavioural changes that experience can cause in human mind. The cognitive processes and events taking place when two elements are connected in our brain and a new response becomes associated with a particular stimulus is known as Associative learning that is a continuous process of adaption to the circumstances. The processes related to associative learning takes place through experience that becomes a guide for future actions and teaches humans how to tell apart what is beneficial from what is harmful (Roediger, 1980; Mitchell and Le Pelley, 2010; Anderson and Bower, 2014). Learning-related neural activity happens within a network of hippocampal neurons during the formation of new associative memories. Other brain areas may be involved in associative learning including the prefrontal cortex (Asaad et al., 1998), frontal motor-related areas (Brasted and Wise, 2004; Chen and Wise, 1995; Chen and Wise, 1995b; Mitz et al., 1991) and striatum (Brasted and Wise, 2004). As inferential tacit thinking is the result of experience and expertise, it is essentially a product of associative learning. In the setting of our review, we pose the accent on how expert knowledge allows seasoned professional to rely on long-term memory of typical configurations of pieces and strategies (Chi et al., 1988).

In Economics and Management literature the concept of "Learning by doing" was utilized extensively (Arrow, 1971; Foster and Rosenzweig, 1995; DuFour, 2013) borrowing insights about its functioning from the psychological literature (Anzai and Simon, 1979). Learning by doing is clearly an implicit form of learning (Raab and Johnson, 2008) and is tightly connected to implicit attitudes (Plessner, Betsch, Schallies, and Schwieren, 2008). Implicit learning is considered a System 1 process and configures as tacit since the individuals are often completely unaware of the acquisition or the application of rules. It pertains less to learning and more to how learned information is accessed and used. In the laboratory studies on implicit learning (Litman and Reber, 2005), researchers extensively used artificial grammar (AG) paradigms. Matthews and colleagues (1989) in a four-day study found that participants who had engaged in an AG implicit learning task could distinguish well-formed letter strings but were unable to explicate what they had learned already at the end of the first day. Lewicki and colleagues conducted a series of studies named Tulsa whose participants were requested to track the position of an on-screen target (X). Although the movement of the target was set by complex algorithms, the participants were able to learn the complex rules for accurately predicting the target's position but could not explain what sort of rules they were responding to (Lewicki et al., 1992, 1998). This body of work provided evidences that the tacit cognitive responses governed by System 1 are not necessarily limited to basic and

mundane operations but can be involved in more sophisticated processing (Lewicki et al., 1998).

As a consequence of the implicit and tacit learning processes associated with experience, individuals sometimes experience undeliberate perceptions about their knowledge. This phenomenon was defined "Feelings of knowing" and configures as an individual's belief of the decision maker of being able to proceed in such a way that will lead to a successful outcome. This perception and deep sensation that the answer is within reach (Ippolito and Tweney, 1995) should be subjected to accurate verifications as it is essentially non substantiated by data and analysis. In Koriat's (1993) study, the participants who were able to assess the potential availability in their memory of a correct response still being unable to recall a given solicited target perceived this feeling. The Feeling of knowing sometimes manifests as a 'tip-of-the-tongue' phenomenon and can be interpreted as the result of unintentional inferential heuristics mediating between implicit-automatic (System 1) processes and explicit-controlled (System 2) processes (Koriat, 2000). This phenomenon provides the opportunity to explicate the distinction between intuition and insight that is distinct cognitive phenomenon from intuition although partially similar to it. Insight is a process culminating in a moment when individuals suddenly realize that they can dissect a problem and feel that within few moments the answer will burst into consciousness accompanied by a strong conviction of certainty (Smith, 1995; Hogarth, 2001). Indeed, intuition plays a role in the non-conscious incubation period that leads to the actual realization of the insight when the problem solution suddenly enters conscious awareness (Sternberg and Davidson, 1995; Dane and Pratt, 2007; Hodgkinson et al., 2008; Hogarth, 2001). Metcalfe and Wiebe (1987) observed that along the problem-solving task of non-insight problems, the feeling of knowing emerged following an incremental pattern while the insight-problem solutions were associated to a sudden, unforeseen flash of illumination. The findings of this work resonated with the conclusions on the phenomenological attributes of insight and intuition described by Bowers and colleagues (1990) and by Damasio (1994) respectively.

Researchers in social psychology, cognitive psychology and decision theory agreed that the process of intuiting originates from the tacit knowledge accumulated through experience and explicit and implicit learning (Agor, 1989; Behling and Eckel, 1991; Claxton, 2000; Hogarth, 2001; Klein, 2003; Shirley and Langan-Fox, 1996). Some researchers of the Intuitive decision-making current inquired about the most suitable learning approaches to foster intuition studying the learning process of managers and other decision makers in real life settings to shed light upon how they use experience (Denzin and Lincoln, 1998; Sadler-Smith and Shafy, 2007). The learning process that leads to intuitive awareness requires the capacity to distinguish between intuition and emotions such as fears, biases, prejudices based on category membership and wishful thinking (Hogarth, 2001; Sadler-Smith, 2006). Smith and Osherson (1989) argued that logical approaches are appropriate in some situations whereas intuitive approaches are appropriate in other situations. Consequently, the adoption of an intuitive approach in situations that require analysis causes dysfunctional outcomes. This author rejected the dual-

process conception as bases for nurturing decision capabilities and proposed to shift skills development to a middle ground positioned between System 1 and System 2. The concepts adopted and developed by Intuitive decision-making literature show several connection points with those adopted in organizational learning as in the case of mindfulness (Langer, 1997; 2000; Langer and Moldeveanu, 2000; Claxton, 1997) versus double-loop learning (Argyris and Schön, 1978).

Naturalistic decision-making researchers posed the accent on the superiority of experts' decisions and their peculiar features. Experts' decision-making is seen as a quick appraisal backed by experience and rooted in "intuitive information processing system" (Salas et al, 2010; Kahneman and Klein, 2009) that sometimes manifests as "an emotional sense that something is not right" (Klein, 2003). This interpretation of intuition by Naturalistic decision-making researchers encouraged the onset of a sort of "Faith in expertise". Intuitive decision-making tradition followed in these footsteps providing recommendations to executives on how to use intuition more effectively and develop better intuitive judgemental skills. Sadler-Smith and Shefy (2004) collected Hogarth's (2001) legacy and coined the construct of "intuition-as-expertise" in the attempt to synthesise the Somatic marker hypothesis and the Naturalistic decision-making tradition (Hogarth, 2001; Sadler-Smith and Shefy, 2004). In this new conception, informed intuition springs from deliberate and extensive practice accompanied by feedback and reflection (Dreyfus and Dreyfus, 1986; Ericsson, Prietula, and Cokely, 2007). Nonetheless, it would be akin to caricature of these approaches to describe them as blind advocates of expertise. Indeed, they have all documented and analysed failures of experts' performance (Cannon-Bowers and Salas, 1998; Klein, 1998; Woods, O'Brien, and Hanes, 1987). Naturalistic decision-making scholars were shaken by the catastrophic failure of expert decision-making occurred in 1988 when the technologically advanced Aegis cruiser, USS Vincennes, accidentally shot down an Iranian Airbus (Fogarty, 1988; Collyer and Malecki, 1998; Klein, 1998). The disastrous error that determined the accident was at the centres Tactical Decision-making Under Stress (TADMUS) program commissioned by the US navy that provided an opportunity to explore the issue of judgmental reliability (Cannon-Bowers and Salas, 1998). Consequently, it became more and more evident that the high road toward the development of sound judgemental skills passes through a deeper understating of the true meaning of rational and intuitive expertise and the conditions for its acquisition and efficacy (Salas et al., 2010; Kahneman and Klein, 2009). Kahneman and Klein (2009) tried to reconcile the considerable differences between the Heuristics and biases and the Naturalistic decision-making traditions. These authors mapped the boundary conditions to ensure that an intuitive judgment is effective, reliable and free from biases. Other scholars belonging to the Naturalistic decision-making current proposed a programme of empirical research in field settings that tests models of individual- and team-level expertise-based intuition using methods such as think-aloud protocols, narratives, and shadowing. The objective is to identify the factors that influence the use and the effectiveness of intuition (i.e. level of expertise of a decision maker, task structure,

feedback availability, characteristics of the environment) and to set up adequate system to monitor the achievements of the tools and plans to promote the development of intuitive expertise (Salas et al., 2010).

Within the Naturalistic decision-making current, the study of how individuals apply expertise is built and applied to judgment and decision-making has been at the centre of the research work. The investigation connected to these topics examined the most relevant types of knowledge and learning in the achievement of outstanding expertise. Both explicit and tacit knowledge were considered and weighed but the latter drew the attention of researchers being connected to perceptual abilities, pattern recognition, judgments of typicality, and mental models. In a review of the literature, Klein (1998) identified four key ways in which experts learn: engaging in deliberate practice, and setting specific goals and evaluation criteria; compiling extensive experience banks; obtaining feedback that is accurate, diagnostic, and reasonably timely; and enriching their experiences by reviewing prior experiences to derive new insights and lessons from mistakes. These learning techniques are considered especially suitable to nurture tacit knowledge. This type of knowledge presents one especially delicate feature. Decision makers are usually unable to articulate the basis of their judgments and decisions when these are driven by tacit knowledge. This similarity with the impossibility to explain the origins of one's intuition is indeed not a coincidence. In fact, tacit knowledge is tightly connected to expertise, which in turn leads to intuition. In the pattern recognition process, decision makers formulate judgments that are mysterious and inexplicable as opposed to logical-rational reasoning. To remedy this problem, Naturalistic decision-making researchers have devised methods and tools for probing tacit knowledge such as the cognitive task analysis based on the critical decision method (Crandall et al., 2006). This tool was used to examine field cases and to elicit the actual cues used by the informants as in the case of the US naval officer who had to decipher and assess whether a radar blip belonged to Silkworm missile that the Iraqis had just fired at his ship or to an American A-6 aircraft during the Kuwait war in 1991. Based on his perceptions, the officer concluded that it belonged to a missile even though he was unable to articulate what was typical. This sense of typicality is the result of a long experience at observing aircraft tracks that enabled the officer to internalize patterns and detect anomalies. In Klein and Hoffman's (1993) own words, intuition is what provides us with these expectations.

All the strands of literature examined in this review converge in considering human decision-making as a complex and multifaceted process difficult to explain through the prescriptions of the normative theories. Each current posed the accent on different aspects and different drivers of the decision process. A recurrent and key factor is expertise whose interpretation differs greatly from one theoretical tradition to the other. Some decision theorists conceive expertise as domain-independent and assume that it can be fostered through the enhancement of standard and domain-general decision skills. These researchers emphasized that streamlined processes can be used to eliminate biases (e.g., Hammond, Keeney, and Raiffa, 1999; Hogarth, 2001; Russo, Schoemaker, and Hittleman, 2001). In contrast to this view, the Naturalistic decision-making scholars proposed

an alternative approach focused on the development of substantive, domain-specific expertise rather than on the optimization of standardized decision processes. Salas and Klein (2001) explained that the acquisition of decision-making expertise in specific domains could be facilitated through well-structured, scenario-based training sessions. The Naturalistic decision-making researchers identified a broad array of competences and knowledge that favour the development of expertise (Anderson, 1983; Klein and Militello, 2002). These include perceptual skills (Klein and Hoffman, 1993), the capacity to nurture one's own mental models or cognitive representations of "how things work" (Rouse and Morris, 1986), the ability to master a wide variety of tactics for getting things done (Anderson, 1983). The individuals who reach a high degree of domain expertise can feel a strong sense of typicality that derive from the capacity to recognize patterns from a vast repertoire (Ericsson and Smith, 1991; Newell and Simon, 1972; Chase, 1983; Dreyfus, 1997; Gentner, 1988). In addition, domain experts can spot anomalies and detect problems (Feltovich, Johnson, Moller and Swanson, 1984; Feltovich, Spiro, and Coulson, 1997; Kobus, Proctor, Bank and Holste, 2000), generate novel courses of action through mental simulations using unapparent opportunities as leverage points (Klein and Wolf, 1998; Klein, 1998). Furthermore, domain experts are able to manage uncertainty by filling the information gaps with assumptions and using information-seeking tactics inspired by highly detailed cognitive models (Lipshitz and Strauss, 1997; Schmitt and Klein, 1996; Christensen-Szalanski and Bushyhead, 1981; Loftus and Wagenaar, 1988). They are able to evaluate the strengths and limitations of their action (metacognition) through fine grained self-monitoring and sel-assessment (Simon, 1975; Chi, 1978; Chi, Feltovich and Glaser,1980; Chi et al., 1981; Larkin, 1983).

The mirabolant performance of some experts observed in several field studies conducted by the Naturalistic decision-making researchers (Lipshitz et al. 2001; Pliske and Klein, 2003; Klein, 1998, 1999, 2002) opened the way to further investigations on the peculiar features of experts in contraposition to novices. The role of extensive domain-specific knowledge accumulated over years of experience was gradullay explored contributing to the knowledge-based view of expertise (e.g., de Grout, Chase and Simon 1973). It was observed that expert decision makers are able to rely both on their analytic and perceptive thinking while novices rely almost exclusively on analytical thinking due to the more limited experience and knowledge stock at their disposal. Novices are more prone to resort to generalized strategies while experts master inference patterns. The superior performance of experts was considered the output of specialized knowledge and inference patterns (Ericsson and Lehman, 1996; Glaser, 1987; Glaser and Chi 1988; Bedard and Chi, 1992; Hoffenan et al., 1997; Chi 2006; Feltovich et al. 2006). However, the achievement of high levels of expertise should not be considered a foregone consequence of experience as the mere repetition of a task is not sufficient per se (Ericsson and Lehman, 1996). Sternberg (1997) defined a "prototype" of expertise to highlight the main conditions to make quality decisions. The observation of experts' decision dynamics and mechanisms revealed that expertise thrives when individuals commit to nurture their motivation to learn, improve knowledge and skills, pay attention to subtle cues, self-

coach their perception of meaningful patterns, exercise to develop abstract and functional knowledge-base conceptualizations of key phenomena (Salas and Rosen, 2011). The RPD model developed by Klein (2012) was used to explain how individuals build expertise and apply it to cognitive functions such as judgement and decision-making (Kahneman and Klein, 2009). The predictions of the RPD model were tested and it emerged that novice decision makers tend to make more accurate and structured analysis comparatively to their senior colleagues who size up situations quickly and are usually satisfied of the first option they consider (Klein et al, 1995, Johnson and Raab, 2003). Despite this might appear as a non-rational decision process, it is the result of the diagnostic and judgemental skills developed by experts with experience. Experts are able to interchange rational and holistic approaches mixing analytical and intuitive judgements as they can draw upon highly elaborated cognitive structures built up over decades. These structures allow them to make predictions and complex decisions quickly and sometimes unconsciously. In these cases, experts are often unable to articulate the basis of their judgement since it has its roots in tacit knowledge (Klein, 2003). As already anticipated, Kahneman and Klein (2009) identifies some conditions for effective expertise building such as adequate opportunity to practice and learn the relevant cues, type of practice, level of engagement and motivation, and the self–regulatory attitude (Ericsson, Charness, Hoffman and Feltovich, 2006), adequate high validity in the environment (Hogarth, 2001), sufficient repetition (Chase and Simon, 1973). In addition, Kahneman and Klein (2009) emphasized that some people have an innate talent for perceptive thinking and ceteris paribus are able to develop skilled intuitions more quickly than others are. The Naturalistic decision-making literature explored a number of techniques to promote expertise building elaborated based on the empirical studies with firefighters, air traffic controllers, ER doctors, army commander, etc. Two of the most popular techniques are the realistic simulation scenarios and the “pre mortem” that enable participants to imagine circumstances beyond their immediate experience and to anticipate what could go wrong when they execute response plans (Klein, 1989). The efficacy of these techniques was challenged due to their inferiority compared with actual and vicarious experience (Sagan, 1993) and to possible lack of realism and inadequacy to reproduce the complexity of reality (Perrow, 1984; Clarke, 1999).

Individual characteristics

The individual characteristics of decision makers affect their choices in various ways. Former literature distinguished a number of factors that affect decision-making as illustrated by Soane and Nicholson (2012). Among the most recurrent ones, we find age whose increases are associated with overtime personality changes (McCrae et al. 2005; Roberts et al. 2006), declines in information processing but also compensatory effects connected to experience (Salthouse 1984) and evolutions in response biases (Huh et al 2006). Equally recurrent

is gender that influences the decisions about: forecasting of own behavior and the behavior of others (Song et al. 2004), attention to emotion in speech (Schirmer et al. 2005), perceptions of distributive and procedural justice in organizations (Bernerth 2005), ethical decision-making (Buckley et al. 1998). Gender has an impact also in reference to hiring and firing (Levin et al 2005), stereotyping to increase gender inequality in hiring decisions (Gorman 2005), decisions concerning new technology (Venkatesh 2000), risk-taking (Nicholson et al 2005), leadership style (Eagly and Johnson 1990) and responsive adaptation to uncertainty (Washburn et al. 2005). When individual-level values, skills, attributes and characteristics align to organizational demands, expectations and rewards, there is a high level of person-job fit and this promotes performance optimization (Edwards 1991).

None of the literature traditions considered in this review made a systematic analysis of the drivers connected with decisors' individual features. Nonetheless, each current underscored the factors that more suitably fit the theoretical framework developed in each tradition.

The theoretical framework of Behavioural decision-making is built on the assumption of Bounded rationality for which the complexity of reality clashes with the limitation of human cognition (Simon, 1955, 1957; March, Simon and Guetzkow, 1958. As observed by March (1997), decision makers do not have complete data and exhaustive knowledge of all the existing alternatives. They cannot process information and figure out the consequences of every alterative action thus being unable to rank them to calculate costs, benefits and probabilities. Moreover, decision makers do not have a consistent preference when ordering the alternatives and their decision rules cannot lead to the selection of a single course of action. For this reason, they do not seek for optimal solutions but rather search a satisfying option. Simon (1979) showed that at the level of the organization, decision makers consider alternative subordinate goals and define them based on their experience and knowledge. Debates about decision makers' rationality. Several empirical studies confirmed the actual dynamics of decision-making in organizations (Hall and Hitch, 1939; Harrod, 1939; Lester, 1946; Mintzberg et al., 1976; Wittem 1972). March (1971) remarked that rational theories ignore that individuals often discover their preferences through taking actions and experiencing their consequences rather than in an ex-ante maximization effort.

Behavioural decision-making emphasized the role of subjective confidence remarking that it is often determined by the internal consistency rather than the quality of the information on which a judgment is based (Einhorn and Hogarth, 1978; Kahneman and Tversky, 1973). When a decision maker behaves overconfidently, there is a risk that the available evidence may be misinterpreted and decisions risk to be driven by superficial judgements. If the judgments stemming from *Overconfidence* are presented too assertively, erroneous decisions might be made relying on misleading beliefs. This behaviour and many others features and charcateristics corresponding to *Individual differences* in judgement are potentially conducive to decision biases. The dual nature of thinking

mirrors the bipolarization of choices that for one part involve automatic processing and for the other part involves conscious and effortful information processing. Individual differences influence the thresholds between these two modes and the behaviours within each mode (Baumeister and Tice 1988; Soane and Nicholson 2006).

Individual propensity for emotionality is another influencing factor as it affects the perception of loss in risk taking decision behavior (Arkes et al.1988), interacts with risk preferences and influences thoughts about loss (lsen and Geva 1987), and interacts with task conditions to influence cognitive processes associated with motivation (Erez and lsen 2002). Motivation intended as the psychological mechanism influencing the direction, intensity and persistence of actions (Vroom 1964) influences goal choice (Kanfer 1990; Locke and Latham 2002) and allocation of resources (Kanfer and Ackerman, 1989). The tendency to self-monitor and control the image of oneself that is projected to others in social situations (Snyder 1987) influences the ethical decisions (Ross and Robertson, 2003) and impacts the aptitude to report fraudulent behaviors (Uddin and Gillett 2002). The core beliefs and values about acceptable behaviours affect the perceptual screening of the decision environment (England 1967), selection, retention in organizations (Schneider 1987) and responses and adaptations to the environment (Simon 1993). Lastly, individual characteristics and personality-related aspects influence risk orientation and the tendency to accept potential losses (Soane and Chmiel 2005; Nicholson et al., 2005; Kahneman and Lovallo, 1993). Intrinsic attitudes towards risk-taking can influence decisions and organization performance (Singh 1986).

Personality, defined as the ensemble of non-physical and non-intellectual qualities that make one person distinct from another (Adler 1996), interacts with information framing to influence decision-making (Levin ct al. 2002). The personality type determines and interacts with a number of individual characteristics such as ex ante risk tolerance (Filbeck et aL 2005), responses to risk, individual-level attitudes, self-corrective behaviours, cognitions and emotions (Endler and Magnusson 1976; Powers, 1973). In addition, decisions are affected also by the combination of personality with situational factors and framing effects (Lord and Levy, 1994; Kowert and Hermann, 1997). The advancements in personality literature parallel the utilization of psychometric tools to highlight its impact on experiential and rational information processing modalities, as we will see in further detail later.

A direct consequence of personality characteristics is the perception of self-efficacy that ultimately contributes to individual confidence that is deeply interconnected with self-esteem, emotional ability and locus of control. The perceived capacity to accomplish a task is at the root of self-efficacy and influence leadership, strategic decision-making (Hiller and Hambrick, 2005) and performance (Forbes, 2005; Bandura, 1982; Lee et al., 1997). When confidence is misused or misinterpreted, risks might be considered opportunities (Krueger and Dickson 1993) and possible detrimental courses of action might be selected (Whyte et al. 1997). Each person has a

distinctive Cognitive style that can be more oriented toward sub-conscious automaticity or rather more oriented toward conscious rationality based on preferences that were elaborated in response to personality traits and the stimulus of experience (Whyte et al. 1997). Different levels of conscious processing and the functioning of conscious and unconscious information processing influence decision-making and its efficiency (Chartrand, 2005; Dijksterhuis 2004; Fulmer and Barry 2004). On one side, impulsive, goal independent, habit driven decision-making is usually automatic or tend to become automatic over time. On the other side, ponderate, goal oriented, novel decision-making is usually rational (Van Osselaer et al., 2005; Kim et al. 2005).

Individual thinking styles were objects of investigation for both cognitive psychologists and decision theorists. As already mentioned, psychometric tools were used by several researchers to shed light on *Rational, Holistic and Inferential Thinking* and the role of cognitive preferences in decision-making. Pretz and Totz (2007) made a compative analysis of two measures used to map the perceptive-intuitive and the rational-analytic systems namely, the Myers Briggs Type Indicator (MBTI; Myers et al., 1998) and the Rational Experiential Inventory (REI, Pacini and Epstein, 1999). They found that these measures were developed accounting for two different constructs of perceptive-intuitive thinking still being more prone to detect preferences for abstract, conceptual thinking. More specifically, they realized that the MBTI intuitive/sensate subscale measured holistic intuition only whereas the REI experiential subscale assessed intuition in a more general sense combining holistic and inferential intuitive thinking. Another measure, the Types of Intuition Scale (TIntS - Pretz et al., 2010) was developed to capture individual differences in preference for three types of intuition: holistic, inferential, and affective. This measure proved to be valid and useful thus allowing to treat holistic and inferential intuition separately given the intrinsic differences between the two.

Both the Intuitive decision-making and the Naturalistic decision-making scholars accepted the existence of two cognitive systems interacting among them. The former current relied on the theorization of CEST and C – X model while the latter used the conceptualization of mental simulations. In both cases, the effect on cognitive mechanisms of the existence of individual differences in preferences for intuition and rationality was widely acknowledged (Betsch, 2008).

Intuitive decision-making spotlighted the distinctive characteristics of the two systems, their positive and negative attributes and the connections with the cognitive styles of the individuals who rely more on one or the other thinking system. The rational/analytic thinking style relates more strongly to intellectual performance and to a variety of measures indicative of good adjustment, including low anxiety, low depression, low stress, low neuroticism, high self-esteem and high meaningfulness of life. An experiential/intuitive thinking style is positively associated with a variety of non-intellective favourable attributes, including creativity, empathy, aesthetic judgment, intuitive ability, and establishing satisfactory interpersonal relationships. It is also

associated with several unfavourable attributes, including naive optimism, stereotyped thinking, superstitious beliefs, and unrealistic beliefs (Epstein et al., 1996; Norris and Epstein, 2008).

Discussion and conclusion

After presenting the theorization and the debates between the strands of literature covered by the review, we reflect now on the research approach, investigation novelties, theorization, contribution, weaknesses and research opportunities of each current (Table 2). The latter are based essentially on a deeper and more collaborative interaction between the scholars from different disciplines and traditions.

As expected, the research approaches differ significantly from one strand of literature to the other. Most of the data informing Behavioural, Heuristics and Biases decision-making literature has largely been collected and analysed in laboratory-based experiments. This corpus of analysis has rigorously formalised the experimental research protocol to study heuristics-driven decision distortions in low fidelity simulated environments. For this reason, the lab-based findings of this current cannot be easily generalized to domain-specific judgements due to the limitations and challenges in the applications to real-life scenarios. In their interpretation, intuitions often turn into faulty judgements since it is the output of a fragile mental process susceptible of distortions. These alterations intervene during the automatic phase of information processing when unconscious mechanism interfere with the rational-analytic cognitive processes. More field experiments with professional decision makers beyond probabilistic reasoning and abstract judgements could help overcome current challenges.

In the Cognitive Psychology and Neuroscience literature, new paths have been opened up for the analysis of cognitive dynamics through new technologies (e.g. fMRI, ECG and SCR). Using data on neural activity, researchers can draw conclusions on the cognitive and neural processes operating during the decision-making processes. It provides a strong framework capable of explaining behaviours through neural and biological evidence, but is limited by the restricted use of lab equipment necessary for data-generation and -collection. While the equipment is unlikely to be usable in a field-context, data generated with the help of this technology provides many opportunities for a cross-disciplinary collaboration to establish a neuro-decision-making current in management.

Intuitive decision-making theories are based on conceptual speculations and still limited empirical research. These researchers performed a thorough analysis of the existing decision-making literature through the lenses of cognitive psychology and produced an insightful and broad synthesis of the main constructs. Despite relatively little engagement with management theories, Intuitive decision-making theories have provided a tangible contribution to management studies and expanded knowledge of the ways managers use intuitions in strategic decision making. They initiated seminal empirical works on how to nurture intuition acting on individual

awareness. More empirical studies arrear necessary to support an already reach conceptual framework and to bridge management and cognitive sciences.

Natural decision-making, in contrast to Behavioural decision-making theory, uses an ecological approach to conduct field studies. Through this approach, it was one of the first schools to identify the centrality of expertise in decision-making. However, as theories were generated based on decisions made in high-stake and specific contexts, more work needs to be done to provide general evidence. It places an emphasis on successful decisions, but only marginally considers flawed judgements. This may affect the predictive quality of the systemised models of pragmatic decision-making. In addition, Natural decision-making works with a subjective and non-robust definition of expertise. As with the other strands of literature, these weaknesses are suitable starting points for further research. Closer collaboration with other traditions can confer more rigour to the research protocol for optimisation of empirical data and increased publications.

Table 2

	Decision-making theory Main strands of literature that conceptualized tacit-unconscious-intuitive and explicit-conscious-rational decision drivers			
	Behavioural and Heuristics and Biases Decision Making	Cognitive Psychology and Neuroscience	Intuitive Decision Making	Naturalistic Decision Making
Research approach	Human behaviour in decision-making analysed mainly using laboratory studies.	Cognitive dynamics analysed through sophisticated techniques.	Conceptual speculations and limited empirical research.	Ecological approach adopted to conduct numerous field studies.
Investigation novelties	Observational approach conferred realism to decision interpretation. Prescriptive view to elaborate rigorous and credible decision options (e.g. algorithms).	The application of new technologies such as fMRI, EECG, SCR, etc opened new paths in the research of neural activity in decision-making.	Thorough analysis of the existing decision-making literature used to make an insightful and broad synthesis of the main constructs.	Forerunner role in identifying the centrality of expertise in decision making. Inductive approach to systematize professional decision behaviour.
Theorization	Decision-making distortion factors are isolated (biases, systematic errors, overconfidence) but decision process is limited to automatic responses to logical puzzles rather than subtle judgments in nuances-rich contexts.	Explanation of the cognitive and neural processes that determine decision-making. Physiological limits of human approach to choices are mapped.	Theoretical background built on cognitive psychology assumptions. Tangible contribution to management studies despite limited osmosis with management theories.	Emblematic empirical studies inspired comprehensive decision-making models. Findings of decisions in high stake contexts were used for generalized decision theory.
Contribution	Rigorous formalization of the experimental research protocol to study decision distortions still in low fidelity simulated environments.	Scientific framework capable of explaining behaviours through neural and biological evidences.	Investigation on intuitive decisions of managers and intuition nurturing. Emphasis on cognitive awareness for effective decision making.	Systematized model of pragmatic professional decision-making by experts (especially RPD) built through empirical studies.
Weaknesses	Decisions conceived as domain-general heuristics-driven judgements. When instances are automatically retrieved from memory, biased heuristics are misinterpreted as faulty intuitive judgments.	New investigation techniques require lab equipment being unsuitable to study decision makers in real life contexts.	More empirical studies needed to support an already reach conceptual framework and to bridge management and cognitive sciences.	Emphasis on successful decisions but limited considerations for flawed judgements. Subjective and non-robust definition of expertise.
Research opportunities	The usual criticisms could be overcome performing more field experiments with professional decision makers not limited to probabilistic reasoning and abstract judgment.	Cross-discipline pollination toward the establishment of a neuro decision-making current in management.	The increasing resonance of intuition stimulated curiosity on the means and modalities to develop it thus soliciting more empirical research.	Closer collaboration with other traditions can confer more rigour to the research protocol for optimization of empirical data and increased publications.

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How individual and environmental factors interact and influence the effectiveness of strategic decisions through rational and intuitive dynamics

Abstract

The conditions of effective decision were investigated placing the accent on specific aspects of the situation or on peculiar features of the decision-maker in isolation thus leaving almost unexplored the interconnections and mutual influences between environmental and individual factors. In this study, we explore how the individual characteristics of the decision maker and the contextual features of the decision environment influence each other through cross-moderating effects. The impact of these effects on decision effectiveness is studied through the lenses of the analytic and intuitive cognitive dimensions. The research is conducted through the critical incident approach adopting a person-situation interactionist framework to connect the situational and individual factors and to explore a number of organization, situational and individual dimensions. This empirical approach allows to observe the interrelation between several levels: the decision-maker level, the team level and the organization level. The evidences emerged from the data suggested a clustering of the job families into three groups (opportunities scouting, emergency response, crisis mitigation) and allowed to isolate several cross-moderating effects bridging different dimensions across different individual and environmental factors. These effects were translated into five multidimensional conditions connecting cognitive versatility and alert status, profession-personality fit and semi-rigid hierarchies, talent appreciation and regulated flexibility, holistic envisioning and knowledge management, team synchronization and mutual trust. We concluded defining a multidimensional model of decision effectiveness.

Introduction

"Situational variables can exert powerful influences over human behavior, more so that we recognize or acknowledge."

"One can't live mindfully without being enmeshed in psychological processes that are around us."

(Philip Zimbardo – Stanford Prison Experiment)

The topic of decision effectiveness has been explored in several disciplines from philosophy to behavioural science and researchers inquired on which are the most favourable conditions for effective decisions to thrive (Etzioni, 1967; Argyris, 1976; Horan, 1979; Marsh et al, 2006; Eisenhardt, 1999; Endsley, 1997; Alper et a., 1998). Until now, the most prominent theoretical contributions placed the accent on specific aspects of the situation or on peculiar features of the decision-maker in isolation (Khatri

and Ng, 2000; Hogarth, 2001; Dane and Pratt, 2004, 2007; Kahneman and Klein, 2009; Salas et al., 2009; Guion and Gottier, 1965; Mischel, 1968; Murphy and Dzieweczynski, 2005; Hogan, 2007; Ones, Dilchert, Viswesvaran, and Judge, 2007; Roberts, 2009) leaving almost unexplored the interconnections and mutual influences between environmental and individual factors (Bandura, 1999, Funder, 2001, 2006, 2008; Buss, 2009). This is problematic in at least one sense since the effectiveness conditions related to a given factor might be exacerbated or mitigated by the presence of a concurrent factor.

In this study, we aim to investigate the conditions of decision-making effectiveness bearing in mind the mutually enforcing or deterring role that individual and environmental factors play in the decision-making process. Our objective is to explore how the individual characteristics of the decision maker and the contextual features of the decision environment influence each other through cross-moderating effects and how this exerts an impact on decision effectiveness. The analysis of effective decision judgements is performed through the lenses of rational-deliberate and intuitive-unconscious cognitive mechanisms.

We decided to embed this investigation on the conditions of effective decisions in a setting where human cognition is conceived as the ensemble of both deliberate and tacit mental mechanisms. This framing responds to the choice to adopt a micro-founded approach to the study of decision-making processes underpinned by the cognitive science conception that even numerous higher-level cognitive operations originate in the non-conscious sphere of thought (Lakoff and Johnson, 1999). Consequently, reasoning is seen no longer as an exclusively deliberative process but rather as a more articulated system of aware and unaware cognitive mechanisms (Hodgkinson et al, 2009). The analytic and intuitive cognitive dimensions are inherent to the level of analysis of the individual decision-maker who resorts to rationality or intuition depending on his own personality, thinking style, risk preferences but also on the distinctive features of the decision environment. In this setting, the inquiry on the boundaries of effective choices cannot neglect the decision drivers rooted in the subconscious cognitive mechanisms. On the contrary, a sound analysis solicits the adoption of a broader research framework encompassing both conscious-rational and unconscious-intuitive thinking to capture the complexity of a realistic decision space.

In order to investigate this question, we borrowed from different disciplines and sometimes from apparently distant literature adopting an ecological approach that interprets decisions and judgements in a multi-layer framework looking at the decision process from multiple perspectives. This multifaceted approach was inspired by our intention to respect the complexity of the strategic decision-making process and to avoid simplistic stereotyping. This view conceives the decision judgments not only as manifestations of who the decision-makers are but also as the result of the environment in which they

act (Lucas and Donnellan, 2009). The definition of decision effectiveness we adopt centres on the outcome produced by the implementation of an informed judgment in a proof-of-practice approach. When this outcome minimizes the negative consequences for the actors involved and is in line with the ex-ante expectations of experienced decision makers then the decision can be considered effective (Pearce, Freeman and Robinson, 1987; Eisenhardt, 1989: Judge and Miller, 1991; Dean and Sharfman, 1996).

In the first place, we build on the effectiveness conditions already identified in former literature and we focus on the decisions of forty three seasoned professionals from twelve job families operating in large organizations in executive and top management roles. The research is conducted through the critical incident approach adopting a person-situation interactionist framework to connect the situational and individual factors and to explore a number of dimensions (individual preferences, role in organization, situation characteristics, organization style and team composition). This empirical approach allows to observe the interrelation between several levels: the decision-maker level, the team level and the organization level. In this way, the decision-making process is analysed from multiple perspectives coinciding with these different levels: the decision-maker, the interaction between the decision-maker and the other individuals involved in the judgement, and the broader regulatory and corporate environment where the decision-maker acts. Interviews were complemented with cognitive, personality and risk appetite psychometric tests.

The patterns and recurrences emerged from the data analysis allowed to cluster the job families into three groups (opportunities scouting, emergency response, crisis mitigation). These regularities were trended along the already mentioned dimensions that were eventually crystalized in a taxonomy. The analysis highlighted the existence of cross-moderating effects bridging different dimensions across the individual and environmental factors. These effects were translated into five multidimensional conditions connecting cognitive versatility and alert status, profession-personality fit and semi-rigid hierarchies, talent appreciation and regulated flexibility, holistic envisioning and knowledge management, team synchronization and mutual trust. We concluded defining a multidimensional model of decision effectiveness.

Theoretical Background

The study of the distinctive features and conditions that positively contribute to the outcome of a given decision is a multidisciplinary effort due to the multifaceted nature of the processes involved. Everything starts with a situational judgment that involves both tacit and explicit considerations and ends with the elaboration of a course of action (Etzioni, 1967; Argyris, 1976; Horan, 1979; Marsh et al, 2006; Eisenhardt, 1999; Endsley, 1997; Alper et a., 1998).

Before presenting the main literature on effective decision-making, we provide an overview of the Dual-Process Theory utilized to conceptualize the duality of cognitive processing systems mentioned before. This model contraposes the intuitive, tacit, automatic and unconscious thinking mechanism to the rational, explicit, analytic and conscious thinking mechanism and explains the possible synthesis between the two. According to this theory, both these mechanisms are equally necessary (Chaiken and Trope 1999; Gilovich et al 2002; Evans 2007, 2008; Hodgkinson et al. 2008; Sinclair and Ashkanasy, 2005). The former allows decision makers to make sense of vast quantity of information rapidly while the latter enables to perform detailed analysis. On one hand, the automatic unconscious processing mode is essentially contextually-dependent, associative, intuitive, implicit, and fast. On the other hand, the analytic conscious processing mode is contextually-independent, rule-based, explicit, and relatively slow (Chaiken and Trope, 1999; Stanovich and West, 2000; Evans, 2008).

This view was supported by psychometric evidences such as the Rational Experiential Inventory (REI-40) (Hodgkinson and Sadler-Smith, 2003) and reconciled with the "Two Minds in One Brain" interpretation of judgements. The two minds are merely figurative and exemplify two different forms of neural-cognitive processing referred to as Type 1 (intuitive, experiential, automatic, tacit, unconscious, non-effortful, heuristic, implicit, impulsive, associative and holistic) and Type 2 (rational, controlled, conscious, intentional, effortful, analytic, explicit, rule-based, reflective). The former approach is driven by experientiality ('faith in intuition') while the latter is driven by independent rationality ('need for cognition') (Hodgkinson and Clarke, 2007; Hodgkinson et al, 2009; Leybourne and Sadler-Smith, 2006; Sinclair and Ashkanasy, 2005).

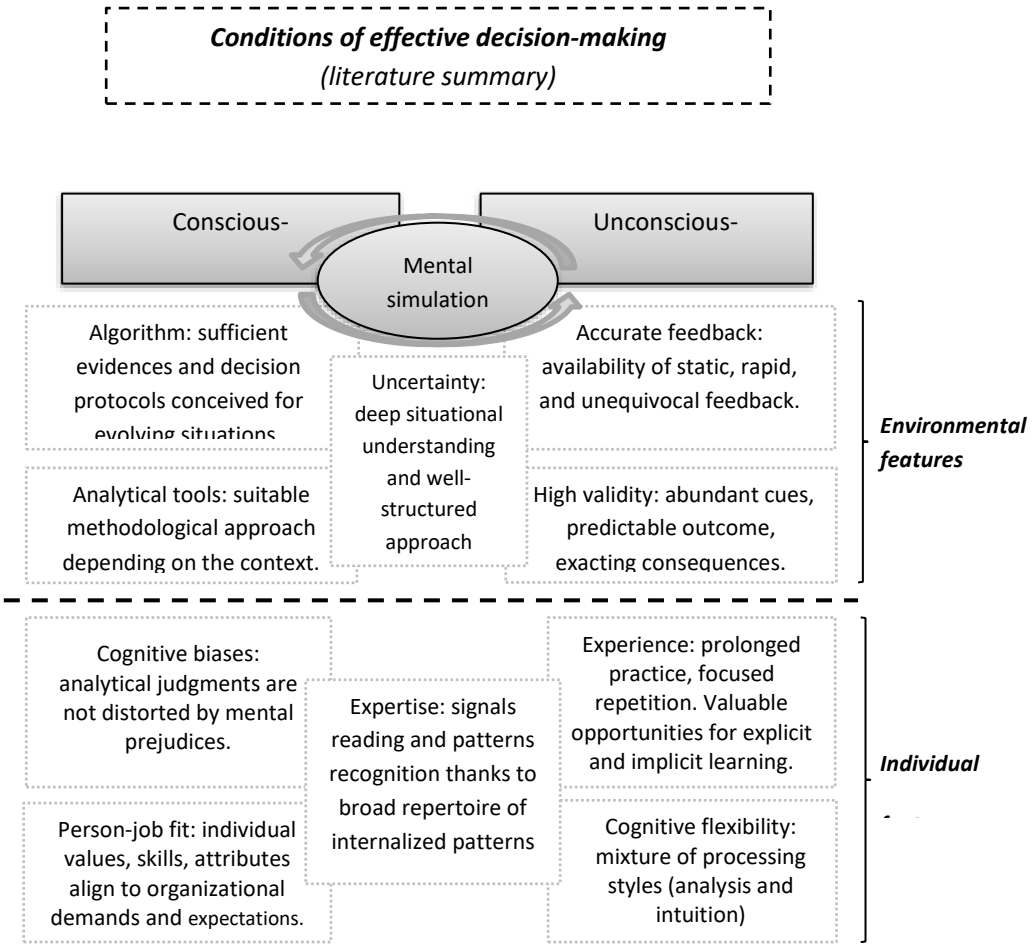
We introduced these concepts as the underlying mental mechanisms that heavily influence the decision process and to what extent judgments are inspired by analysis (conscious-rationality) or perceptions (unconscious-intuition). Intuition[1] is defined as an affectively charged judgment arising through rapid, non-conscious and holistic associations that derives from the capacity to attain direct understanding

[1] We do not provide a definition of analytical judgements as the concept is self-explanatory. We are however keen on clarifying the meaning of intuition due to the numerous definitional issues related to this concept.

without the apparent intrusion of conscious mind. Intuition should not be conceived as the opposite of rationality nor as a random process of guessing but rather as the thoughts, conclusions and choices produced through non-conscious mental processing (Dane and Prat, 2007; Hodgkinson and Ford, 2009).

To return to the key concepts related to effective decision-making, we provide a brief review that instrumentally distinguishes the theoretical positions related to environmental features from those focusing on individual features. Similarly, we present these contributions along the virtual axe of a cognitive continuum that spans from rationality (analytical approach) to experientiality (intuitive approach). It should be noted that this representation is merely figurative since the concepts share a number of common points and interrelations proving the high degree of interconnection between the main conditions (Figure 1).

Figure 1: Key concepts in the extant literature



The terms of successful rationality-driven decisions

Within the research programme on Heuristics and Biases, behavioural decision scholars were pioneers in the study of effective decision-making, highlighting the main sources of inconsistence and weakness of human cognitive performance (Kahneman and Tversky, 1979). These scholars demonstrated that individuals in their everyday judgments perform rapid and automatic 'natural assessments' that depart from the laws of logic and probability of classical decision theory (Allais, 1953; Ellsberg, 1961; Kahneman and Tversky, 1979; Bell, 1982; Loomis and Sugden, 1982; Machina, 1982; Pratt, 1986). They provided sufficient evidences to reject the assumption that decision makers perform optimal choices selecting the option that maximizes their expected utility from an array of possibilities, as proposed by the axiomatic probabilistic models of utility, uncertainty and risk (von Neumann and Morgenstern, 1947; Edwards, 1954).

Cognitive biases related to memory, attention or perceptions can diminish the effectiveness of decisions reached through an analytical approach. The application of psychology to probability estimation and choice behaviour led Kahneman and Tversky to investigate the systematic biases deriving from automatic judgements and choices that result from fallacies and distorted appraisals inherent in human information processing (Kahneman and Tversky, 1973; Tversky and Kahneman, 1974). The 'Heuristics and Biases' programme hosts several research strands, namely judgement under uncertainty (Kahneman et al., 1982), and prospect theory and framing in individual choice behaviour (Kahneman and Tversky 1984).

In 1971, Tversky and Kahneman affirmed, "following intuitions scientists are more prone to reach incorrect conclusions and make inferior choices, and despite training and actual experience, faulty statistical intuitions remain pervasive". This position that claims the superiority of computer-based and analytical judgements over human appraisals was reiterated in the meta-analysis conducted by Grove, Zald, Lebow, Snitz, and Nelson (2000). The Heuristics and Biases approach favours a sceptical attitude toward the judgments of experts. This is in line with the findings of Meehl's (1954) study on human judgements compared to statistical predictions and Goldberg's (1970) study on the bootstrapping effect".

Meehl's (1973) study of clinical diagnostics revealed that statistical predictions were more accurate than human predictions due to systematic human errors. Meehl discussed the tendency of clinicians to rely uncritically on intuition and their failure to adopt statistical tools. Heuristics and Biases scholars' scepticism toward expertise is also motivated by the inconsistency of informal judgment emerging when individuals reach different conclusions using the same information but on separate occasions. Goldberg's (1970) study proved the inconsistency on the validity of diagnostic judgments of clinicians due to the

noise intrinsic in human judgments. On this base, behavioural decision theorists advocated the superiority of rationality-driven decisions that are considered less susceptible to distortions and errors.

Several researchers suggested the application of streamlined processes to eliminate these biases (e.g., Hammond, Keeney, and Raiffa, 1999; Hogarth, 2001; Russo, Schoemaker, and Hittleman, 2001) and pointed out that overconfident judgments presented assertively should be considered carefully as they are often grounded in misleading beliefs. Such judgements potentially lead to decision biases due to inadequate, sparse, ambiguous or delayed post-failure feedback (Shapira and Berndt, 1997; Kahneman and Lovallo, 1993; March and Shapira, 1992) and due to overconfidence about perceived skills and competences.

In contraposition to this view, Hogarth (2001) emphasized that human judgments are not systematically inferior soliciting a more punctual consideration of the boundaries of intuition reliability. In an environment characterized by simple and valid cues, experienced individuals who received enough rapid feedback perform as well as the algorithms. On the contrary, in low-validity environments where only slack regularities can be detected, available cues are weak and uncertainty is high, individuals perform worse than algorithms. In a subsequent work, Karelaia and Hogarth (2008) showed that consistency of judgment account for much of the advantage of algorithms over humans. These authors defined some conditions for the construction and use of an algorithm.

These include: (a) confidence in the adequacy of the list of variables that will be used, (b) a reliable and measurable criterion, (c) a body of similar cases, (d) a cost/benefit ratio that warrants the investment in the algorithmic approach, and (e) a low likelihood that changing conditions will render the algorithm obsolete. Any algorithm should remain under human supervision to ensure continuous performance monitoring and adaptation to eventual changes in the environment. Those in charge of monitoring should resist the 'automation bias': the tendency to become more passive and less vigilant when algorithms are in charge (Skitka, Mosier and Burdick, 1999, 2000).

Despite these findings, some behavioural researchers maintained their uncompromising position on the superiority of algorithms even in high-validity and high-predictability environments. They reasoned that the accurate predictive power of algorithms could minimize errors in contexts where decision makers intentionally and unintentionally, consciously and non-consciously apply rules of thumb (Das and Teng, 1999; Hodgkinson et al., 1999; Highhouse, 2001; Neale et al., 2006; Hodgkinson and Sparrow, 2002). Another tool to improve decision effectiveness is to align individual-level values, skills, attributes and characteristics to organizational demands, expectations and rewards. This alignment defined "person-

job fit" promotes performance optimization and relate to the quality of individual judgements (Edwards, 1991).

Fast and frugal heuristics: a new interpretation of heuristics

In contraposition to the Heuristics and Biases tradition, Gigerenzer and his colleagues inaugurated the so-called "Fast-and-Frugal Heuristics" research programme to explore decision approaches adopted by decision makers in real-world settings under conditions of limited time and knowledge without computing probabilities and utilities (Gigerenzer and Todd, 1999; Gigerenzer, 2007). This research programme reposed on a fundamentally different conception of Simon's bounded rationality namely ecological rationality and identified alternative category of heuristics adapting to the informational structure and demands of the decision maker's environment. The programme was aimed at designing simple heuristics models that ensure successful results, analysing the environmental structures under which such heuristics work well, testing their performance in real-world (as opposed to laboratory) environments, and determine if and under what conditions people use them (Gigerenzer and Todd, 1999). According to Gigerenzer and Todd (1999), people behave in an ecologically rational manner when they use heuristics that suit their environments. Fast-and-frugal heuristics requires minimal computational demands and was deemed to produce fewer errors and less bias than the heuristics identified by conventional behavioural decision-making researchers.

The position of Fast-and-Frugal Heuristics scholars is in open contrast with the view of human mind struggling to overcome the obstacles of computational limitations that is instead popular among behavioural decision researchers and cognitive scientists. According to Gigerenzer and colleagues, heuristics and intuition make part of the cognitive processes developed by human mind to support decision making under time pressure and in the absence of complete information (Gigerenzer and Todd, 1999).

New strands of literature challenged the position of behavioural decision theorists

The dominant interpretation of intuition in the Heuristics and Biases tradition conceived intuition as a by-product of heuristics. In this literature, decision makers are unaware of the origins of their thoughts and often experience confidence in inaccurate and non-valid judgments (Arkes, 2001; Griffin and Tversky, 1992; Einhorn and Hogarth, 1978). Tversky and Kahneman (1974) did not deny the possible utility of heuristics but emphasized the severe and systematic errors they can cause if judgments are not rooted in specific experiences.

This position was challenged by numerous other researchers (Lipshitz, Klein, Orasanu and Salas, 2001; Hodgkinson and Healey, 2008; Hodgkinson, Langan-Fox and Sadler-Smith, 2008; Hodgkinson and Sparrow, 2008) who remarked that this interpretation of intuition as a cognitive shortcut that contravenes the laws of probabilistic logic is the result of a simplistic view of human reasoning and judgment. In their conception, intuition configures as a judgment associated to a feeling of rightness or plausibility 'knowing but without knowing why' (Hodgkinson et al., 2009) that cannot be articulated and justified rationally (Claxton, 1998; Klein1989, 2004). Intuition researchers define intuition as 'affectively-charged judgments based on experts' complex domain relevant schemas developing adaptively' and consider the stereotyped reproduction of problems used in the laboratory experiments of behavioural decision research unsuitable to investigate the high degree of complexity faced by decision makers in real life. The fundamental difference in the interpretation of the cognitive mechanisms behind it motivates the contraposition of the definitions of intuition given by these two schools of thought (Hodgkinson et al, 2009; Klein 2003).

Among the main antagonists to the positions of the behavioural decision theory, we can identify to distinct sides. On one side, we find intuition researchers who are experts on cognitive psychology and neuroscience literature, who are well acquainted with the similarities and differences between the several mental faculties hosted by the unconscious mind (e.g. intuition, insight, instinct; Dane and Pratt, 2007; Naresh and Ng, 2000; Hodgkinson, et al, 2009; Hodgkinson and Healey, 2008; Burke and Miller, 1999; Sinclair and Ashkanasy, 2005; Sadler-Smith and Burke, 2009; Sinclair and Ashkanasy, 2005; Claxton, 1998). On the other side, the Natural Decision theorists focus on the empirical observation of how decisions are taken by experts in real life contexts (Klein, 2008; Karol, Shafer and Klein, 2006; Lipshitz, Klein, Orasanu and Salas, 2001).

The terms of successful intuition-driven decisions

Natural Decision researchers and Gary Klein, the theorist of the Recognition-Primed Decision (Klein, 1989) postulated that experts can take good decisions without extensive, multi-attribute analyses as they are capable of recognising problems with and violations of patterns based on their experience of previous cases (Klein, 1989; Klein, 1998). In one of his most famous fieldworks with firefighters, Klein described how seasoned commanders use their experiences to detect patterns. A repertoire of patterns helps them anticipate how flames were likely to spread through a building, notice signs that a house was likely to collapse and judge when to call for additional support (Klein et al., 1986). In this theoretical framework, decisions are taken thanks to a dynamic cognitive process named mental simulation that is made possible by a high level of expertise in a given domain.

All the cases treated in the past contribute to the creation of a broad and detailed mental repertoire of situation typologies stored in memory. When decision makers need to make a decision, they can match the situation to the patterns stored in their memory, classify it as familiar-prototypical or unknown and then define the most suitable course of action. The contextual categorization is performed through a subconscious recognition of convergence or deviation from the internalized patterns. This cognitive mechanism consists of an automatic, involuntary comparison between the mental representation or schema that the decision maker has of a given situation and the actual cues and signals of the situation (Scholz, 1983; Klein, Calderwood and Clinton-Cirocco,1986; Lipshitz and Strauss, 1997, Klein, 1998). It is straightforward that the achievement of a high degree of expertise is of paramount importance to ensure the effectivity of the decisions taken through mental simulations. Shanteau (1992) investigated the most favourable conditions for expertise nurturing as isolated aspects such as: predictability of outcomes, amount of experience, availability of good feedback, and static stimuli. Shanteau observed a phenomenon labelled "fractionated expertise" to indicate the tendency to accumulate genuine expertise in some activities but not in others. This is because some professions exposing workers to brand new tasks recurrently do not grant them the opportunity to develop the necessary skills (Stewart, Roebber, and Bosart, 1997). On the contrary, when experts have performed a given task long enough to master it, they are able to detect unfamiliar situational characteristics and become aware of the boundaries of their own professional competence (Gawande, 2002; Groopman, 2007). In this setting, informed intuitive judgments arise from decision makers' complex, domain-relevant mental representations of the problem. In turn, decision makers resort to rational thinking to assess the reliability of their intuitions and to confirm hunches and gut feeling through tests and analysis (Klein, 2008; Coget and Keller, 2010).

This expertise-based view of intuition is embraced by numerous scholars spanning from Sadler-Smith and Shefy (2004), who were inspired by Hogarth's findings (2001), to Leonard and Swap (2005) who touched this topic indirectly in their work on 'deep smarts'. 'Deep smarts' refers to experts' ability to comprehend complex, interactive situations by using tacitly held expertise acquired from first-hand life experiences. It follows that one of the main conditions for effective intuitive judgments is that the decision maker has domain-relevant expertise (Hodgkinson et al., 2009).

In this theoretical framework, human decision-making is conceived as a knowledge-based and domain-specific process that requires experience to achieve expertise. This occurs through the gradual synthesis and categorization of experience that is used to make sense of situations, formulate judgments and define an appropriate course of action (Hodgkinson et al., 2009). It is important to note that no intuition can occur in an 'unprepared mind', therefore, decision makers should create the enabling conditions for expertise to flourish through deliberate and extensive practice accompanied by feedback and reflection

(Dreyfus and Dreyfus, 1986; Ericsson, Krampe and Tesch-Romer, 1993; Ericsson, Prietula, and Cokely, 2007). Creating adequate opportunity and frequency to practice (Chase and Simon, 1973) and learning, the relevant cues in an environment characterized by high validity (Hogarth, 2001) configure as the main condition for effective expertise building. These conditions lead to another implicit contextual requirement that is the existence of sufficient regularity in the environment (Brunswik, 1957; Hertwig, Hoffrage, and Martingnon, 1999). Additionally, the type of practice, the level of engagement and motivation, and the self–regulatory attitude (Ericsson, Charness, Hoffman and Feltovich, 2006) play an important role. On a different note, Kahneman and Klein (2009) emphasized that some people have an innate opportunities for perceptive thinking and ceteris paribus are able to develop skilled intuitions more quickly than others are. In view of this, the development of substantive, domain-specific expertise should be preferred to the optimization of standardized decision processes (Salas and Klein, 2001).

Scholars of both the Intuitive and Naturalistic decision-making strands of literature agreed on the centrality of uncertainty in the functioning of both the implicit and explicit cognitive mechanisms that drive the decision-making process (Orasanu and Connolly, 1993; Lipshitz et al., 1997). In uncertain settings, objective, logical, exact and rational approaches might be ineffective due to unavailable or inaccurate information, limited data, and unpredictable cause-effect relationship (Chia and Holt, 2008). In these loosely structured situations, no objective criterion for success or pre-conceived solution, intuition can represent a valid alternative provided a deep understanding of the decision-making situation (Lagadec, 2007; Khatri and Ng, 2000; Hensman and Sadler-Smith, 2011). In addition, decisions have more chances of being reliable when decision-makers adopt a well-structured approach to reduce uncertainty. Lipshits and Strauss (1997) used a heuristic model to isolate the most effective strategies for copying with uncertainty: collecting additional information, assumption-based reasoning, weighing pros and cons, developing a response to anticipate contingencies, and suppressing uncertainty. Similar methods were suggested by Allaire and Firsirotu (1989), Janis and Mann (1977), Klein (1998) and Shapira (1995).

Former reflections on the conditions that enhance decision effectiveness

The present work follows in the steps of former attempts to define the boundaries of effective decision-making in relation to the characteristics and constraints deriving from the environment and the decision maker. In the famous article “Conditions for intuitive expertise: A failure to disagree” (2009), Kahneman and Klein (2009) tried to reconcile the considerable differences between Behavioural and Naturalistic decision-making traditions and identified some conditions for effective intuitive judgments. Behavioural Decision-making focused on “environmental predictability” that plays a major role in the reliability of the

conclusions reached through tacit perceptive thinking culminating in unconscious and automatic judgements. In fact, some key binding conditions of judgment reliability that often remains unmet in professional contexts are environmental high-validity and predictability, and the abundance of opportunities to learn the rules of the reference context (Kahneman and Klein, 2009). These authors concluded that the high road toward the development of sound judgemental skills passes through a deeper understating of the true meaning of rational and intuitive expertise and the conditions for its acquisition and efficacy (Kahneman and Klein, 2009).

Other scholars belonging to the Naturalistic decision-making current proposed a programme of empirical research that tests models of individual- and team-level expertise-based intuition. This programme aim is to identify the features that influence the use and the effectiveness of intuition (i.e. level of expertise of a decision maker, task structure, feedback availability, characteristics of the environment) and to set up adequate system to monitor the achievements of the tools and plans to promote the development of intuitive expertise (Salas et al., 2010).

Research Methods

One of the main distinctive feature of this research work is the adoption of a person-situation interactionist framework to study the effect of individual and environmental characteristics on decision effectiveness (Judge and Zapata, 2015). The validity of this approach was proved by Judge and Zapata (2015) who integrated two situational/interactional theoretical models (Meyer, Dalal and Hermida, 2010; Tett and Burnett, 2003) to connect the situational and individual dimensions. In order to systematize the conditions and boundaries of effective decisions, we conducted an empirical study through critical incident interviews and complemented it with cognitive, personality and risk appetite tests. These additional tools were utilized to reframe the findings of the critical incident technique in a broader interpretative scaffolding that connects them to decision makers' cognitive preferences, personality characteristics and risk aptitude (Chell, 1998).

The critical incident qualitative approach was developed by Flanagan and further elaborated by Fitzgerald and Mullavey-O'Bryne to study catastrophic accidents (Flanagan 1954, Fitzgerald, et al., 1996; Fitzgerald, 2001). This technique is used to shed light on sparingly documented or poorly understood areas using factual reports of an individual's observation of their own behaviour or of others. The incidents are defined as neither inherently negative nor positive significant instances. These stories are characterized by a climax, dilemma or issue to be addressed but no clear resolution. After the incident resolution, there

is usually still a need to ascribe some meaning to it before a true resolution in the mind of the respondent (Fitzgerald, 2000, 2001). This technique was used as a vehicle for reflection to dissect the decision process and modalities followed by the respondents for the resolution of sensitive but non-dramatic incidents by means of crucial decisions during their professional career.

While recounting the critical incidents, the respondents reflected on the events and the narration allowed seeking for understanding and eventually ascribing meaning and significance to the overall decision-making processes under analysis (Flanagan, 1954; Fitzgerald, 2000, 2001). The unit of analysis is the individual decision maker but thanks to the versatility of the critical incident technique, the focus was gradually widened to encompass the team and the organization levels. The study was performed in line with the procedures for data collection provided by this research protocol and offered the opportunity to perform a detailed comparative analysis to identify similarities, differences and patterns (Kain, 2004). The output of the critical incidents analysis was interpreted in relation to the results of three psychometric tests: the Rational Experiential Inventory (REI-40 modelled on Pacini and Epstein, 1999); a Risk Taking Test (RTT) in line with the Risk Taking Propensity Measure (MacCrimmon and Wehrung, 1985); and the Myers-Briggs Type Indicator of personality characteristics (MBTI, Myers et al., 1998). The findings of this further analysis were systematized in a taxonomy with the purpose to isolate the main patterns and recurrent features of decision effectiveness boundaries. The qualitative data gathered in the interviews was further elaborated by means of a Grounded Theory methodology to define a model that crystallizes the emerging conditions of effective decisions in relation to key individual and environmental factors.

Data Collection and Analysis

As portrayed in Figure 2 on data structure, the study involved 23 male and 20 female informants (age range 46-77 years) with more than 10 years of experience in executive and top management roles from 12 job families (movie producers, venture capitalists and start-up incubators specialists, editors, HR officers, ER doctors and nurses, firefighters, army pilots and navy commanders and experts of humanitarian emergency, ICT cyber-attacks, bank and reputational crisis). Each respondent referred on two critical indicants for total 86 cases. The rational for extending the study to multiple professional domains consists in the intention to reproduce a multidimension space where judgement efficacy is assessed vis-à-vis numerous dimensions in a comparative analysis. The selection of numerous job families responded to the need to define an empirical scaffolding that is used to observe how the rational-analytic and perceptive-intuitive cognitive mechanisms that regulate decision-making deploy in

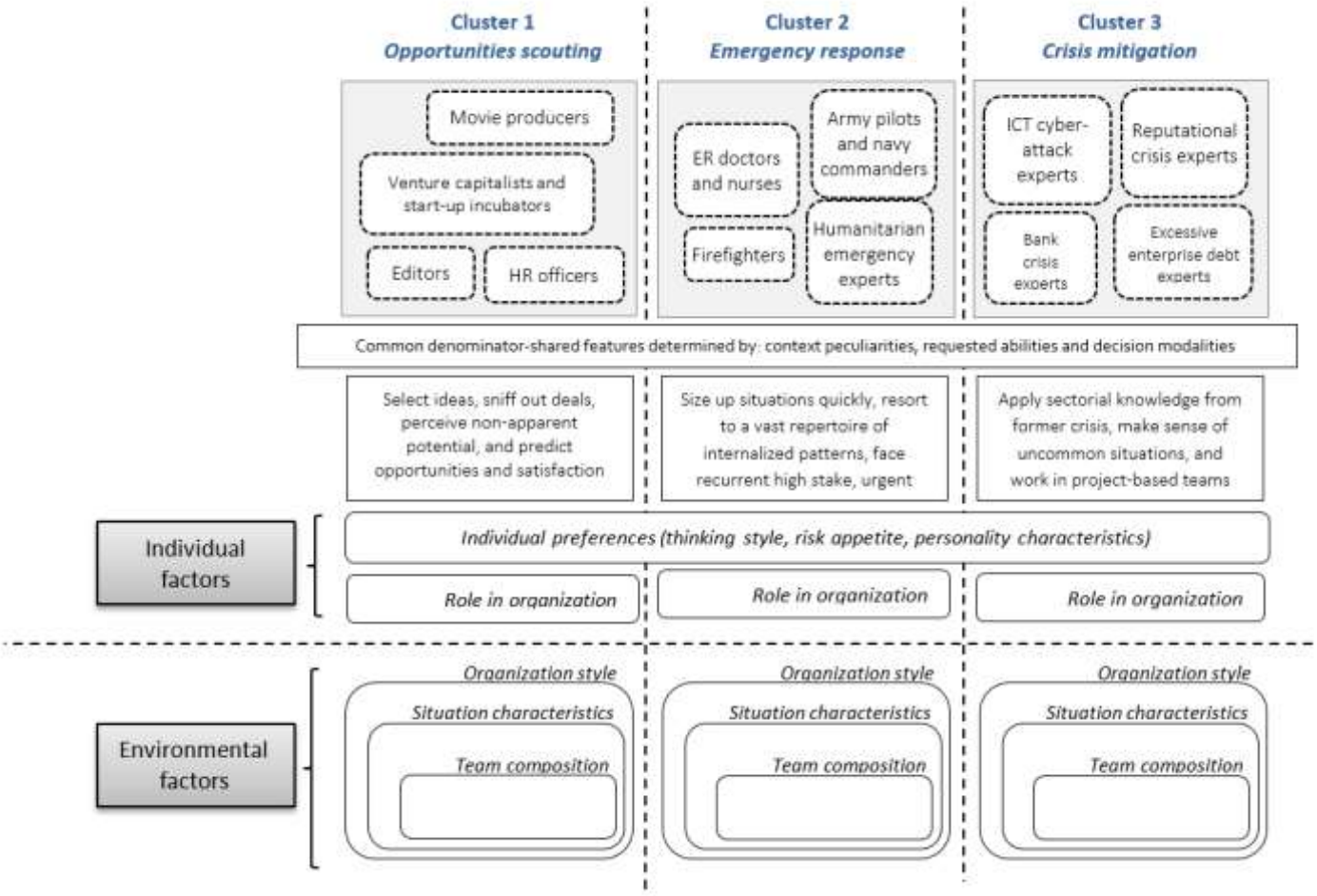
connection with specific dimensions across the domains (Rice and Ezzy, 2002). These dimensions coincide with the most salient individual and environmental aspects that influence decisions as identified in former literature. As part of the individual dimensions, we focused on the decision-maker's role in the organization with specific reference to hierarchical level (Orasanu and Connolly, 1993; Ross and Robertson 2000) and managerial role (Hensman and Sadler-Smith, 2011). The environmental dimensions we considered are numerous and articulate in three groups. The first one is the organization style connoted by proceduralization (Barrick and Mount, 1993; Allaire and Firsirotu, 1989) and hierarchization (Hollenbeck, Williams and Klein, 1989). The second dimensional group consists in the situation characteristics summarized by: time pressure (Monson, Hesley and Chernick, 1982), stake (Klein, 2008; Salas et al., 2010; Ericsson, Krampe and Tesch-Romer, 1993), perceived risk (Coget and Keller, 2010) familiarity (Kahneman and Klein, 2009, Janis and Mann, 1977; Hogarth, 2001), information quality (Ericsson, Charness, Hoffman and Feltovich, 2006; Lagadec, 2007), and uncertainty (Hertwig, Hoffrage and Martingnon, 1999; Khatri and Ng, 2000). The third group refers to the team composition that includes two dimensions: collaboration duration and frequency (Salas and Klein, 2001; Klein, 1998; Shapira, 1995; Lipshits and Strauss, 1997), and trust (Sadler-Smith and Shefy, 2004; McKenna and Martin-Smith, 2005).

Data collection was articulated in three phases according to the principle of in-depth exploration provided by the critical incident technique.

Table 1: Data collection and analysis by phase

Phase 1	*Data collection*	The informants received the interview protocol two weeks before the first interview and were requested to recall two important, difficult and high stake professional decisions they made in their careers (critical incidents). They were exhorted to reflect and note down the evolution of the decision process and how their position changed over time. During the interview, the respondents were guided to isolate the rational-analytical and unconscious-intuitive cognitive mechanisms that were activated during the decision process.
	Data analysis	Critical incident interviews were transcribed and coded by units of meaning. The identification of significant patterns was made possible by open coding supported by constant comparative analysis. The commonality was found in the shared features of the respondents in connection with the peculiarities of the professional context, the requested abilities and the usual decision modalities. Each cluster contains four job families.
Phase 2	*Data collection*	In the second interview, the informants were requested to assign a rate and inform about their hierarchical position (scale from 1-entry level to 9-upper senior management) and about their people management responsibilities (scale from 1-no supervisee to 9-more than 20 people supervised). In addition, they were requested to discuss the characteristics of the professional environment at the time of the decision focusing on organization style (scale from 1-very few and barely applied procedures to 9-streamlined, clear and pervasive procedures; scale from 1-undefined reporting line and frequent collective decisions to 9-rigid reporting line and sanctions for unauthorized decisions), situation characteristics (scale from 1-loose deadlines, limited stake and low perceived risk to 9-tight deadlines, high stake and high perceived risk; scale from 1-unfrequent novel tasks to 9-always new tasks; scale from 1-limited and unclear information to 9-abundant and clear information; scale from 1-clear connections between cause and effect, limited uncertainty to 9- unclear connections between cause and effect, high uncertainty) and team composition (scale from 1-occasional and short collaborations to 9-reiterated and long collaborations; scale from 1-suspition and low trust between team members to 9 confidence and high trust). The interviewer guided the respondents to explore the interconnection between these individual and environmental factors and the decision effectiveness in a hindsight critical approach.
	Data analysis	The interview data of Phase 2 was collated to the data of Phase 1 thus preserving the holistic, contextualized nature of the stories and coding was refined using axial techniques. Each cluster was assigned a rank (high, medium, low) along the several dimensions under the individual and environmental factors. The identification of patterns was deepened and extended while the critical incident stories were kept as narrative structure in the critical incident exploration.
Phase 3	*Data collection*	The third round of data collection was aimed at measuring individual preference and detecting eventual regularities and connections with decision effectiveness. Respondents were invited to take tests on: individual thinking style (REI-40); risk preferences (RTT); and personality characteristics (MBTI).
	Data analysis	The analysis of the interview data of Phase 1 and the tests results allowed the identification of three homogeneous clusters based on a common denominator (Opportunities scouting, Emergency response, Crisis mitigation). The most salient personality traits were isolated and presented by cluster. Thinking styles and risk preferences of the respondents in the three clusters were mapped graphically to show trends and correlations. The ensemble of interview and psychometric data was elaborated to draft a taxonomy of the features and characteristics associated with the highest level of decision effectiveness. The taxonomy was used as an intermediary step to develop a model through a grounded theory approach.

Figure 2: Data structure



Findings

The 'compare and contrast' approach used to analyse the data in the person-situation interactionist framework allowed to aggregate the observations of the considered individual and environmental dimensions into clusters. Each cluster is characterized by peculiar patterns and recurrences that were used to isolate the conditions for decision effectiveness.

Cluster distribution by individual factor and dimension

The study of individual dimensions was performed combining interviews to explore the implications of respondents' role in the organization with psychometric tests to collect evidences on thinking style, risk preferences and personality characteristics.

The MBTI psychometric test was used to investigate eventual regularities in the psychologic features and

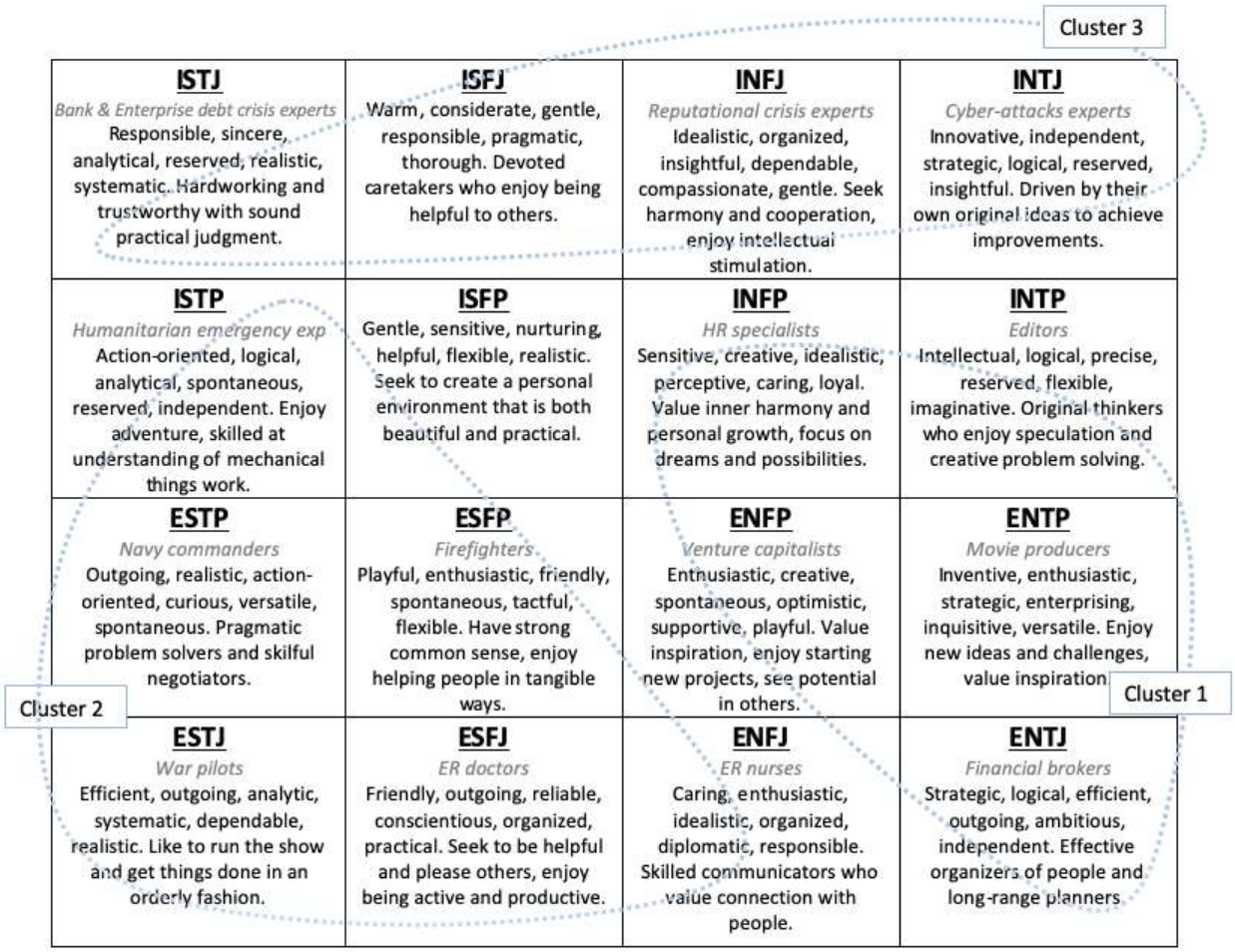
to identify the personality types of the informants (Carlyn, 1977; Carlson, 1985) with due caution to account for its imperfect validity (Tzeng et al., 1984; Cowan, 1989; McCrae and Costa 1989; Pittenger, 1993, 2005). Respondents were reassured that their scores would remain strictly confidential and were thus requested to avoid falsifying their preferences in the attempt to reproduce socially desired traits (Ganster, Hennessey and Luthanks, 1983; Cabral and Joyce, 1991; Kummerow, 1988; Walck (1992).

MBTI test identifies 16 personality types and is articulated in fours scales expressed as dichotomies although each individual displays features of both the functions since he develops a dominant function and an auxiliary function for balancing (Beebe, 2012). The first one is Extraversion-Introversion and compares the extravert type of individuals who are "outward-turning" and action-oriented to the introverts who are "inward-turning" and thought-oriented. The former enjoy frequent social interactions, feel energized after spending time with other people while the latter feel recharged after spending time alone, and enjoy deep and meaningful social interactions. The second scale consists in the contraposition between Sensing-Intuition that refers to how people gather information from the world around them. People who prefer sensing tend to pay a great deal of attention to reality, particularly to what they can learn from their own senses. They tend to focus on facts and details and enjoy getting hands-on experience. Those who prefer intuition pay more attention to things like patterns and impressions. They enjoy thinking about possibilities, imagining the future, and abstract theories (Carey, Fleming and Roberts, 1989; Corman and Platt, 1988). The third scale refers to the preference for Thinking-Feeling namely to how people make decisions based on the information they gathered from their sensing or intuition functions. The individuals with a predisposition for thinking place a greater emphasis on facts and objective data and tend to be consistent, logical, and impersonal when weighing a decision. On the other side, the individuals with a predisposition for feeling are more likely to consider people and emotions when arriving at a conclusion. The last scale is based on the dichotomy Judging-Perceiving that refers to how people tend to deal with the outside world. The individuals who prefer a judging aptitude are more inclined to adopt a structured and firm decision approach. On the contrary, the individuals who lean toward a perceiving aptitude are more open, flexible, and adaptable. A distinctive feature of this dimension is the interaction with the other scales describing whether and how individuals extravert when taking in new information (sensing and intuiting) or making decisions (thinking and feeling) (Barr and Barr, 1989; Myers and Myers, 1980; Myers and McCaulley, 1985, Nutt 1989, 1990).

Although it is obviously impossible to assign all the informants of a given job family to the same MBTI type, some regularities were actually detected and illustrated in the matrix in Figure 3. The scores by gender aligns with the features and preferences already observed in men and women populations in former studies (Myers and Myers, 1980; Sorenson, Hawkins and Sorenson, 1995). In the sample, women

appear slightly more extroverted, leaning for Feeling and Judging while men are comparatively more introverted, leaning on Thinking and Perceiving. Moving up the organization hierarchy, the proportion of decision-makers with intuitive preferences increases vis-à-vis sensing preferences in line with extant literature (Hurst, Rush and White, 1989).

Figure 3: Personality typologies



The comparative analysis of the test results collected during Phase 3 and the evidences emerged from the interviews of Phase 1 and 2 allowed to define the three clusters already portrayed in Figure 2 (Steckroth, Slocum and Sims, 1980; Gardner and Martinko, 1990). The first cluster was assigned the tag of 'Opportunities scouting' and includes: movie producers, venture capitalists and start up incubators, editors and HR officers. The second cluster was assigned the tag of 'Emergency response' and includes: ER doctors and nurses, firefighters, army commanders and humanitarian emergency experts. The third cluster was assigned the tag of 'Crisis mitigation' and includes: experts dealing with ICT cyber-attack, bank crisis, reputational crisis and excessive enterprise debt.

The most salient personality traits of the respondents of each cluster are summarized in Figure 4. On one side, the respondents in Cluster 1 and 2 are characterized by extraversion being more assertive, active, sociable and projected toward the outer world of the environment, organization, group and tasks. On the other side, the respondents in Cluster 3 are characterized by introversion being more reflective, reserved, focused and directed toward the inner world of ideas, beliefs and values (Carlson, 1985; Carlyn, 1977; Myers and McCaulley, 1985). It is worth noticing that no pattern emerged for Thinking-Feeling preferences across the cluster that appear scattered throughout the clusters and the two gender groups. In Cluster 1, we observe a higher degree of polarization compared to the other clusters since its members share three distinctive features namely Extraversion, Intuition and Perceiving aptitude and are inclined toward unconventional and innovative behaviours. The opportunity scouters acknowledged a certain degree of contrariety to streamlined decision rules and protocols and the tendency to reach conclusions based on limited data points or unstructured qualitative analysis. They feel confident in unstructured and dynamic situations and favour more abstract information and perceptual processes. These preferences were in 70% of the incidents associated with decision errors and misleading attributions in line with the conclusions of former studies (Schweiger, 1985; Evered, 1987; Boreham, 1987). At the same time, the holistic outlook of these decision makers allow them to identify opportunities at first sight and perform tacit considerations on the potential of new ideas and projects (Chenhall and Morris, 1991).

The members of Cluster 2 appear extraverted and collaborative with a considerable sensing aptitude. Emergency response specialists appear oriented toward factual data and tend to perceive and process concrete stimuli better. They show a more marked tendency to rely on both initial perceptions and subsequent measurements and evaluations in line with what was observed by Rodgers (1991). Furthermore, they are predisposed toward practical, conventional, detail-oriented and systematic behaviour as already observed by Carne and Kirton (1982), Humter, and Levy (1982)

The members of Cluster 3 appear intuitive but also possess a judging aptitude that leads them to engage in methodical logical analysis and strategic planning. Crisis mitigation is characterised by permanently changing contexts and complex challenges requiring a great capacity to see the big picture, pay attention to explicit and tacit signals and interpret the connections among elements quickly also through heuristics. Crisis mitigation experts are expected to restore order suggesting an action plan to solve the crisis, therefore, a propensity for planning inherent in the judging aptitude is functional to their mandate. These findings resonate with the conclusions reached by Chenhall and Morris (1991).

A further exploration of the individual dimensions was performed through the critical incidents interviews when informants were requested to rate and provide information on their role in the

hierarchical pyramid at the time of the reported incident. Similarly, respondents were requested to rate and inform on their managerial role intended as people coordination responsibility.

The respondents of Cluster 2 are in a slightly higher position compared to the other clusters and show a higher score under managerial level unlike the respondents in Cluster 3.

Opportunities scouters and emergency response experts act in structured organizations with a well-defined hierarchical structure and formalized supervisor role that affect the way decisions are taken introducing rigidities both at the level of the organization and the team (Kriger and Barnes, 1992). However, these constraints are also coupled with benefits deriving from being part of a rigid reporting line like the opportunity to seek for advice from superiors who are ultimately responsible for eventual mistakes and the tacit learning opportunity implied by managing subordinates.

Crisis mitigation experts are not connected to other workers through supervisor linkages and often appear more similar to specialized freelance consultants recruited on specific needs. This temporary and out-of-the-hierarchy role has pros and cons. They are perceived as outsiders and cannot access information easily through the internal formal and informal channels available to insiders but they can manage the crisis using their expertise and creeping into the fighting factions to turn the power games to the advantage of the crisis resolution (Hensgen, Desouza and Kraft 2003).

Figure 4: Personality traits and individual factor and dimensions

				Role in organization	
Professional cluster	Salient personality traits			Hierarchical level	Managerial role
Professional cluster				*Defined layer in the organization pyramid*	*Formalized supervisor/ coordination role*
Cluster 1 *Opportunities scouting*	**Extraversion** Appreciate working in fast-paced environment and work out ideas with others.	**Intuition** Tend to notice the big picture and try to understand connections and possibilities. Figurative approach.	**Perceiving** Appreciate improvisation and spontaneity. Prefer to leave options open.	M	M
Cluster 2 *Emergency response*	**Extraversion** Appreciate working in fast-paced environment and work out ideas with others.	**Sensing** Focus on reality. Pay attention to facts and details and prefer ideas with practical application. Descriptive approach.		H	H
Cluster 3 *Crisis mitigation*	**Intuition** Tend to notice the big picture and try to understand connections and possibilities. Figurative approach.	**Judging** Prefer to have matters settled. Respect rules, deadlines, detailed instructions. Plan ahead.		M	L

As part of the analysis on individual dimensions, respondents took also the Rational-Experiential Inventory (REI) (Epstein, Pacini and Norris, 1998; Pacini and Epstein, 1999) and a Risk Taking Test (RTT) developed in line with the categories defined by MacCrimmon and Wehrung (1985) for Risk Taking Propensity Measure (RTPM) that are hypothetical, standardized scenarios and self-report attitudes toward risk. These tests represent the thinking style and risk appetite of individuals in a given moment in time and do not account for the evolution of the preferences throughout the professional career (Figure 4).

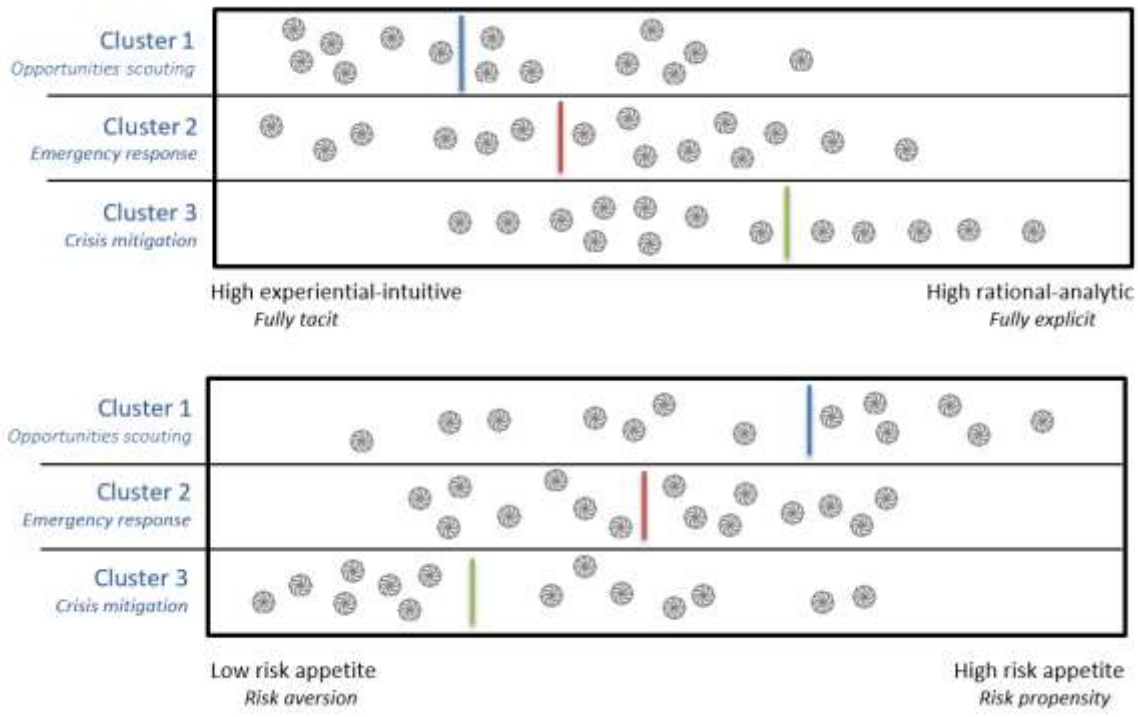
REI is used to investigate rational, holistic and inferential thinking and the role of cognitive preferences in decision-making. The results of this test were elaborated to produce a compact indicator of preference for rational versus experiential thinking. The four subscales composing REI (Rational Ability, Rational Engagement, Experiential Ability, and Experiential Engagement) were aggregated in two scales calculating the average for rational and experiential abilities. These two synthetic indicators were combined into a single one subtracting the scores of the experiential scale from the ones of the rational scale (values interval: -5; +5). REI scores confirm what was observed in former studies namely that experts report higher level of experiential-intuitive thinking (Pretz et al, 2014; Sadler-Smith and Shefy, 2007; Sinclair and Ashkanas, 2005).

As you can see in Figure 5, the cluster with the most marked predisposition for rational-analytic thinking is the crisis mitigation one. On the contrary, individuals in the emergency response and the opportunities scouting clusters show respectively slight and marked preferences for experiential-tacit thinking. This distribution suggests that the professionals of job families such as venture capital, publishing, movie production, start-up incubators or HR are naturally more confident in the use of gut feeling and rely on their perceptions. The emergency response professionals position in the middle possibly due to an intrinsic tendency to balance analytical approach and perceptions in fields characterized by high stake and urgency but also by protocols and guideline (Phillips, Klein and Sieck, 2004; Klein, Calderwood and Clinton-Cirocco, 1988).

It is worth noticing that the MBTI was used primarily to draft a psychologic identikit of the informants but contributed also to map the perceptive-intuitive and the rational-analytic systems in combination with the REI test. In fact, as revealed by a comparative study by Pretz and Totz (2007), these measures were developed accounting for two different constructs of perceptive-intuitive thinking. More specifically, it was observed that the MBTI intuitive/sensate subscale measured holistic intuition only whereas the REI experiential subscale assessed intuition in a more general sense combining holistic and inferential intuitive thinking.

The risk appetite of respondents was mapped through a risk propensity test (RTT) whose results spanning from 31.78 to 86.83 were aggregated and sorted along a 11-item scale (values interval: 0; +11). As Figure 5 shows, the results of the risk propensity test (RTT) mirror the distribution of the REI test scores with the crisis mitigation experts essentially risk averse, the emergency response specialists risk neutral and the opportunities scouters more risk prone. The risk aversion of crisis mitigation experts clashes with the risk tolerance profile of Intuitive-Feeling and Intuitive-Thinking individuals (Gardner and Martinko, 1996). However, it fits with a professional mandate aimed at restoring the order of a derailed situation and reducing the contextual risk profile. The risk neutrality of emergency response experts matches the profile of a cautious decision maker who is deeply aware of the potentially disruptive consequences of his actions and try to avoid at any cost prejudice for human safety still keeping a cool head. Nonetheless, navy commanders, war pilots and humanitarian crisis experts are more risk averse than what the nature of their profession might suggest. The high-risk appetite of opportunities scouters configures as a necessary feature for professionals whose objective is to appraise the value and potential of business ideas, projects and individuals. This value creation mandate responds to the law of high return for high risk (Mukherjee, 2010; Barbosa, Gerhardt and Kickul, 2007).

Figure 5: Individual thinking style and risk preferences



A general trend is that more experienced decision makers have higher levels of risk appetite; higher levels of experiential intuitive thinking are associated with higher risk appetite whereas higher levels of rational-analytic thinking are associated with lower risk appetite. No appreciable effect of gender on decision effectiveness was detectable. This shows that experienced female decision-makers overcome the decision confidence deficit observed among novices.

Cluster distribution by environmental factor and dimension

In order to simplify the presentation of the findings, we will introduce the evidences connected to the organization style of the job families covered by the analysis (Figure 6). Subsequently, we will focus on what emerged investigating the characteristics of the situation in which the key decisions examined in the study were taken. Lastly, we will present the evidence that emerged in relation to the composition of the decision team.

When we look at the organization style, we notice that the decision-makers of the emergency response cluster act in an environment with the highest number of procedures. This construct differs from routines (Feldman and Pentland, 2003) and is defined as an organizational space marked by well-defined guidelined and protocols due to the need to minimize risk for human life and liability for decision-makers (Dean and Sharfman, 1993). At the opposite end, we find the crisis mitigation experts who do not work based on streamline procedures due to the project-based nature of their activities whereas in an intermediary position we find the decision makers of the opportunities scouting cluster who need semi-rigid procedures to adapt to new business opportunities rapidly. For what refers to hierarchization, we observe that the cluster operating in the context with the most rigid reporting line is the emergency response, followed by the crisis mitigation and then by the opportunities scouting cluster. This distribution reflects the pyramidal structure of the organizations and the level of risk and stake inherent in a given job family (Cabantous, Gond and Johnson-Cramer, 2010).

The situational dimensions related to the decision context we considered in the study are four: familiarity (Klein, 1989, 2003), information quality (Salas and Klein, 2001; Sadler-Smith and Shefy, 2004), uncertainty (Khatri and Ng, 2000; Lipshitz and Strauss, 1997; Hensman and Sadler-Smith, 2011) and the combination of time pressure, stake and perceived risk (Orasanu and Connolly, 1993; Klein, Calderwood, and Clinton-Cirocco, 1986). The last was predictably higher in the emergency response cluster, average in the crisis mitigation and lower in the opportunities scouting cluster. Familiarity intended as absence of novelty is a key dimension to interpret automatic decisions suggested by intuition and relates to the internalization of a repertoire of patterns. The highest level of familiarity is achieved by the decision-

makers of the emergency response cluster who develop a deep sense of typicality dealing recurrently with situations with similar characteristics. This phenomenon is slightly less marked in the opportunities scouting cluster while it becomes very modest in the crisis mitigation cluster due to the very peculiar and original features of each critical event.

The crisis mitigation experts, moderate by the emergency response professionals and low by the opportunities scouters, deem the average quality of the information available high. The crisis mitigation decision-makers benefit of more complete and abundant information compared to their emergency response fellows as they get into action in response to a specific crisis and they are usually put in the position to obtain direct access to the information upon request by the organizations. The emergency response decision-makers act in conditions of severe time pressure and high stake that reduce their possibilities to collect quality information. The opportunities scouting decision-makers experience considerable information asymmetries and perform appraisals on the potentialities of enterprises, projects, and people based on scanty or preliminary data. The last dimension related to the characteristics of the decision situation considered in the study is uncertainty that is predictability a pervasive feature for all the clusters. The crisis mitigation experts reported a higher level of perceived uncertainty because each crisis is significantly different from the rest. This lack of typicality does not allow decision makers to identify patterns or to read recurrent patterns to break the uncertainty perception. Similar motivations explain why the decision-makers in the opportunities scouting cluster perceive a medium level of uncertainty. At the other end of the spectrum, the emergency response experts rely on their repertoire of internalized patterns developed through repeated exposure to similar cases to make sense of situations that appear less uncertain.

The two dimensions related to the team composition we examined are the collaboration duration and frequency and the level of trust among the team members. The teams of the emergency response cluster are characterized by higher continuity in the collaboration, followed by the opportunities scouting and the crisis mitigation cluster. This pattern is the result of the aggregation modalities that regulate how teams are formed throughout the fob families. The emergency response cluster contains professional groups such as ER doctors and nurses, firefighters and army commanders who collaborate with the same colleagues on a regular basis. Something similar happens to the opportunities scouting cluster but with a slightly lower magnitude. On the contrary, the crisis mitigation experts do not entertain frequent collaborations with the same people due to the nature of crisis management. Trust within team members follow the same pattern of the collaboration stability confirming that duration and frequency matter to create an environment of mutual trust. For the emergency response experts, trust is highly correlated to stake and perceived risk since the situational force majeure often force the decision-makers to rely on

each other to rescue or preserve human life. The crisis mitigation experts report the lowest levels of trust because often the culprits of the critical accident or their followers converge in the crisis management team and try to manipulate information and opinions.

Figure 6: Patterns by cluster throughout the environmental dimensions

	Organization style		Situation characteristics				Team composition	
Professional cluster	Proceduralization	Hierarchization	Time pressure, stake, perceived risk	Familiarity	Information quality	Uncertainty	Collaboration stability	Trust
Group of job families	*Well-defined guideline and protocols*	*Rigid and pyramidal reporting line*	*Stress and perceived pressure*	*Non novelty*	*Info completeness and abundance*	*Non predictability haziness*	*Duration and frequency*	*Mutual reliance*
Cluster 1 ***Opportunities scouting***	M	L	L	M	L	M	M	M
Cluster 2 ***Emergency response***	H	H	H	H	M	L	H	H
Cluster 3 ***Crisis mitigation***	L	M	M	L	H	H	L	L

A taxonomy to map the dimensional manifestations associated with superior decision effectiveness

As indicated in Figure 7, the outcome of the comparative analysis on the epilogues of the decisions inspected through the critical incident cases highlighted a number of individual and environmental features associated with high decision effectiveness.

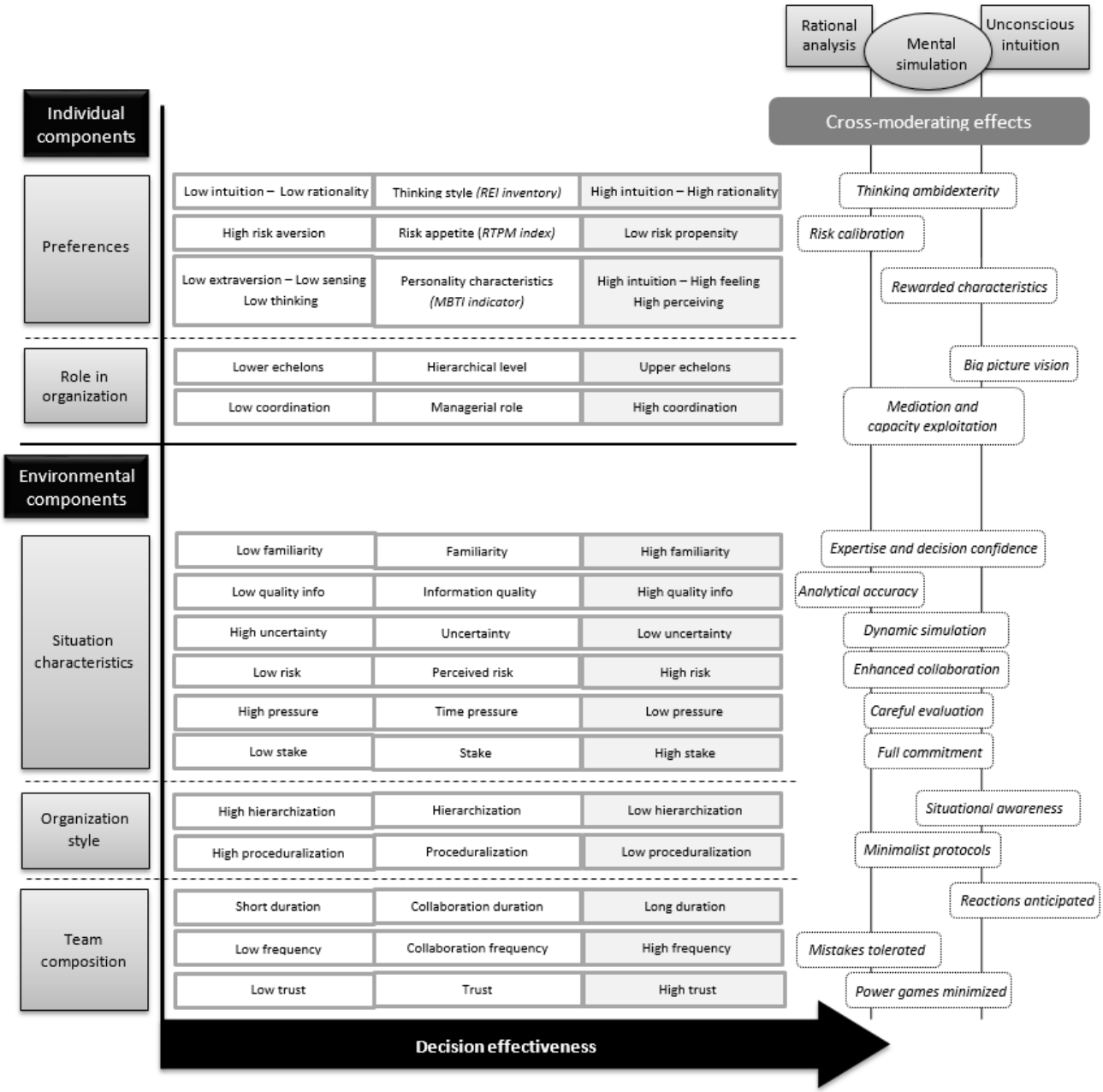
On the side of individual features, effectiveness of complex decisions reaches its highest level when decision-makers can rely on a mixed thinking style then combining both high intuition and high rationality (Hodgkinson, Langan-Fox and Sadler-Smith, 2008). Decision performance is superior when decision-makers' risk appetite is low and their personality profile is characterized by 'high intuition', 'high feeling' and 'high perceiving' (Thorne and Gough, 1991). These features imply marked perceptive skills and permit to complement the analytical approach with tacit skills (Sadler-Smith and Shafy, 2007). Senior executives show superior wisdom and judgement capacities in defining effective course of action (Klein, 2008). However, their decision mastery should not be interpreted as a consequence of their hierarchical position but rather as a cause. Indeed, top executives combine ambition, dedication and talent to climb the organization hierarchy (Hurst, Rush and White, 1989). The good decision performance of these executives derives also from the abilities they develop coordinating people. Being a team leader requires high diplomatic skills to neutralize tensions and bring out the best in people (De Dreu, 2008).

On the side of environmental features, the highest decision effectiveness is noticed in presence of familiarity with the tasks and the context (Klein, 2003), availability of complete and good quality information (Salas and Klein, 200) and limited uncertainty (Khatri and Ng, 2000). These conditions allow the adoption of a full-round intertemporal vision rather than limiting the situational assessment to short-term myopic considerations (Klein, 2008). Surprisingly, decisions taken in contexts characterized by high stake and high perceived risk were associated with high effectiveness due to the required focalization and exclusive attention (Klein, Calderwood, and Clinton-Cirocco, 1986). Less surprisingly, time pressure resulted a hindering factor for effective decisions as it leads to inaccurate judgments and biased interpretations (Leybourne and Sadler-Smith, 2006).

At the level of the organization style, high hierarchization and cumbersome procedures turned out to be a source of ineffectiveness as they hinder decision autonomy. This status is sometimes welcome by risk averse decision-makers who consider the binding reporting line reassuring. On the contrary, risk prone experienced executives enjoy freedom along the reporting line and value organizations that acknowledge their judgemental and decision abilities. They are less eager to exchange decision freedom for security and prefer to shape ad-hoc processes based on situational specificities (Cabantous, Gond and Johnson-Cramer, 2010).

At the level of the team, durable and frequent collaborations improve the effectiveness of collective and individual decisions within teams. Decision-makers feel more confident when the decision environment is not hostile as this promotes team cohesion and allows members to become gradually more and more close-knit and focus on problem-solving (Ancona, 1990). When team members can rely on each other, a relaxed environment is gradually created. Internal tensions are neutralized and nobody fears potential intrigues. In this way, more time and resources are available for creative work and profitable interaction to the benefit of decision efficacy (Lee et al, 2010).

Figure 7: Dimensional features of effective decisions and cross-moderating effects



Discussion

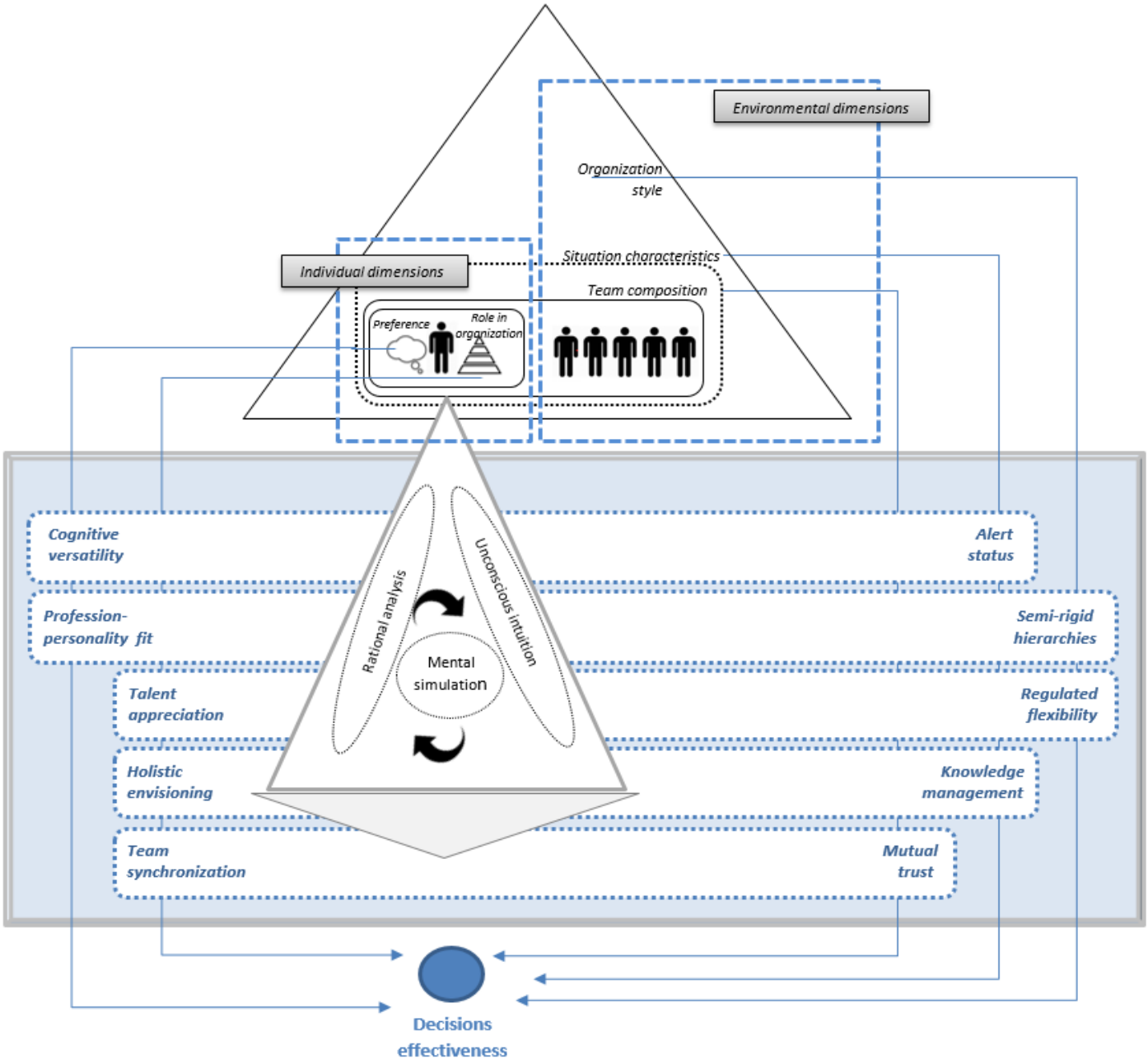
Cross-moderating effects bridge different dimensions of the individual and environmental factors

As already stated, in this research we started investigating how features of the decision-maker individual preferences and characteristic interact with the environment features of the decision space. The emergent

interactions were subsequently interpreted in view of their impact on decision effectiveness. In this exercise, we functionally used the construct of cross-moderating effects to connect different dimensional levels. These potentiate the effect of a given feature when it connects to another from a different dimension. This analysis produced a set of five most prominent multidimensional conditions that are associated with the highest level of decision effectiveness.

Each condition reproduces a locus of superior effectiveness that is characterized by mutually enhancing features that refer to both the individual and the environmental dimensions. The cross effect ultimately strengthens the decision performance.

Figure 7: A multidimensional model of decision effectiveness conditions



Multidimensional decision effectiveness conditions

Multidimensional condition I: Decision-makers with high cognitive versatility take better decisions in alert status

In the first locus, decision-makers are endowed with a high degree of cognitive versatility that allows them to master both analysis and intuition in a sort of thinking ambidexterity (Hodgkinson et al, 2009). This ability to balance tacit and explicit skills help the decision maker to calibrate risk. The capacities of these decision-makers are exalted by situational features such as high stake and high perceived risk (Akinci and Sadler-Smith, 2012). These extreme conditions impose full commitment and promote collaboration (Klein and Woods, 1993). In such a context, the decision-makers who are capable of maintaining coldness and lucidity can perform careful evaluations, run dynamic cognitive simulations, and test the reliability of perceptions and gut feeling through rational control.

Multidimensional condition II: Decision-makers with a high level of "profession-personality" fit take better decisions in semi-rigid hierarchy organizations

In the second locus, decision-makers with good perceptive skills work in professional environments that require and reward their characteristics as they unconsciously seek for a job that match their pretensions and tacit abilities (Edwards, 1991). This match grants them a more rewarding and fulfilling working experience that culminates in very high quality decisions when there are no binding constraints (Hurst, Rush and White, 1989). These decision-makers attach a great value to autonomy as they have a natural tendency for experimentation and empirical validation of the decisions (Leonard and Swap, 2005). This approach allows them to develop deep situational awareness because they feel suitable and qualified to do their job and are able to enforce their motivations before the supervisor. Organizations characterized by semi-rigid hierarchies are the most able to capitalize the abilities of these decision-makers.

Multidimensional condition III: Decision-makers capable of holistic envisioning take better decisions when their judgments are substantiated by their own knowledge management arrangements

In the third locus, middle and top management decision-makers see the big picture better thanks to the professional wisdom achieved through experience. Practice and repeated exposure make seasoned executives familiar with tasks and situations contributing to the formation of complex cognitive schemes (Clarke and Mackaness, 2001). These schemes are deeply connected to the degree of expertise of each decision-maker and allow grasping also the non-apparent connections between phenomena (Hough and

Ogilvie, 2005). These superior situational judgements conduct to the best choices when decision-makers value information and certainty and set up their own knowledge management arrangements (Turner and Makhija, 2006). The combination of information care and full-round vision allows experienced decision-makers to perform accurate analysis, reduce uncertainty and increase decision confidence.

Multidimensional condition IV: Ability to recognize and appreciate talent in organizations characterized by regulated flexibility

In the fourth locus, decision-makers with people coordination responsibilities are strategic and cautious because of their team-leader role that requires high diplomatic skills to neutralize tensions and bring out the best in people. Indeed, managing a team polishes mediation skills and fosters the ability to assign tasks exploiting the talent of each team member (Currie and Procter, 2005). This is made possible by procedures that allow adaptable tasks assignation and variable geometries in team management (Marks, Mathieu and Zaccaro, 2001). A minimalist framework of essential checks and balances creates an ideal space for decision makers to elaborate insightful and effective courses of action autonomously. When protocols can be relaxed without compromising image or operations functionality, the comparative advantage of each worker is maximized to the benefit of individual and collective decisions.

Multidimensional condition V: Synchronized teams whose members are connected through linkages of mutual trust converge on effective decisions

In the fifth locus, long and frequent collaborations allows team members to rely and attune with each other and to learn how to anticipate reactions and eventually feel more confident. In an environment without hostility, mistakes are tolerated and thanks to cohesion, decisions can be weighed up through the proof-of-facts (Ayoko, Callan, and Härtel, 2008). Confidence in the spirit of the group plays a catalytic effect as it infuses a problem-solving aptitude to the teamwork (Jordan and Troth, 2004). In this relaxed environment, all team members feel connected and perceive the others as reliable; therefore, internal tensions are neutralized and less time and effort is needed to minimize power games. In this way, more time and resources are freed for creative work and profitable interaction to the benefit of decision efficacy.

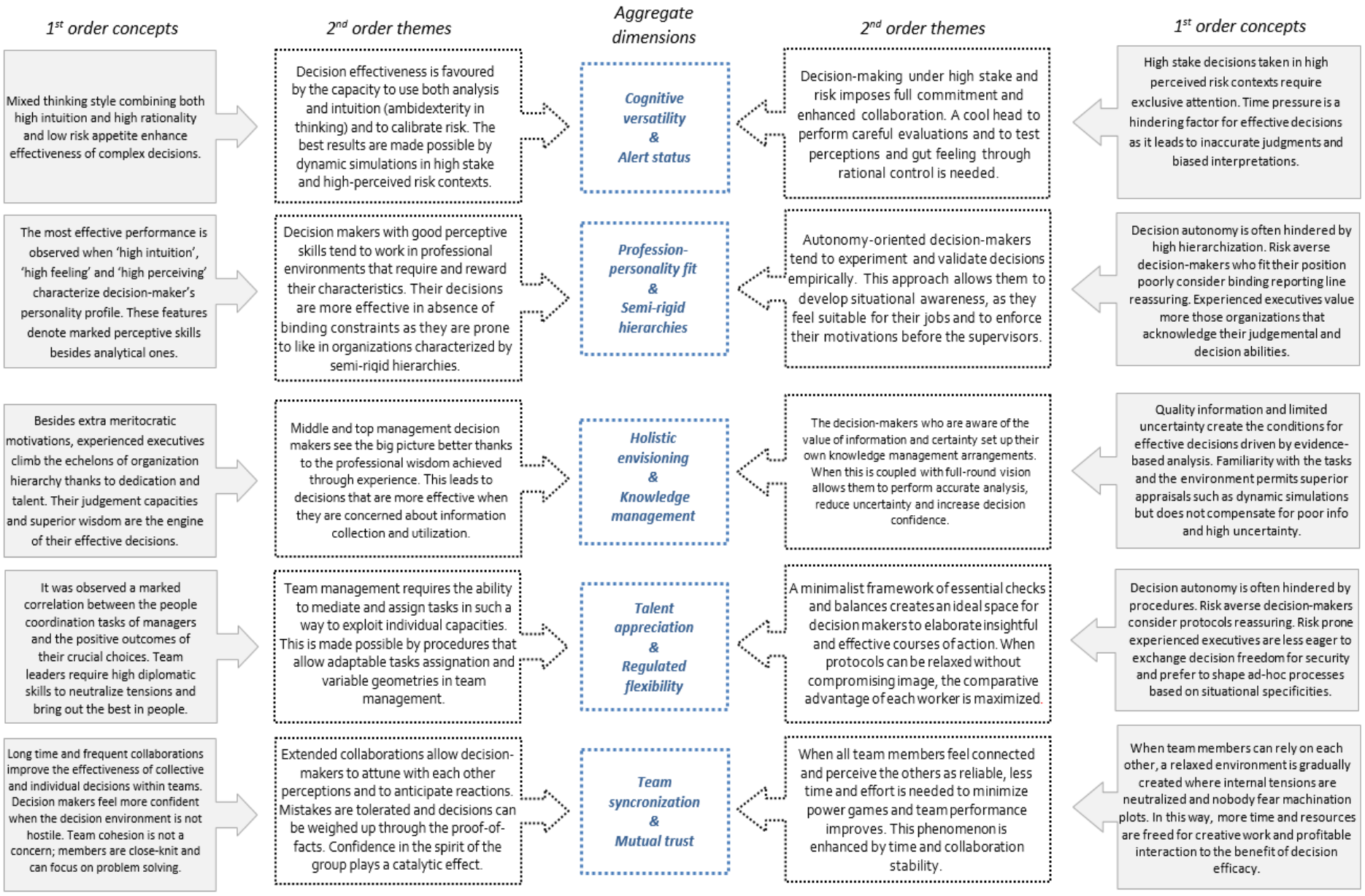
Conclusions

This empirical study led us through different job families and situations characterized by different contextual features. All this diversity was a source of plentiful richness and complexity at the same time. After several rounds of extensive and thorough data analysis, we detected patterns and cross-dimensional factors and defined five multidimensional conditions of decision effectiveness. These conditions suggest just as many considerations on how organizations can nurture good decisions acting on several levels that span from the individual, through the team, to the corporate level.

The organizations acting in domains where tension, stake and risk are habitually high are the ones that need cognitively versatile workers the most. The organizations that set high recruitment standards assessing both technical and hard skills, tacit and soft skills and job-personality fit do not need rigid hierarchies, as their workers tend to perform very well autonomously. Organizations that excel at retaining experienced executives and promoting the development of individual-, team- and corporate-level knowledge management arrangements and systems indirectly promote strategic decision effectiveness. When senior executives assign tasks to their subordinates who are best placed to perform them, this increases the chances that the designated decision-maker will produce effective results without the need of cumbersome procedures. Organizations should promote trust through team building initiatives as this has an indirect positive effect on decision effectiveness.

This study is not without limitations mostly connected to the size of the respondents sample and the numerous additional dimensions that remained unexplored. These constraints might represent opportunities for future research. Most specifically, decision researchers may focus on a larger data collection scale on single professional domains and possibly engage in comparative analysis. Similarly, they could expand the study to further environmental and individual dimensions such as leadership style, project-based corporate structure, intercultural team composition and so on to detect additional effectiveness conditions.

Annex 1: Data table



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Mentoring and the promotion of self-confidence in decision-making: the role of cognitive awareness and expertise building through the lenses of rationality and intuition

Introduction

The debate on how to improve decision-making was framed in different terms by the several literature strands dealing with decision theory. The rational decision theorists claim that the decision process can be enhanced through the application of streamlined analytical approaches such as practical tools, prescriptions, and ad-hoc decision methodologies (von Neumann and Morgenstern 1947; Edwards et al.,1963; Hammond, Keeney, and Raiffa, 1999; Russo, Schoemaker, and Hittleman, 2001). The Heuristics and Biases scholars suggested the development of domain-general decision skills with the objective to eliminate biases (confirmation, representativeness, availability, anchoring, etc.) and other sources of decision error (Kahneman and Tversky, 1973, 1979). The intuition scholars claim that intuition can be educated and nurtured (Sadler-Smith and Shefy, 2007; Sadler-Smith and Burke, 2009; Hogarth, 2003) leveraging on intuitive intelligence that is the capacity to understand, apply, and develop one's intuitive judgment based on three components: understanding intuition, intuitive expertise, and intuitive self-awareness (Sadler Smith, 2016). The Naturalistic Decision Making researchers supported an alternative view claiming that the most suitable approach is through the development of domain-specific expertise through guided experience techniques to improve mental models (Rouse and Morris, 1986), refine the sense of typicality and associations through repertoire of patterns (Ericsson and Smith, 1991; Newell and Simon, 1972; Chase, 1983; Dreyfus, 1997; Gentner, 1988), and develop the ability to run mental simulations (Einhorn and Hogarth, 1981; Kahneman and Tversky, 1982).

This multiplicity of approaches provided diversified directions to practitioners and inspired some empirical researches. In this paper, we argue that decision-making is not a science but an art and requires the capacity to select the most suitable approach through vision, sound analytical and technical competences and the flexibility to dose intuition and rationality. The application of rational-analytic approach to all situations is not possible and in some cases in even detrimental. The intuitive-tacit approach is reliable only when the decision-maker is experienced and capable as explained by the 'intuition-as-expertise' view and requires careful self-examination and questioning.

This research is framed within the setting of the Dual-process theory, however, it aligns with the newest literature that postulates the absence of rivalry in information processing between rationality and intuition that are considered interdependent and osmotic (Hodgkinson and Sadler-Smith, 2003). A number of solutions could be explored to allow organization decision-makers to nurture their tacit and deliberate abilities and to make the most out of the synergies between the tacit-experiential and the deliberate-analytic components of thinking and decision-making.

We decide to use mentoring as a tool to explore solutions on how to improve decision-making facilitating at the same time the acquisition of expertise in specific domains within organizations (Agor, 1989; Claxton, 1997, 2000; Khatri and Ng, 2000; Leonard and Straus, 1997; Parikh, 1994; Sadler-Smith and Shefy, 2004). An on-the-job mentoring programme became the treatment of a field experiment to study the effect of the combination of enhanced cognitive awareness and improved comprehension of the expertise-building dynamics on individual self-confidence in decision-making. This field experiment overcomes the individualistic conception of a single person working on his or her subconscious sphere to improve personal attitude toward analytical or intuitive thinking but prefers a joint dynamic based on the interaction of a mentor and a mentee.

The study was conducted at a United Nation organization involving 20 mentoring couples in the treatment group and 20 couples in the control group over a nine month period. In the study we tested four hypothesis on the effect of continuous learning, mindful teaching, rational-analytical thinking and experiential-intuitive thinking on decision confidence. The mentoring programme was conceived to overlap real life experience and consists of an inception presentation, the administration of a psychometric test to measure cognitive style accompanied by the provisions of feedback, a decision game and two applications.

The analysis was conducted applying both a one-way ANOVA (with post-estimation tests Bonferroni and Tukey) and the difference-in-differences regression technique to depurate the results from the effect of the counterfactual from the control group. The treatment had a positive significant effect on the self-confidence in decision making and we obtained sufficient evidences to support two hypothesis, limited evidences to support another one and no evidences to support the last one.

Theoretical framework

The debate on how to improve decision-making

Decision-making belongs to the category of higher order thought together with critical thinking, problem solving, and creativity, which makes it difficult to teach (Nickerson et al. 1985; Perkins 1995). Nonetheless, scholars have been debating on which is the most suitable approach between normative and descriptive arguments. The normative approach provides the adoption of formal methods informed by universal principles of rational choice while the descriptive approach claims that effective and ineffective decision practices can be adopted or avoided depending on the results of empirical research (Smith, 1986).

Different literature traditions suggested numerous alternative techniques with a marked contraposition between the Rational and Behavioural Decision researchers focused on rationality-centred tools and the Intuition and Naturalistic Decision-making researchers focused on intuition-centred tools. A review of all these approaches is beyond the scope of this work; however, we will mention the main tools for each of the strands of literature that treated this topic.

The approaches to improve decision-making proposed by Rational and Behavioural Decision Theorists

Rational decision theorists developed normative rational models connected to the economic theories of choice and expected utility (von Neumann and Morgenstern 1947), multi-attribute utility theory (Keeney and Raiffa 1993), social judgment theory (Brehmer and Joyce 1988), and Bayesian inferential methods (Edwards et al. 1963). These authors assumed that the decision process can be enhanced through the application of streamlined analytical approaches following processes that are closer to normative standards, and that eliminate biases (Hammond, Keeney, and Raiffa, 1999; Russo, Schoemaker, and Hittleman, 2001). In this rationality-driven view, decision-making is a matter of choosing from a set of alternatives whose outcomes is evaluated in terms of preferences. In this setting, the deviations are foreseen as contingencies and uncertainty is modelled probabilistically (Hastie and Dawes 2001). Rational decision researchers have translated these principles into practical tools, prescriptions, and ad-hoc decision methodologies (von Winterfeldt and Edwards, 1986; Edwards and Fasolo, 2001) such as decision trees, influence diagrams, multi-attribute utility analyses and so on (Clemen and Reilly, 2001).

Behavioural decision theorists raised doubts on the validity of rational decision theories arguing that the model assumptions are not realistic (Herbert Simon, 1955). A number of assumptions were

refuted due to persistent behavioural violations of rational norms (Einhorn and Hogarth, 1981), biased probability judgments (Kahneman et al., 1982), unstable preference structures (Payne et al., 1992) and irrational behaviours (Shafir and LeBoeuf, 2002). These difficulties contributed to a "rationality critique" that eventually challenged the overall model validity (Shafir and LeBoeuf, 2002). Behavioural decision theorists claimed that decisions can be improved fostering the development of domain-general skills with the objective to recognize and avoid biases (confirmation, representativeness, availability, anchoring, etc.) and to eliminate other sources of decision error (Kahneman and Tversky, 1973, 1979).

The approaches to improve decision-making proposed by Intuition Decision Theorists

In the 1990s, we assisted to a sort of "intuition boom" that brought attention to the subconscious cognitive processes that influence decisions besides rational analysis, namely the tacit mental dynamics associated with hunches and gut feeling. According to cognitive scientists (CITE) and in line with Simon's position (1987), the main source of intuition is past experience as it is essentially a form of tacit knowledge accumulated unconsciously through repeated exposure to a given activity or environment. Until mid-2000s, scholars had not converged on a single definition of intuition (Dane and Pratt, 2007; Sinclair and Ashkanasy, 2005). In 2007, Dane and Pratt defined it as "affectively charged judgments that arise through rapid, non-conscious and holistic associations". In that decade, researchers agreed to consider intuition as the result of patterns recognition allowed the development of a wide range of mental schemes (Dane and Pratt, 2007; Hodgkinson et al, 2008; Hodgkinson et al, 2009; Miller and Ireland, 2005; Sadler-Smith and Shefy, 2007). From this starting point, psychological research used the human ability to acquire knowledge without being aware of it to explain how decision makers resort to the tacit knowledge they accumulated through many years of learning, experience and feedback in their domains of specialization. This marked the origin of the conception of 'intuition-as-expertise' that interprets it as tacit or unconsciously held knowledge acquired through implicit learning (Lieberman, 2000).

Intuition decision theorists maintain that intuition can be educated and nurtured (Sadler-Smith and Shefy, 2007; Sadler-Smith and Burke, 2009; Hogarth, 2003) leveraging on intuitive intelligence that is the capacity to understand, apply, and develop one's intuitive judgment based on three components: understanding intuition, intuitive expertise, and intuitive self-awareness (Sadler Smith, 2016). In their view, intuition nurturing is made possible through several techniques aimed at attuning conscious and unconscious minds. Since much behaviour occurs automatically and has been enacted before people are consciously aware of it, Hogarth (2003) urged the use of 'circuit

breakers' of the subconscious, automatic behaviour to allow the deliberate system to control reactions. Sadler Smith and Shafy (2007) formulated seven recommendations to nurture intuition and remarked the distinction with instinct and insight. These authors encouraged decision-makers to leave to the intuitive mind the freedom to roam and to log its production before it is censored by rational analysis; elicit feedback to create a good learning environment; explore feelings, hunches and intuitive judgments to benchmark and assess their reliability. Furthermore, they recommend using imagery to visualise potential future scenarios, play devil's advocate to challenge intuitive judgments, generate counterarguments and ultimately validate intuitions. In addition, Sadler Smith and Shafy (2004) advocated the adoption of mindfulness, a state of consciousness based on focusing the attention on present moment to grasp the stimuli of the environment and to attune gradually to one's own non-conscious processes. These authors offered guidelines for the development of intuitive awareness, which were implemented successfully on MBA programmes. Hodgkinson and Clarke (2007) started from the dual-process conceptualization of cognitive styles and strategies to remark the centrality of cognitive self-awareness. This should be developed to extend the mental faculties decision-makers can rely on. On the same note, Hodgkinson and colleagues (2009) stated that 'managers' intuition in the workplace can be leveraged by developing individuals' expertise, self-awareness and reflexivity and that they should achieve a requisite blend of intuitive and analytical competencies besides developing a shared understanding of intuitions on a subjective and experiential basis. These authors defined a set of lessons for managers who want to improve their decision skills. They focused on four key points: acquiring intuitive expertise mixing experiential and conceptual/analytical knowledge through exposure to challenging problems; developing self-awareness over one's cognitive style; selecting team members based on competence, diverse cognitively styles and encouraging the most intuitive people to use stories to transfer their gut feeling; recognizing that situations that demand creativity also demand intuition. It should be noted that the expertise-based nature of intuition does not subtract it to important concerns on its validity and reliability also considering that one of its peculiar feature is the feeling of knowing without being able to explain how and why (Myers 2002; Miller and Ireland 2005).

The approaches to improve decision-making proposed by Naturalistic Decision-making theorists

The Naturalistic Decision-making researchers reached the same conclusions on the nature of intuition reached by the Intuitive Decision-making scholars although working separately. Based on the evidences of large empirical studies, Gary Klein (2009), the most prominent author of the Naturalistic Decision-making current, developed the recognition-primed decision (RPD) model

(1989). This model rests on the idea that people orient their judgements through prior experience that is crystalized into mental schemes. The concept of scheme was borrowed from cognitive psychology and is used in the RPD to categorize situations (Klein, 2007). In Klein's words, "when experts recognize anomalies, using judgments of typicality and familiarity, they are detecting violations of patterns in the external situation". Experts sometimes experience "an emotional sense that something is not right" (Klein, 2003) caused by an involuntary appraisal rooted in "intuitive information processing system" (Salas et al, 2010). In this view, intuition is interpreted as the consequence of clues reading and patterns recognition (Kahneman and Klein, 2009). Indeed, experienced decision-makers unintentionally compare the characteristics of the current situation against their internalized repertoire of patterns. The outcome of this appraisal informs the judgments and decisions of experts while novices, who do not have yet complete cognitive schemes, are unable to formulate similar unconscious evaluations (Klein, 2003).

The RPD model is also an attempt to reconcile intuition and analysis through mental simulation that connects the tacit-intuitive (System 1) component and the explicit-analytical (System 2) component of the cognitive process that informs decision-making (Klein et al., 1986). Once a violation from the patter is subconsciously detected, the decision-maker engages in conscious mental simulations to define the best course of action to adopt. The simulation is a projection into the future to imagine the evolution of the current situation. This dynamic simulation is possible provided deep knowledge of the main mechanisms that regulate a given situation (Klein, 2003). This projective ability of the mind is acknowledged also by Sadler Smith (2014). This author aligned to the vision that sees dynamic simulation as a propagative function enabling experienced decision makers to project into the uncertain future and make sense of information, which would appear fragmented to a novice.

According to the Naturalistic Decision-making researchers, decision-making skills can be enhanced through the development of substantive, domain-specific expertise. The acquisition of decision-making expertise in specific domains can be facilitated by the adoption of well-structured, scenario-based training sessions (Klein and Militello, 2003). These learning activities aim to improve the perceptual skills of decision-makers namely the ability to make fine discriminations (Klein and Hoffman, 1993), improve mental models (Rouse and Morris, 1986), and refine the sense of typicality and associations through repertoire of patterns (Ericsson and Smith, 1991; Newell and Simon, 1972; Chase, 1983; Dreyfus, 1997; Gentner, 1988). Decision abilities improve when decision-makers expand their 'know-how', the variety of their tactics for getting things done (Anderson, 1983), their explicit and tacit knowledge (Klein and Militello, 2003), and the ability to run mental simulations (Einhorn and Hogarth, 1981; Kahneman and Tversky, 1982). In essence, decisions become gradually

more effective when the decision-maker becomes an expert and is able to spot anomalies, detect problems (Feltovich, Johnson, Moller, and Swanson, 1984; Kobus, Proctor, Bank and Holste, 2000) and to take into account his own limitations (i.e., metacognition) (Simon, 1975; Larkin, 1983; Chi, Feltovich, and Glaser, 1980; Chi et al., 1981; Chi, 1978). Lastly, decision skills are fostered when decision makers become able to use leverage points and mental simulation for improvisation (Klein and Wolf, 1998; Klein, 1998), and to manage uncertainty (Lipshitz and Strauss, 1997; Schmitt and Klein, 1996).

Decision-making in the frame of Dual Process Theory

The dichotomy that depicts decision-making as the product either of a rational cognitive model or of an intuitive model was reinforced by the Dual Process Theory of human mind (Evans and Over i996; Sloman, 1996; Stanovich, 1999; Kahneman, 2003). This is also named 'Two minds model' and coincides with the duality between the two contrasting modes of thinking we already mentioned: System 1 and Systems 2 (Epstein, 2002; Gollwitzer and Bayer, 1999; Sloman, 1996).

System 1, which from an evolutionary perspective is believed by some to be the older of the two (Epstein, 1994; Reber, 1992), entails a mechanism of information processing and learning that is automatic and relatively effortless (Stanovich and West, 2000; Kahneman, 2003; Stanovich and West, 2000). This system, which allows individuals to learn from experience and reach perceptions of knowing without conscious attention (Hogarth, 2001), has been referred to as experiential (Epstein, 1990, 1994, 2002; Epstein, Pacini, Denes-Raj, and Heier, 1996; Pacini and Epstein, 1999), automatic (Bargh, 1996; Bargh and Chartrand, 1999), tacit (Hogarth, 2001), natural (Tversky and Kahneman, 1983), associative (Sloman, 1996). It is affect laden, parallel, fast in operation, slow in formation, holistic, involuntary, cognitively undemanding, imagistic and unavailable to conscious awareness (Epstein, 2008; Evans, 2008).

System 2 enables individuals to learn information deliberately, to develop ideas, and to engage in analyses in an attentive manner. This system has been referred to by various names, including rational (Epstein, 2002; Epstein et al., 1996; Pacini and Epstein, 1999), intentional (Bargh and Chartrand, 1999), deliberate (Hogarth, 2001), extensional (Tversky and Kahneman, 1983), rule based (Sloman, 1996). It is affect-free, serial, slow in operation, fast in formation, details focused, intentional, cognitively demanding, symbolic and open to conscious awareness (Epstein, 2008; Evans, 2008).

The rational-analytical cognitive process is a conscious-deliberate response available both to seasoned and young professionals. In fact, rationality does not require the interiorised of accurate

mental schemes of the environment and can be reliably used by any decision-maker with good analytical. Intuition is a subconscious response triggered automatically to feel the environment and grasp the big picture. It can be reliably used only once the decision-maker has achieved a high level of patterns interiorisation, as explained by the 'intuition-as-expertise' view, and requires careful self-examination and questioning (Yates and Tschirhart, 2006).

Some part of the literature presented the two systems as alternative and opposing motivating this position with the fact that you cannot use effectively both the processing mode for the same decision. These motivations were exacerbated by the misinterpretation that considered intuition as "non-logical" due to some of its distinctive features such as unconsciousness, instantaneousness and non-deliberateness (Klein, 2003). According to this view, mistakes result when decision makers adopt an approach not required by a given situation (Smith, 1986).

From a false dichotomy to a cognitive spectrum for decision-making

The presumed rivalry between System 1 and 2 is nowadays overcome and a new conception followed in which intuition is seen as interdependent with rational analysis rather than in opposition to it (Hodgkinson and Sadler-Smith, 2003). The dichotomy between normative and descriptive approach to decision-making was laid apart since almost all decision researchers agreed that only experience and expertise can suggest which options should be compared, what is the most suitable methodology to perform an analysis and which way forward 'feels' better than another. Rationality and intuition can co-exist and inspire effective decisions (Sinclair and Ashkanasy, 2005) since both the systems are necessary. Indeed, pure intuition might lead to flawed options whereas a deliberative analytical approach would be too slow (Klein, 2003). This conception of interdependency between intuition and rational analysis was reiterated in the most recent literature (Hodgkinson and Sadler-Smith, 2003). There is nowadays unanimity of thought that in order to achieve effective decisions, the opposition between rationality and intuition should be superseded to adopt a new conception inspired to co-existence (Dane and Pratt, 2006; Sinclair and Ashkanasy, 2005). On these premises, we could imagine all the possible mixes of intuition and rationality along a decision spectrum available the decision-maker depending on the characteristics of the decision setting and the judgement at stake. The extent to which an individual is able to deploy the intuitive or analytic mode in ways that are contextually appropriate is named cognitive versatility (Sadler-Smith, 2009). The individuals with higher levels of cognitive versatility possess an advantage as they can easily discern when it is time to use one or the other (Smith, 1989).

Determining the most suitable approach is challenging and the debate on the reliability conditions is not at all concluded. In a breakthrough paper, Kahneman and Klein (2009) identified a set of conditions that enhance the reliability of intuitive judgements namely: validity of the environment in which the judgement is made (stable or unstable relationship between cues and events), opportunity of the decision maker to learn the regularities of the environment (relationship between the cues and the events), irregular and unpredictable environments (risk of being unable to distinguish between lucky judgement and skilled intuitions), adequate balance between taking advantage from intuitive skills without neglecting predictable errors.

The importance of expertise building and cognitive awareness for effective decisions within organizations

As already mentioned, expertise is considered a precondition for effective and reliable decisions no matter the rational or intuitive nature of the underlying judgments. Organizations tend to invest in hard skills development and formal training while limited attention and resources are devoted to the enhancement of tacit skills and formalized on-the-job learning (Garavan et al., 2002). This is partially due to the preference of workers for training aimed at developing certifiable capacities and to the intrinsic difficulties of setting up programmes focused on tacit abilities (Ashton and Sung, 2002). This trend penalizes intergenerational knowledge transfer and programmes aimed at developing tacit abilities. But the capacity to resort to intuition to make key decisions builds right on tacit competences which require a structured and dedicated solutions to be nurtured as any other capacity. This happened in a world whose level of complexity has been increasing constantly and rapidly which requires like never before tacit skills and the capacity to see the big picture (Leonard and Sensiper, 1998).

How expertise-building improves decision-making

Former studies showed that in the decision process, novices tend to weigh options carefully as they need a decision-making framework to guide their decision (Das and Bing-Sheng, 1999). This happens as novices are unable to recognise patterns and to select promptly the most promising alternatives due to their limited exposure to the relevant professional environment and their not yet developed mental schemes. On the contrary, experts are able to take their decisions on the basis of signals reading, experience-driven patterns recognition and mental simulations thanks to their sophisticated mental schemes of how a given professional environment functions (Hutton and Klein, 1999).

The centrality of complex, domain relevant mental representations developed through experience leads us to the phenomenon of ‘‘deep smarts’’ introduced by Leonard and Swap. These authors defined it as the capacity of some individuals to comprehend quickly intricate, interactive situations by invoking tacitly held expertise derived through experience. Sadler Smith (2011) acknowledged the relevance of deep smarts as “informed intuitive judgments arising from a decision maker’s complex, domain relevant mental representations” thus in line with the expertise-based view of intuition. The factors that according to Leonard and Swap can favour the development of deep smarts align with the techniques recommended with several Natural decision-making researchers in the form of direct and indirect experiences and formal and informal training.

The acquisition of knowledge passes through implicit and explicit learning processes throughout the professional career of decision-makers. Direct experience is acquired through engaging in a trials and errors path and soliciting and receiving feedback (Hogarth, 2001). The continuous process of knowledge elaboration, consolidation and expansion fosters the development of those analytical and experiential skills that gradually contribute to expertise building in given professional domains (Simon, 1987). Organizations are privileged laboratories where professionals can engage not only in knowledge accumulation but also in long and gradual process of expertise building achieved through continuous learning. In the growth path of a novice, a key role is played by supervisors and senior colleagues who can contribute to his evolution and at the same time can benefit of the spill overs that emanate from mindful teaching. Indeed, knowledge transfer is beneficial for both receivers and givers as the latter as an involuntary consequence of their teaching effort develop critical thinking and strategic vision. (Agor, 1989; Claxton, 1997, 2000; Khatri and Ng, 2000; Leonard and Straus, 1997; Parikh, 1994; Sadler-Smith and Shefy, 2004).

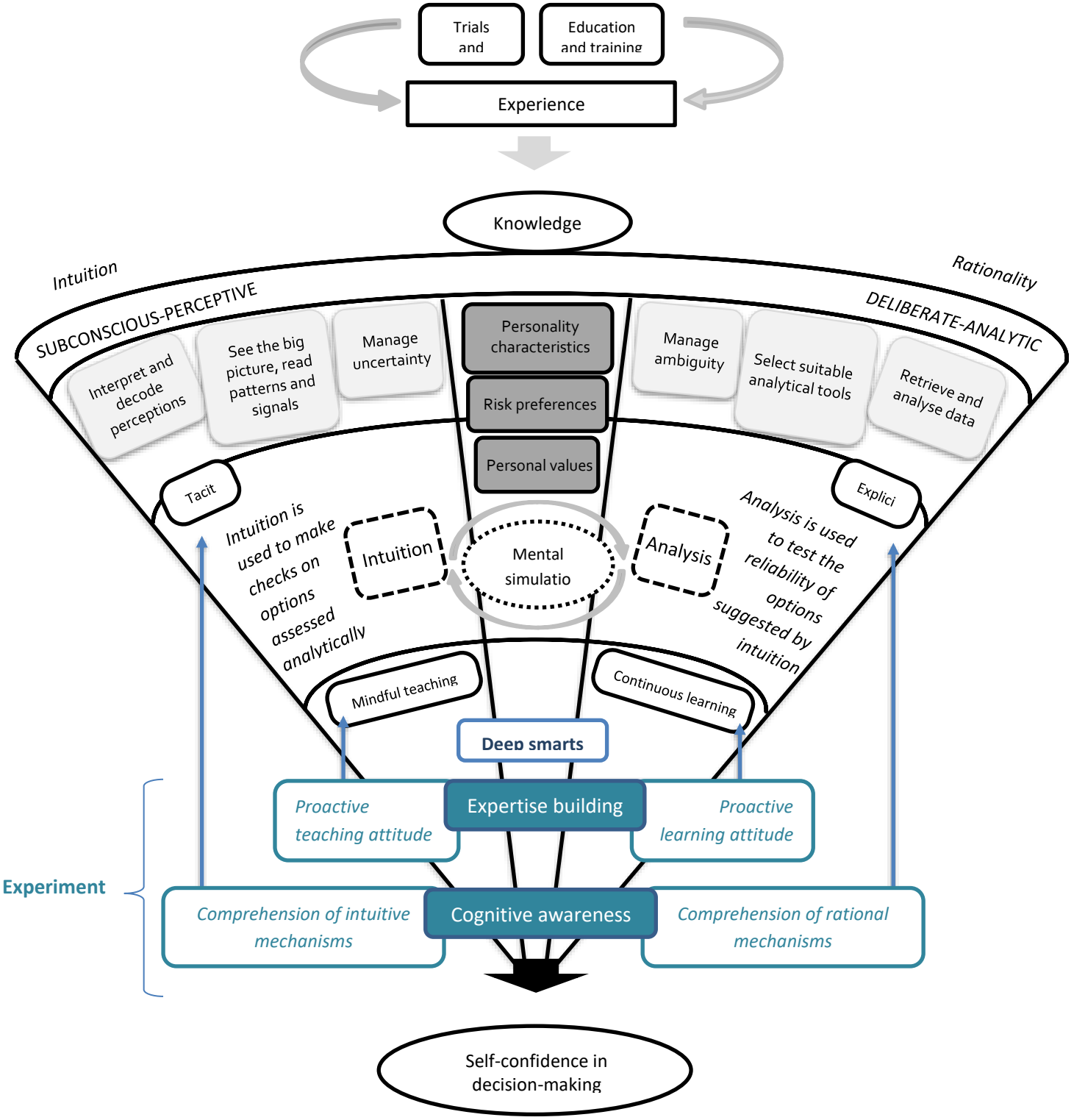
In the upper echelons of the hierarchical pyramid, what really allows an individual to behave strategically and to outstand is the capacity to see what is invisible to the others namely use intuition as a driver for decisions and to adopt the most suitable approach through rational analysis as a structured tool for informed decision-making. Whoever is able to size up a situation quickly thanks to superior perceptual and analytical abilities has an unquestionable comparative advantage and can contribute to organization’s outcome significantly. Experts often match this identikit and for this reason are extremely valuable for organizations. The development of soft skills and decision abilities among future top executives and managers is clearly part of a long journey and, therefore, should necessarily be part of a medium-long run strategy. This future-oriented vision may allow the organizations to favour the creation of middle and senior management teams capable of anticipating problems, adopting well-tailored solutions and maintaining a broad outlook vision (Dover and Dierk,

2010).

How cognitive awareness improves decision-making

The information derivable from the environment is not limited to the tangible data sources that can be processed through the analytical mind but, on the contrary, it encompasses also intangible data sources such as gut feeling, perceptions and implicit equilibria among phenomena and individuals. This data might appear inaccessible to those individuals who are not connected with their own perceptive dimension despite being authentically eager to establish that linkage. Abundant literature is available on the benefits of being aware on one's own cognitive style as this enable decision-makers to reach more informed and conscious conclusions. In fact, being conscious of which are the main implicit and explicit drivers of human judgements not only allows the individuals to understand better their own cognitive processes but also other non-mental determinants such as personality characteristics, risk preferences and personal values. The techniques to develop intuitive awareness isolated in former literature are promising starting points to enhance cognitive awareness of both experiential and rational thinking. Practicing mindfulness, reflecting critically on the dynamics of a given professional context, seeking and providing feedback are all valuable instruments to achieve a gradual attunement to one's own conscious and sub-conscious cognitive processes. Without detracting from their effectiveness, these techniques could be complemented with solutions to increase the comprehension of how cognitive processes work and how they can be used to improve decisions. Hodgkinson (2003) in his research of cognitive versatility presented the benefit of informing managers of their thinking style and illustrated a quadripartition depending on individual inclination for intuitive and rational thinking. The people who are highly analytic with little regard for intuition are named "detail conscious" while those who are highly intuitive with little regard for analysis are named "big picture conscious". The individuals with equal predisposition for analysis and intuition are "big picture conscious" whereas those who are not inclined neither for analysis nor intuition are named "non-discerning". Personal inclination for intuitive thinking is not a sufficient reassurance that a given individual is able to distinguish authentic and reliable intuition from wishful thinking and lucky guess inspired by overconfidence (Sadler-Smith and Shefy, 2004). This is due to the fact that often individuals rely on intuitions that are not the results of sound experience or they have not yet developed the capacity to convert this experience into the necessary expertise to read signals and recognize pattern. The mere repeated exposure to a given professional environment is indeed insufficient to ensure that an individual will develop the tacit capacity to experience valuable intuitions (Sadler Smith, 2012). A proactive attitude for personal and professional growth remains an essential requirement (Klein, 2009).

Figure 1: Theoretical framework



Experiment design and hypothesis

Mentoring and the promotion of effective decision-making within organizations

A wide range of different solutions might be adopted to allow decision-makers to nurture analytical and intuitive skills and to use them to inform effective decisions within organizations. We opted for mentoring as in our conception is a promising tool to facilitate the acquisition of expertise and the comprehension of basic cognitive mechanisms regulating thinking and decision-making. A mentoring relationship between an experienced and a junior professional can become a very favourable space to experiment the effects of a proactive attitude for teaching and learning and to explore the analytic and intuitive drivers behind professional judgments (Scandura, 1992; Arora and Rangnekar, 2014).

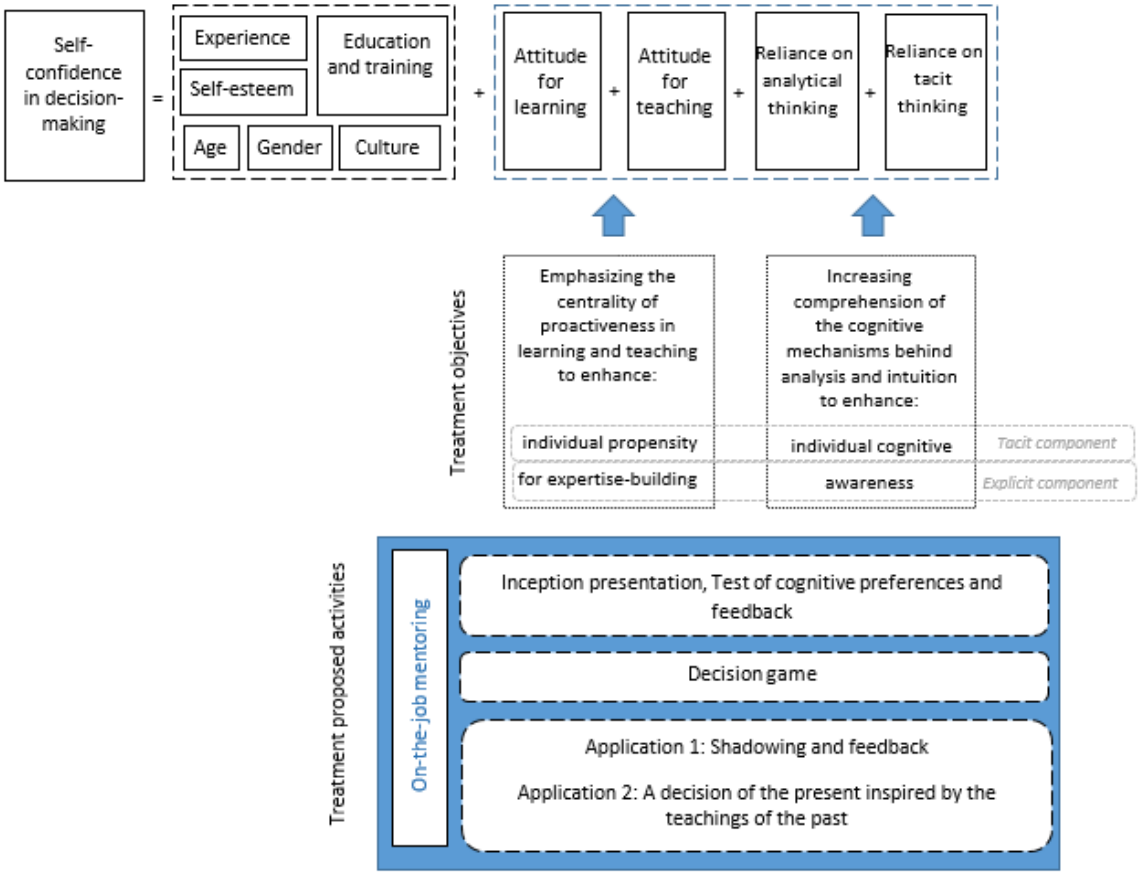
The theoretical substrate of this study is rooted in a conception in which positive decision outcomes are interpreted as the result of effective decision-making by experts besides lucky random guessing. This assumption is in line with the literature that considers quality decisions reached applying both intuition and analysis as the consequence of proactive and mindful experience accumulation (Sadler Smith, 2003; Klein, 2003). As already mentioned, this research assumes absence of rivalry between the rational-analytical and the experiential-intuitive cognitive processes that are instead conceived as interplaying mental mechanisms (Hodgkinson and Sadler-Smith, 2003).

On these assumptions, we crafted an on-the-job mentoring programme used as treatment of the present field experiment to study the effect of higher comprehension of cognitive processes and expertise building dynamics on individual self-confidence in decision-making. The decision to elect self-confidence as dependent variable is motivated by the time and operational constraints of observing in real time a large number of decisions in empirical settings. Decision confidence can be considered an adequate proxy since its connection with effective decision outcomes was already debated and endorsed in former studies (Bruine de Bruin, Parker, and Fischhoff, 2007). The positive relation between increased self-confidence in decision-making and better decision outcomes is explained by the propulsive effect exerted by higher decision confidence. In fact, self-confidence in decision-making induces individuals to trust their capacity to manage decisions effectively. When the decision makers rate their judgemental skills positively, they generate positive expectations on the decision outcome that set the ground for effective performance (Bandura, 2000).

Hypothesis and data collection

Starting on this premise, we hypothesize that mentoring can be used to act on two components that affect self-confidence in decision-making, namely the individual propensity for expertise-building and cognitive awareness. The former is achieved emphasizing the centrality of a proactive attitude for learning and teaching while the latter is enhanced increasing the comprehension of the cognitive mechanisms behind analysis and intuition.

Figure 2: Experiment design



As illustrated in Figure 2, the dependent variable is `Self-confidence in professional decision-making` that in our model is supported by a number of controls such as years of `Experience` and `Education/training`, individual `Self-esteem`, `Age`, and `Gender`. These constants are accompanied by the `Profession` cluster that we will see in further details later. The functional constructs of `Expertise building` and `Cognitive awareness` are associated with related variables that make explicit their effect on the dependent variable.

Expertise-building is a never ending process that involve both experienced and young professionals who can improve the way they make decisions over time. In this framework, individual attitude is considered an important determinant since, as already mentioned, the mere exposure to certain

tasks and a given environment is not a sufficient condition per se to develop superior expertise. For this reason, the variable `Expertise building` is linked to `Attitude for learning` and `Attitude for teaching` and the perceived comprehension of the participants on the way these attitudes influence expertise accumulation.

Hypothesis 1a: *Self-confidence in professional decision making of mentors and mentees can be increased improving the understanding of the importance of individual attitude for learning.*

Hypothesis 1b: *Self-confidence in professional decision making of mentors and mentees can be increased improving the understanding of the importance of individual attitude for teaching.*

The popularity of books, guides and publications on the origin on gut feeling and the development of perceptive skills reveals the widespread interest in the non-apparent cognitive mechanisms that regulate thinking and decision-making. The actual development of tacit abilities rooted in the subconscious mind is comprehensibly a big challenge but also a source of considerable opportunities to improve decision-making (Stolper et al., 2009). More specifically, deeper understanding and awareness of what happens behind the stage of the cognitive processes permits to set up a decision space where both the rational and the intuitive minds contribute to the judgement reinforcing mutually. What is suggested by the subconscious intuitive mind can be appraised through the checks performed by conscious analysis. For this reason, the variable `Cognitive awareness` is linked to `Reliance on analytical thinking` and `Reliance on tacit thinking` and the perceived comprehension of the participants on the way these attitudes influence cognitive awareness.

Hypothesis 2a: *Self-confidence in professional decision making can be increased improving the understanding of the deliberate cognitive mechanisms that regulate explicit-analytical thinking.*

Hypothesis 2b: *Self-confidence in professional decision making can be increased improving the understanding of the tacit cognitive mechanisms that regulate implicit-intuitive thinking.*

The field experiment is conceived as a mentoring and was proposed to the staff of a large organization of the United Nations named International Fund for Agricultural Development (IFAD) based in Rome. The mentoring programme articulated in several phases took place over a period of nine months. In this work, we aimed to expand the level of analyses from the individual to a more interactive level such as the mentoring couple. The unit of analysis is, therefore, the couple made of an experienced mentor and a novice or journeyman mentee

During a preliminary phase, 72 possible couples were pre-identified with the support of five internal informants in a quasi-randomized selection. A set of criteria was identified to inform the selection: working together in the same functional area for the foreseeable future, daily professional interactions, same professional background, and minimum experience (more than ten years for mentors, less than three years for novice mentees and between three and six years for journeymen mentees). The couples that met the criteria established for the selection were invited to participate to the mentoring programme by email. 24 couples declined to take part in the experiment, the first 24 couples that showed interest in taking active part in the experiment among the remaining 48 were included in the treatment group while the other 24 were included in the control group. 4 out of 24 mentoring couples of the treatment group abandoned the experiment due to professional or personal motivations. Similarly, 2 couples of the control group abandoned the experiment.

Participants were clustered in 4 job families: financial management, economic analysis, knowledge management, and project performance monitoring. Each job family represents a homogenous professional cluster whose members work together and perform analogous tasks though at different level due to seniority. Part of the activities proposed during the mentoring (e.g. decision game) were tailored to the distinctive activities of each professional cluster.

Data collection was done through questionnaires to gather demographic information and data on the dimensions captured by the main variables (self-assessment, 9 Likert scale) (Table 1). The internal informants who supported with participants identification were also requested to provide feedback to test the adequacy of the questionnaire content. They provided suggestions on the most suitable topics and jargon to use with the participants depending on professional cluster and the questionnaires length that was agreed in a 10 minute completion timing. The pre-treatment and post-treatment questionnaires were administered to the participants of both the groups. The activities proposed to the participants of the treatment group were recorded in as many questionnaires after the end of each activity. Data were sorted by `Groups` to differentiate the observations of the treatment and control groups before and after the mentoring programme. The observations of the treatment at time zero were included in Group 1 while the observations of the treatment at time one were included in Group 2. The observations of the control at time zero were included in Group 3 while the observations of the control at time one were included in Group 4.

Table 1: Data collection arrangements

		Treatment (20 mentoring couples)	**[2]Control** (20 mentoring couples)
	Manipulations	*Data collection*	
Time 0	Invitation + REI[3] cognitive test	Pre-treatment questionnaire + REI scores	Pre-treatment questionnaire + REI scores
	Activity 1	Inception presentation, feedback on REI	
	Activity 2	Decision game	
	Activity 3	Application 1	
	Activity 4	Application 2	
Time 1	closure	Post-treatment questionnaire	Post-treatment questionnaire

The treatment: on-the-job mentoring programme

The field experiment was conceived to overlap the activities proposed within the mentoring programme with the real life experience of mentors and mentees who work together creating value for both. The proposed mentoring intend to increase the participants' comprehension of the two acting component isolated in Figure 2: expertise-building and cognitive awareness. The treatment targets both expertise-building and cognitive awareness as learning, teaching, analysis and intuition are deeply connected and exert a mutual influence on each other. For this reason, the elaboration of different treatments for the two constructs separately was deliberately avoided.

The programme seeks to capitalize on the favourable conditions of the organization environment to create a stimulating learning environment in any professional experience is lived by the experiment participants with a more present and reflective mind. Mentoring is a convenient tool for organizations to create a bridge between expert-supervisors and novice-mentees to promote the development of tacit and explicit abilities and intergenerational knowledge transfer through practicing (Scandura, 1992). Mentors and mentees are requested to apply in their everyday professional activities techniques to facilitate the accumulation of conscious experience such as guided observation, guided practice and guided problem solving (Arora and Rangnekar, 2014) (see Annex 1 for a detailed description of the proposed activities). The programme is articulated as a set of activities each of which includes a technique to elicit reflection and equip the participants with a suitable methodological approach to facilitate decision-making (Kram, 1980).

[2] Two couples of the control group were excluded due to missing data on the dependent variable in the final questionnaire at time 1.

[3] Rational Experiential Inventory (REI -40)

The proposed activities were elaborated based on the empirical approaches suggested by some of the most prominent authors of the Intuitive and Naturalistic decision-making currents and by the theorists of Deep Smarts. The techniques on how to nurture rational-analytic and subconscious-intuitive thinking suggested the intuition scholars (Sadler-Smith and Shefy, 2007; Klein, 2002; Sadler-Smith and Burke, 2009; Hogarth, 2003) where combined with those of the Naturalistic decision-making researchers such as the approaches applied by Klein in his field works with US State Agencies (Klein, 2002; Klein, 1999). A further source of methodological insight to refine the proposed guided experience activities was the work of Leonard and Swap with Silicon Valley venture capitalists and young entrepreneurs (Leonard and Swap, 2002). The proposed activities consist of engaging in deliberate practice, providing-receiving accurate and timely feedback and reviewing prior experiences. The objective of these applications is to enhance perceptual skills, enrich domain-dependent mental models, derive new insights and lessons from past mistakes, compile extensive experience repertoires of patterns; develop a broad experience base of instances and routines, acknowledge the importance of individual responsibility in the expertise-building path. The applications are conceived to turn every-day professional activities into observations and opportunities to adopt a proactive and present-mind attitude.

Data analysis

In order to clarify the composition of the treatment and control groups, we calculated descriptive statistics (mean, standard deviation, minimum, maximum, variance and median) for all the variables, testing the mean and median differences with parametric and nonparametric analyses[4] . The purpose of this statistics is to show that the participants in the treatment and the control groups have balanced characteristics and appear representative of the same population.

As preliminary analysis of the experiment effect, we use One-way ANOVA to test for between group variations of the mean on the dependent variable. The utilization of the ANOVA is possible as the dependent variable is assumed continuous and the independent variable (`Groups`) is categorical. The One-way ANOVA[5] is especially suitable also because the independent variable of the experiment

4 We used the t-test as benchmark, but we also performed distribution-free test such as Wilcoxon rank-sum (Mann–Whitney) test for the mean difference and a nonparametric k-sample test on the equality of medians also available in STATA 15. As they don't assume that data follow a specific distribution, they specifically suited in case of small samples.

5 This protects against the risk of Type I error inflation that might happen when multiple tests are conducted in parallel and thus determining an undesired accumulation of the error rate beyond 0.05.

is made of more than two groups and it allows to test the mean differences assessing all possible differences at the same time. The One-way ANOVA analysis is complemented by post estimations such as the pairwise comparisons of Tukey and Bonferroni's tests. In order to further validate the results of the ANOVA, we report the Wilcoxon–Mann–Whitney non-parametric test that does not assume normal distribution and allows to relax the assumption of normality. This is especially useful in this setting as the size of the four groups is relatively small (40 observations each) and normal distribution cannot be given for granted. This non-parametric test investigates whether these groups were selected from populations having the same distribution regardless of the fact that the mean accurately represents the centre of our distribution.

The experimental data are then analysed using the 'difference-in-differences' technique to appreciate the effect of the mentoring programme on the treated group once the counterfactual effect is netted out. This corresponds to the trend effect generated by external causes that impacts simultaneously both the treatment and the control group. We do not have reasons to believe that during the mentoring programme the trend affecting the treatment group may differ from the trend affecting the control group. In fact, the quasi-randomization performed during the selection phase of the experiment allowed to create a specular and homogeneous composition of the couples by key control variables across the treatment and the control group. This means that the distribution of the control group mirrors the distribution of the treatment group very closely reproducing the same composition by professional cluster, age, experience rank, gender, etc. We run multiple regressions for three model: a main model to appreciate the effect on the experiment of the dependent variable, a secondary model to test hypothesis 1a and 1b, and lastly, another secondary model to test hypothesis 2a and 2b.

Multicollinearity bias was checked through the variance inflation factor diagnostics (`vif`) to assess to what extent the standard errors of the coefficients of interest and the variance of the standard errors were inflated because of linear dependence with other predictors. In addition, we checked whether the standard error of the estimated coefficients was correlated between couples (mentor-mentee). We obtained clustered standard errors robust to possible heteroskedasticity.

Results

Balanced treatment and control group

As shown in the descriptive statistics of Annex 2, the treatment and control groups before the experiment appear well balanced in all the main variables also as a consequence of the criteria set in the selection stage. The observed mean value of the dependent variable is slightly higher in the control group (6.15 – Group 3) than in the treatment group (6.05 – Group 1) while the variance is higher in the treatment group (2.561) than in the control group (2.253). The t-test on the mean, and the Wilkoxon rank sum on the distribution and on the median show that there are no significant differences.

Positive impact of the mentoring programme on the treatment group

As proved by the ANOVA (Annex 3), the mean value of Self-confidence in decision-making in the treatment group increased from 6.05 before the mentoring programme (Group 1) to 7.8 after it (Group 2). Both Tukey and Bonferroni tests allowed to reject the null hypothesis that the means of all the four groups are equal namely that at least one mean is different from the others. In addition, the pairwise comparisons embedded in these tests allowed to confirm that the mean of Group 2 (treatment group after the mentoring) is different from the means of Group 1 (treatment group before the mentoring), 3 (control group before the mentoring) and 4 (control group after the mentoring) with very high level of significance (p-values is lower than .001). As further supporting evidence, we run the Wilcoxon–Mann–Whitney non-parametric test for each pair of groups in our analysis (Annex 4). The tests allowed to reject the null hypothesis that the distributions of the populations considered are equal. More specifically, we could conclude that the distribution of the treatment group after the mentoring (Group 2) is statistically significant different from the distribution of Group 1 (the treated before the treatment), 3 and 4 (control group, at time 0 and time 1).

In order to confirm the positive effect of the experiment, we resorted to difference-in-differences (DID) regressions. The model is computed on 160 observations and appears well specified with very high explanatory power, as shown by the F test p-values that are lower than .001 in all the regressions we run. R-squared values are above .82 showing that more than 82% of the dependent variable variation is captured by the model and the root MSE values are above .64 in all our

regressions (Annexes, 5, 6 and 7). The effect of the mentoring programme on the dependent variable is captured by the interaction term coefficient that is significant at 1% level in all the regressions we run. The size of the effect of the mentoring programme on the dependent variable is captured by the coefficient of the interaction term that is equal to 1.4 in the main model. This shows that the mentoring is associated with a 1.4 point increase of `Self-confidence in decision-making` along a 1-9 scale in the treatment group. In consideration of the relatively short duration of the mentoring programme, this result is highly satisfactory. It should be noted that the dependent variable modestly increased also in the control group (.13) due to the trend effect. In this context, this is explained by the physiologic increase of confidence connected with professional experience during the mentoring period. There are other control variables that are significantly correlated with the dependent variable in the regressions we run to test the experiment effect. Individual `Self-esteem` coefficient is positive and statistically significant at 1%. An increase of one level (1-9 scale) in individual `Self-esteem` is associated with half level increase in the dependent variable, holding constant the other variables. This is a very stable and ubiquitous association that shows the considerable impact of individual self-confidence on the perception that decision-makers have of their capacities to make effective and successful professional decisions. Age has a positive and significant effect (at 5%) on the independent variable but the intensity of the effect remains low. Ceteris paribus, an increase of 10 years in the age of respondents increases the average self-confidence in decision making by .39. This result might appear surprising as we would expect a greater association between age and the dependent variable, however, the phenomenon is easily explained by the scholarship illusion that affects younger decision-makers. This bias consists in an altered perception of one's own knowledge and mastery due to the ignorance of the breadth of knowledge and required competence in a given domain. This bias reduces gradually as experience is accumulated over the years. Indeed, it is not surprising that the variable `Experience` follows a similar tendency. `Education and training` is positively and significantly correlated at 5%. An increase of ten year in `Education and training` is associated with an increase of .5 level in the dependent variable thus confirming the positive relation between formalized education and confidence in one's abilities and competences. `Experience` is only significant at 10%when we do not account for the duration and quality of the relation of the mentoring couples. On the contrary, `Experience` increases its statistical significance when we account for these variables. On average, an increase of ten year in `Experience` is associated with .36 level increase in the dependent variable. The variable `Relation quality` is positively but only slightly significant (at 10%). An increase of one level in `Relation quality` (1-9 scale) is associated with .14 level increase in the

dependent variable. As expected, good personal relationships between mentors and mentees lead to more satisfactory results of the mentoring programme. Data shows that seven times out of ten, the rating assigned to the quality of the professional relation tend to converge between the members of the same mentoring couple and that the couples with the highest `Relation quality` levels are also the ones that put more effort in the mentoring programme (`Mentoring_ engagement`). We do not observe statistical significance for any of the professional cluster but it should be noted that the Project Performance Monitoring (PPM) cluster performed systematically worse than the Financial Management (FM) cluster in all the model we run. This can be motivated by the deep corporate restructuring undergone by the department of this job family during the mentoring programme, also in line with what is suggested by the `Mentoring_ engagement` variable.

Hypothesis testing

In this section, we run additional regressions to test our four hypotheses (Annexes 6 and 7). Looking more closely at the results of the learning and teaching models (Annex 6) we observe that he interaction term measuring the effect of the mentoring programme on the dependent variable is equally significant at 1% both in the learning and the teaching model but has a higher effect in the former case. This might have more than one explanations, however, we suggest to interpret it as the consequence of the bias that induces people to overestimate their inclination for learning being a skill that is presumed and demanded to the professionals of a large prestigious organization. On the contrary, in the absence of an organization creed that encourages coaching and mentoring, very limited expectations exist in connection to being a good coach for others. The variable Time shows a positive and significant coefficient at 5% when we include the variables related to learning while is not significant when we include the variables related to teaching. This is due to the fact that in the trend effect, we observe a physiological driving role of learning as a result of the experience accumulation while no autonomous driving role is attributable to teaching. Indeed, almost no teaching activities take place besides the mentoring programme. This results aligns with what we observe for `Experience` that is positive and significant (at 10%) in the learning model while is negative and non-significant in the teaching model. This effect is indeed very marginal as the negative coefficients are almost zero. A positive explanation might be that the agenda of experienced professionals is relatively busier and allows for more limited interactions with younger colleagues for mentoring activity when there is no formal commitment to engage in teaching activities. In line

with the results of the former regressions (Annex 5), Education and training and Age are positive and roughly equally significant (5-10% and 1% respectively) in both the models.

For what refers to hypothesis 1a (Self-confidence in professional decision making of mentors and mentees can be increased improving the understanding of the importance of individual attitude for learning), we cannot confirm it. This is because we observe a positive and significant effect (at 10%) of Learning and expertise-building, namely the comprehension of the interconnections between learning and expertise building, and a positive but non-significant effect of Attitude for learning. Indeed as predictable, Attitude for learning is positively associated with the dependent variable confirming that the individual propensity of decision-makers for learning contributes to their perceived decision confidence. However, this variable is never significant meaning that the variation in self-confidence in decision-making cannot be explained by this individual propensity for learning. In our interpretation, this is due to the pervasive mantra of learning by doing that deeply conditions individuals within organizations who give for granted they are involved in a by-default continuous learning process. Further confirmation of this phenomenon is the fact that when we include the variables Learning and expertise-building and Expertise-building, we observe a sudden change in the sign of the relationship. In other words, when participants are exposed and familiarized with the actual complexity of the relation between learning and expertise building, they revise their self-assessment of the role of learning in their professional path. As expected, Expertise-building is not significant as the duration of the mentoring programme is insufficient to generate a variation of this variable that can be affected only in the medium-long term. In addition, we observe a negative relation between Expertise-building and the dependent variable because the mentoring participants gain an increased awareness over the nature and complexity of expertise-building dynamics that has a self-defeating effect in the short term.

For what refers to hypothesis 1b (Self-confidence in professional decision making of mentors and mentees can be increased improving the understanding of the importance of individual attitude for teaching), we can confirm it as we observe that the variable Attitude for teaching is highly significant (1%) and positively associated with the dependent variable. In this case, the variable Teaching and expertise-building is positive but not significant. This apparently conflictual result can be explained considering that within the organization where the experiment took place there was no formal or informal knowledge transfer arrangements between experienced and young

staff. For this reason, the experiment participants were confronted with a pedagogic effort that was completely novel and compelling. Furthermore, the relation between teaching and expertise-building is more difficult to understand due to the low exposure and familiarity that that majority of the individuals have with it. The combination of these two factors determines that mentors in the relatively short period of the mentoring were more focused on the actual effort to teach than on the comprehension of its connections with expertise-building.

When we look at the results of the analytical and intuitive models (Annex 6), we observe that the interaction term on the dependent variable is equally high significant (at 1%) both in the analytical and the intuitive thinking models. This indicates a positive effect of the mentoring programme on self-confidence in decision making that appears equally driven by both the increased understanding and self-awareness of analytical and intuitive abilities. In addition, we observe that `Time` has a positive and significant (10%) effect in the analytical thinking model while is positive but very marginally significant (at 10% in only one regression) in the intuitive thinking model. This can be explained through the widespread ability to refine analytical skills over time with experience without the need to receive dedicated training or coaching for it. In the analytical thinking model, `Experience` is positive and marginally significant (10%) when we include in the regression only the variable `Reliance on analysis`. This suggests that experience is positively associated with decision confidence but that it explains its variation less than the individual awareness of the role of analytical thinking in connection with decisions. In the intuitive thinking model, `Experience` is slightly negative and non-significant throughout all the regressions we run. This result might seem apparently incomprehensible as you tend to assume higher levels of self-confidence in decision-making as experience increases. However, after a pick in the first half of the professional career experienced professionals tend to become more and more aware of their limitations over time and this has a negative impact on their decision confidence. `Education and Training` is positive but non-significant in the analytical thinking model while is positive and significant (5-10%) in the intuitive thinking model. This result is not surprising as the individuals with higher education are habitually in deeper connection with their subconscious dimension and they are more aware of their tacit abilities. `Age` has positive and highly significant coefficients (at 1%) in both the models. An increase in the age of participants is associated with higher self-confidence in decision-making being driven by both superior analytical and the intuitive skills. Under the intuitive thinking model, we observe a modest positive effect (significance at 10%) of the `Economic analysis` (EA) professional cluster showing a better response of this group to the tacit component of the treatment compared to the `Financial Management` (FM) cluster. This predictable effect is due to the

composition of this cluster that gathers individuals with a quantitative background who define themselves as data-oriented. This cluster responded better to the activities focused on tacit and intuitive thinking as they originally presented a lower predisposition for it.

For what refers to hypothesis 2a (Self-confidence in professional decision making can be increased improving the understanding of the deliberate cognitive mechanisms that regulate explicit-analytical thinking), we can confirm it with high confidence. In fact, we observe that `Reliance on analysis` is positive and highly significant also when we include the variable `Analysis and cognitive awareness`. As formerly remarked for `Expertise-building`, we observe a positive but non-significant effect of `Cognitive awareness`. Indeed, this variable represents a consciousness that can be developed only gradually in the medium-long term and, therefore, it cannot be predictably affected in the limited time period of the mentoring programme.

For what refers to hypothesis 2b (Self-confidence in professional decision making can be increased improving the understanding of the tacit cognitive mechanisms that regulate implicit-intuitive thinking), we adopt a conservative approach and we confirm it with some reserves. Although, we observe a positive significance coefficient of the variable `Reliance on intuition` at 1%, this is limited to the regression that includes only this variable. When we include in the model also the `Intuition and cognitive awareness` and `Cognitive awareness` variables, the effect of `Reliance on intuition` becomes positive but non-significant, the effect of `Intuition and cognitive awareness` positive and significant at 5% and the effect of `Cognitive awareness` positive but non-significant. The comparatively higher explanatory power of `Intuition and cognitive awareness` over `Reliance on intuition` should not be interpreted as a disconfirming factor of our hypothesis. Nonetheless, it requires an explanation that can be found in the challenge in understanding the relation between intuitive mental mechanism and cognitive awareness (`Intuition and cognitive awareness`). All participants started from levels of `Reliance on intuition` inferior to the levels of `Reliance on analysis` due to the customary caution that surrounds hunches and gut feeling in the professional environment. In this setting, the comprehension of the tacit mental mechanisms regulating intuition exerted a positive effect on decision confidence but was not enough to win the scepticism and impact `Reliance on intuition`.

As part of the robustness diagnostics, we controlled for possible multicollinearity computing the variance inflation factor[6] (VIF) that allowed to exclude appreciable adverse impact on the results due to multicollinearity.

Discussion

As illustrated in the results section, the experiment had a positive impact increasing self-confidence in decision-making of 1.4 point along a 1-9 scale in the treated group. This encouraging result deserves to be dissected further to clarify the role of the two components (expertise-building and cognitive awareness) and four drivers (learning, teaching, analytical thinking and intuitive thinking) that underpin the mentoring programme we used as treatment.

As argued in former sections, the importance of expertise-building and cognitive awareness was extensively debated in literature (Agor, 1988, 1989; Patton, 2003; Sadler-Smith, 2008) and is at the centre of some empirical works that explored methodologies and techniques for nurturing intuition among young managers and management students (Sadler-Smith and Shefy, 2004; Burke and Sadler Smith, 2006).

The mentioned four drivers constitute the core of the hypothesis we tested in this study. Surprisingly, we could not confirm the most obvious hypothesis namely that decision confidence can be increased improving the understanding of the importance of individual attitude for learning.

Participants' comprehension of the interconnections between learning and expertise building is positively correlated with decision confidence, however, it is not coupled with an increased significant level of the propensity for learning. In other words, the participation in the mentoring was not sufficient to enhance the individual propensity for learning as this was already very high. This elevated self-consideration of one's learning skills is in line with the view of biased judgements deriving from overconfidence in inflated capacities (Shapira and Berndt, 1997; Kahneman and Lovallo, 1993; March and Shapira, 1992). This distortion is widespread especially within organizations where individuals are conditioned by the perceived obligation to depict themselves as skilled professionals always receptive to new knowledge. This tendency is often observed also among those individuals whose performance did not record any improvement attributable to increased knowledge overtime.

[6] The mean values of VIF are below the conventional threshold of 3 in all the regressions we run. Above this threshold additional control tests are recommended to exclude issues associated with multicollinearity (results table in Annex 4, 5 and 6).

The second hypothesis on the importance of teaching to increase decision confidence was confirmed thanks to the efficacy of mentoring in pinpointing its positive effect on expertise-building. As expected, mentors benefited more than mentees from the teaching effort, nonetheless, the adoption of a generalized mindful teaching attitude proved to be beneficial also for the latter. The main reason is that the action of transferring knowledge to someone else requires the adoption of a self-questioning critical stand (Marshall, 2001).

Unsurprisingly, the hypothesis on the understanding of the connection between analysis and the explicit-rational component of human cognition was confirmed with high confidence. The rational dimension is unquestionably the easiest to act on thanks to its permeability.

On the contrary, the hypothesis on the understanding of the connection between intuition and the tacit-unconscious component of human cognition was less straightforward. In this case, we opted for a conservative approach confirming the hypothesis with reserve due to the fact that only time and repeated practice can contribute to the development of tacit skills. We acknowledged the presence of partial statistical significance of the propensity for intuition and full significance of the variable capturing the comprehension of the mental mechanisms that connect intuition to cognitive awareness. At the same time, we appraise that in professional environments reliance on intuition is physiologically diminished by the challenge of convincing peers and supervisors that one's intuitive judgements are sound and grounded in reality despite being inspired by gut feeling. Furthermore, we give credit that the short duration of the mentoring programme might have been insufficient to stimulate a perception of reliability of one's intuitive thinking (Klein, 2004).

Despite this time limitation, the positive effect of the mentoring treatment on self-confidence in decision-making remains intact. Provided a sufficient commitment level, mentoring allows novices and journeymen to progress along their learning curve starting from a more favourable launch pad. This passes through the development of the necessary receptors to process complex information and to contribute to the way novices build their mental representations of the professional environment (Salas et al, 2009). Through mentoring, novices can learn to seek for and interpret feedback, how to develop balanced analytical and intuitive-tacit skills and understand when to deploy the former or the latter (Hogarth 2001).

Contrary to the common opinion, experienced mentors do not benefit from mentoring less than mentees since it awards to them a responsibility that stimulates awareness and reflection on the deep meaning of expertise and its modalities (Westerman, 1991). In addition, a mentoring aimed at developing tacit skills such as big picture vision and intuitive abilities through the understanding of

the underlying cognitive mechanisms allows to endorse, dismiss and investigate the validity of perceptions and to inform decisions. Paying attention to one's subconscious mind to avoid that potentially precious information go unnoticed is clearly a difficult task. Nevertheless, experienced mentors in the process of teaching their mentees eventually end up self-training themselves (Westerman, 1991). In this exercise, they become more and more attuned to their own gut feelings and more receptive toward non-apparent phenomena.

Conclusion

In a world whose level of complexity has been increasing quickly over the last few decades, organizations invest limited resources in the development of tacit abilities. This is problematic in at least one sense since the majority of the formal and informal knowledge development solutions adopted by organizations does not involve the refinement of tacit knowledge and soft skills. These are clearly key abilities in strategic management and are often preconditions for decision success. In fact in complex organizational frameworks, crucial choices are the result of a decision-making process based on both experiential-perceptive and analytical cognitive mechanisms and skills. For this reason, this work contributes to the advancement of the still limited empirical research on practical solutions on how to improve decision-making within organizations leveraging on both rationality and intuition.

This study is not without limitations. The most evident is the relatively short observation period that conflicts with the long time required to observe actual expertise development. In fact, novices achieve high levels of expertise only after several years and provided the maintenance of a proactive attitude throughout their professional careers. Only once reached that point, they can provide the most significant contribution to the organization. For this reason, a larger multiannual research programme is advisable and

Annex 1
Proposed activities within the mentoring treatment

Manipulation	Theoretical background	Proposed activities	Purpose
Invitation + REI[7] cognitive test	Participants were invited to take part in the mentoring programme and received the link to take the Rational – Experiential Inventory (REI) test online. This is a questionnaire that provides independent scales of rational/analytic and experiential/intuitive thinking styles (Epstein et al., 1996; Pacini and Epstein, 1999a).	Participants fill in the pre-treatment questionnaire (both treatment and control group). Participants take REI psychometric test online and send the results to obtain feedback.	Draft an identikit of participants' individual thinking preference and information processing style through REI scores.
Inception presentation, feedback on REI	This treatment is based on the idea that both analytical and intuitive intelligence can be nurtured. Intuitive intelligence namely the capacity to understand, apply, and develop one's intuitive judgment can be nurtured understanding intuition, developing intuitive self-awareness, and eventually achieving intuitive expertise (Sadler Smith, 2016) Simultaneously, this process should pass through the development of domain-specific expertise (Klein, 2003). Experiential and analytic thinking styles are independent and individuals can score high or low in one of the two or in both. None of the two thinking style is superior to the other as each is superior in some important abilities and attributes and inferior in others. (Epstein et al., 1996; Norris and Epstein, 2011; Pacini and Epstein, 1999; Pacini et al., 1998).	Participants are invited to attend an initial event where they receive a presentation to start familiarizing with the key concepts of the mentoring. They are presented the distinctive feature of cognitive System 1 (experiential-tacit) and System 2 (analytical-deliberative) and provided with an explanation of the main constructs (mental schemes, patterns, scripts, cues, signals and mental simulations) through cases. In addition, they are requested to reflect on the importance of the individual attitude toward learning and teaching for expertise development. Lastly, they are invited to reflect on what is the connection between thinking styles, learning, teaching and decision-making. Participants receive feedback on their REI scores to make them aware of the peculiarities of their own cognitive styles as a prerequisite for enabling them to explore and develop for those situations where their preferred ways of thinking are inappropriate and/or difficult to execute. This is conceived as a first step toward the development of meta-cognitive skills and to become more reflective in their own practices.	Enhance participants' understanding of: -the true nature of intuition and its distinctive features vis-à-vis analysis; -which are the conditions of reliable analytical and intuitive judgements; -how to persuade peers and supervisors that a course of action originating from an intuitive judgement is reliable. Feedback to REI test is provided to inform the participants of the main characteristics, strengths and weaknesses connected to one's own cognitive style. This is intended to increase individual awareness over cognitive dynamics.
Decision game	The use of case studies and showcased best practices can boost vicarious learning from indirect experience, allow drawing lessons by apprenticeship and enrich the mental models of decision makers taking part in it. In the case of decision games, this happens since mentees engaging in the simulated	The researcher participates to the game as moderator. During the decision game the researcher plays the role of the moderator who ask questions to direct the participants' attention to a pertinent aspect of the simulation in order to use the case to boost vicarious learning. The decision game is an interactive session involving all the mentoring couples of a given job family and consists of a simulation based on a	Promote a guided learning strategy whereby the mediator facilitates the participants in grasping the intricacies and dynamics of the situation. Reflect on the solutions suggested by both analytical and conscious mind and articulate the basis of judgements and

[7] Rational Experiential Inventory (REI -40)

	practice can learn also observing how their mentors act. Phillips and Battaglia (2003) showed that a carefully designed series of decision scenarios combined with effective coaching can significantly increase decision quality. The decision game should configure as a simulation resembling to a plausible difficult decisions characterized by: compelling and engaging storyline, climax where a key decision is required, no single correct answer but a reasonable range of answers with their own consequences, built-in set of conflicting goals and resource constraints, incorporating the sense of uncertainty, verifications techniques: (i)intuition should be used to recognize a situation and suggest suitable action, (ii) analysis should be used to make a robustness check and exclude that intuition is misleading to reduce overconfidence and improve decisions (Lipshitz et al. 2001). The decision games includes also a pre-mortem application based on the concept of prospective hindsight for reducing overconfidence and improving decisions (Mitchell, Russo, and Pennington, 1989; Klein, 2007).	real life case occurred within their professional area for reflecting on the decision process under particular circumstances and drawing lessons. The game is intended to be a domain-specific simulated practice exercise grasping the essence of decision difficulties through a compelling ad engaging storyline that culminates in unavoidable final decision through an upright climax. The game is a free of costs high-fidelity simulation environment conceived to incorporate the sense of uncertainty and to encourage the participants to practice decisions and to engage in mental simulations in two phases. In the first phase, the moderator presents an introduction on the most common decision biases and the case. Mentees are requested to explain what course of action they suggest before the mentors. Once also the latter have explained their approach, mentees are requested to reflect on which are the main differences between their position and the position of the mentors and then all the participants are encouraged to agree on a common line. In the second phase, the participants are proposed to apply the 'pre-mortem' technique. This technique consists in imaging that the proposed course of action has failed and the decision has been a real disaster adopting a highlight view. They are requested to conjecture on the reasons for this failure thinking backward. Participants envision how their preferred course of action impact the situation in order to reveal potential unintended consequences.	decisions. Generate critical thinking and push participants to challenge assumptions and convictions. Arouse dissenting opinions, doubts, and objections to reduce the risks of overconfidence.
Application 1 *'Shadowing and feedback'*	In learning environment with "kind learning structures" individuals can enhance their intuitive judgements soliciting high quality and effective feedback (Hogarth, 2001). There are is not a single type of feedback. Cognitive feedback consists of information about the relations in the environment, relations perceived by the person, and relations between the environment and the person's perceptions (Balzer, Doherty, and O'Connor, 1989). Process feedback (Cannon-Bowers and Salas, 2001) can inform people of necessary changes to their approach, whereas outcome feedback only indicates whether they tend to be improving or not. Feedback is key as it can improve the quality of learning provided that the learner pays attention to the nature	Participants receive the instructions sheet. This application is based on the idea that active engagement and self-reflection on one's own learning can ultimately improve learning. Expertise building is driven by deep motivation and can be achieved through deliberate practice that requires both depth and breadth of engagement. However, deliberate practice is not limited to passive repetition of tasks but consists of making experience mindfully namely through proactive and present-mind critical reflection. On one side, an attitude based on observation and seeking for accurate and reasonably timely feedback can help mentees to make sense of the professional environment. On the other side, a self-questioning attitude can induce mentors to keep a vigilant eye on those non-explicit contextual dynamics that are often full of meaning and harbinger of apparently unexpected future events.	Professional experience together with knowledge lay the ground to expertise-building that is a never-ending process and can be enhanced through the retention of a curious and self-challenging approach throughout professional life. Benefit for mentee: When novices/journeymen receive feedback in response to queries or to validate their understanding they build their cognitive receptors. These receptors work as catchers in one's cognitive apparatus and allow individuals to make sense of information and to transform it into knowledge through a web

	of the receivable feedback and understands what kind of feedback should request. Feedback seeking and appraising becomes even more profitable when it is done in a state of mindfulness (Sadler Smith and Shafy, 2007), namely a state of consciousness based on focusing the attention on the present moment to grasp the cues and the patterns of the professional environment.	For mentor: Please lead the identification of a suitable event/activity that should be novel and non-trivial for the mentee and invite him/her to "shadow" you. Before the event/activity, please provide an overview to the mentee in a short pre-brief. After the event/activity, please address the queries and provide feedback making an effort to discern what the mentee might struggle to understand, which faint connections may miss and which are the elements that would allow her/him to see the big picture in question (debrief). For mentee: Attend/perform together with the mentor the proposed event/activity. During the event/activity try to grasp the main elements and the critical points, note down which the most salient points are and what you expect to become problematic at a later stage. Present your queries to the mentor and seek for feedback to validate your understanding. Make sure that her/his replies are clear and that you achieve a deep understanding both at technical level (e.g. technical competences needed for that given event/activity) and strategic level (e.g. why the organization decided to host the event or require the activity). Try to seek feedback to assess the validity of your assumptions, speculations and proposed approaches.	of connections between new information and formerly learned one. This process allows the gradual construction of complex, domain-relevant mental schemes that create the cognitive scaffolding necessary to understand the broader environment in which all this information fluctuates. Benefit for mentor: When experts provide feedbacks they make a synthetic effort to analyze the context, isolate the important patterns, and anticipate events or problems. This analytic and perceptive endeavor provides also a benefit for the person who makes it, in this case the mentor, who in order to pass a meaningful message to the mentee is forced to size up the situation, explain how to develop tactical thinking and pay attention both to the big picture and the details.
Application 2 *'A decision of the present inspired by the teachings of the past'*	First-hand direct experience is clearly the most effective way to learn and improve decision-making skills, however, also indirect experience can be very beneficial and create the conditions to enhance proficiency. For this reason, this application proposes to take advantage of a real-life episode such as a hot decision and to inform it through the lessons learned from a past case. To this purpose, mentors are proposed to identify a decision imposed by present business needs and to relate it to an old case. A review of the past experience is used to inspire the current decision. The critical reconsideration of the old decision should isolate the successful arrangements and the eventual missteps and inadequate approaches. This is expected to add value and enhance the tactic of the current decision by	Participants receive the instructions sheet For mentor: Please identify a non-trivial decision solicited by the current professional needs to be used as an application and propose it to the mentee. Recall from your past experiences an episode characterized by some analogies with the present situation and a problematic epilogue that can be useful and meaningful to inspire the present decision. Discuss with the mentee the dynamics and motivations underlying the past case and engage in after-action review of the events to diagnose the reasons for success and failure and learn lessons from the eventual mistakes. If useful, draw a map, a script, a wiring diagram or a concept map while discussing. Then, come back to the present situation and scan it through the lenses of the teachings offered by the past. Play devil's advocate to generate counterarguments and project into the future to visualize the foreseeable potential weaknesses of the decision outcome.	The preservation of a proactive learning attitude based on direct and indirect experience and the tendency to look for opportunities to practice and experiment over professional life gradually contribute to expertise building. Benefit for mentor: The act of selecting suitable cases with a pedagogic value and of reinterpreting an old experience to extract teachings for someone else induces the mentor to a critical reinterpretation. This can permit the achievement of even higher levels of expertise through post-performance assessment and critical reconsideration thanks to the necessary reflection on the complexity

	means of a more informed and structured approach. For mentees, the application is a form of indirect experience based on the lessons learnable from the past case reported by the mentor (vicarious learning). Contextually, the discussion between mentor and mentee and the observation of the modus operandi to make the current decision opens the ground to implicit learning.	For mentee: Please make sure that the main conditions and modalities of the current decision are clear to set the ground for knowledge acquisition. Reflect on the particular circumstances of the past case proposed by the mentor, try to glean insights into why task accomplishment was unsuccessful and draw lessons seeking for feedback, as suitable. Share with mentor reflections on how these lessons can inspire the current decision, engage with mentor in playing devil's advocate and projecting into the future to imagine the decision outcome.	of the selected decision at a deep level. In addition, this kind of teaching can lead to the further development of already advanced skills. Benefit for mentee: During formative years, it is very important to broaden one's own array of methods and techniques to achieve expertise. This can be done being selective in experience acquisition and developing skills consciously. The teachings deriving from direct experience namely the trials and errors iterative process can be complemented by the teachings deriving from the positive and negative experiences of someone else. Once familiarized with their domain and experimented the importance of deliberate practice, mentees can replicate their favourite methods until they gradually attain a higher level of mastery.

Annex 2: Variable tables

Variable name	Definition
participant_id	No. Assigned to each participant
mentoring_couple_id	No. Assigned to each couple
mentoring_role	Binary variable: mentor 1, mentee 0
time*	Time 0: Before the mentoring programme, Time 1: After the mentoring programme.
groups	Group 1: Treatment at time=0, Group 2: Treatment group at time=1, Group 3: Control group at time=0, Group4 : Control group at time=1
control_vs_ treatment	Binary variable: treated group 1, control group 0
i.profession	Cluster1: Financial Management (FM), Cluster 2: Economic Analysis (EA), Cluster 3: Knowledge Management (KM), Cluster 4: Project Performance Monitoring (PMM)

**Analysis done on the data collected before the start and after the end of the mentoring programme. Three intermediary data collections were performed with the treatment group participants in correspondence of each proposed activity to measure their improvements. In these occasions we collected data on technique_ utility, expertise_building_utility and mentoring_ engagement. The trend of this additional data is in line with what was observed in the pre and post treatment results reported here.*

technique_ utility	Perceived utility of a given proposed activity to stimulate professional judgement (self-reported, scale 1-9) *(Treatment group only)*
expert_building_utility	Perceived utility of a given proposed activity to stimulate expertise building (self-reported, scale 1-9) *(Treatment group only)*
mentoring_ engagement	Degree of engagement and effort put in the mentoring programme (self-reported, scale 1-9) *(Treatment group only)*

		Treatment group (Time=0) *Group 1*						Control group (Time=0) *Group 3*					
Variable name	**Definition**	**Mean**	**Std.Dev.**	**Min**	**Max**	**Var**	**Median**	**Mean**	**Std.Dev.**	**Min**	**Max**	**Var**	**Median**
s_conf_dm	Self-confidence in professional decision-making (self-reported, scale 1-9)	6.05	1.600481	3	9	2.561538	6	6.15	1.558076	3	9	2.253846	6
exp	Years of experience in the professional domain of the current job	10.0875	8.204039	1	32	67.30625	7.25	9.79875	8.418149	1	31	70.86522	7.5
edu_train	Years of tertiary education and training in the field of professional specialization	6.1125	3.147012	0	14	9.903686	5.5	6.2125	2.18646	3	12	4.780609	6
age	Age expressed in years	39.175	11.18811	23	60	125.1737	35.5	39.35	11.526	25	63	132.8487	36.5
gender	Binary variable: male 1, female 0	.45	.5038315	0	1	.2538462	0	.5	.5063697	0	1	.2564103	0.5
s_esteem	Belief and confidence in one's own ability and personal value (self-reported)	6.825	1.009887	4	9	1.019872	7	6.775	.9996794	5	9	.999359	7
i.profession*	Categorical variable: Professional groups clustered by similar background and task homogeneity.	2.8	1.136797	1	4	1.292308	3	2.825	1.1522	1	4	1.327564	3
expert_build	Propensity for expertise building (self-reported, scale 1-9)	6.85	.5795666	6	8	.3358974	7	6.9	1.172331	5	9	1.374359	7
att_learn	Attitude for learning (self-reported, scale 1-9)	6.775	.9996794	4	8	.999359	7	6.825	1.174243	5	9	1.378846	7
learn_and_expert_build	Comprehension of how individual attitude for learning influences expertise-building (self-reported, scale 1-9)	6.725	1.012423	3	8	1.025	7	6.65	1.210001	4	8	1.464103	7
att_teach	Attitude for teaching (self-reported, scale 1-9)	5.65	1.54505	3	8	2.387179	5	5.675	1.575249	3	9	2.48141	6
teach_and_expert_build	Comprehension of how individual attitude for teaching	4.975	1.250385	3	8	1.563462	5	5.025	1.386519	3	7	1.922436	5

	influences expertise-building (self-reported, scale 1-9)												
cogn_aware	Awareness of the analytic and tacit mental mechanisms regulating decision-making (self-reported, scale 1-9)	6.325	.6938373	5	8	.4814103	6	6.275	1.300641	4	8	1.691667	6
rel_analyt	Reliance on analytical thinking (self-reported, scale 1-9)	6.95	.8458041	5	9	.7153846	7	7.1	1.335895	4	9	1.784615	7
analyt_cogn_aware	Comprehension of how analytical thinking influences cognitive awareness (self-reported, scale 1-9)	6.925	.8589648	5	9	.7378205	7	6.975	.9996794	5	9	.999359	7
rel_tacit	Reliance on tacit thinking (self-reported, scale 1-9)	5.1	.9818872	3	7	.9641026	5	5.175	1.278771	2	8	1.635256	5
tacit_cogn_aware	Comprehension of how tacit thinking influences cognitive awareness (self-reported, scale 1-9)	4.75	.9268087	3	7	.8589744	5	4.925	1.185111	3	7	1.404487	5
relation_duration_to	Duration of the mentor-mentee professional duration at the experiment inception	.754	.7146051	0	2.42	.5106605	.54	.8535	.6231539	.08	2.33	.3883208	0.71
relation_quality_to-t4	Evaluation of the professional relation quality at the experiment inception and after the end of the experiment (self-reported)	7.05	.8149249	5	8	.6641026	7	7.0	.875595	5	9	.7666667	7

Annex 3: ANOVA and post estimation tests

```
anova s_conf_dm groups
```

Number of obs =	160	R-squared	=	0.2177	
Root MSE =	1.39797	Adj R-squared	=	0.2026	

Source	Partial SS	df	MS	F	Prob>F
Model	84.81875	3	28.272917	14.47	0.0000
groups	84.81875	3	28.272917	14.47	0.0000
Residual	304.875	156	1.9543269		
Total	389.69375	159	2.4509041		

```
. tabstat s_conf_dm, statistics( mean sd skewness kurtosis ) by(groups)
```

Summary for variables: s_conf_dm
by categories of: groups (Groups)

groups	mean	sd	skewness	kurtosis
1	6.05	1.600481	.0697379	2.309814
2	7.8	.7909747	-.8941592	5.270626
3	6.1	1.598076	-.0885687	1.94992
4	6.225	1.440931	-.035706	2.061957
Total	6.54375	1.565536	-.3624161	2.156807

```
.
. pwcompare groups, mcompare(tukey) effects

Pairwise comparisons of marginal linear predictions

Margins      : asbalanced
```

	Number of Comparisons
groups	6

	Contrast	Std. Err.	Tukey t	Tukey P>|t|	Tukey [95% Conf.	Interval]
groups						
2 vs 1	1.75	.3125961	5.60	0.000	.938207	2.561793
3 vs 1	.05	.3125961	0.16	0.999	-.761793	.861793
4 vs 1	.175	.3125961	0.56	0.944	-.636793	.986793
3 vs 2	-1.7	.3125961	-5.44	0.000	-2.511793	-.888207
4 vs 2	-1.575	.3125961	-5.04	0.000	-2.386793	-.763207
4 vs 3	.125	.3125961	0.40	0.978	-.686793	.936793

```
. oneway s_conf_dm groups, bonferroni
```

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	84.81875	3	28.2729167	14.47	0.0000
Within groups	304.875	156	1.95432692		
Total	389.69375	159	2.45090409		

Bartlett's test for equal variances: chi2(3) = 20.8518 Prob>chi2 = 0.000

Comparison of S_CONF_DM by Groups
(Bonferroni)

Row Mean-Col Mean	1	2	3
2	1.75 0.000		
3	.05 1.000	-1.7 0.000	
4	.175 1.000	-1.575 0.000	.125 1.000

Annex 4: Wilcoxon–Mann–Whitney tests

```
. ranksum s_conf_dm if groups==1 | groups==2, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           1 |       40         1105.5        1620
           2 |       40         2134.5        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -591.27
                        ---------
adjusted variance       10208.73

Ho: s_conf~m(groups==1) = s_conf~m(groups==2)
                 z =  -5.092
     Prob > |z| =   0.0000
```

```
. ranksum s_conf_dm if groups==1 | groups==3, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           1 |       40         1599.5        1620
           3 |       40         1640.5        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -343.29
                        ---------
adjusted variance       10456.71

Ho: s_conf~m(groups==1) = s_conf~m(groups==3)
                 z =  -0.200
     Prob > |z| =   0.8411
```

```
. ranksum s_conf_dm if groups==1 | groups==4, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           1 |       40            1565        1620
           4 |       40            1675        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -391.90
                        ---------
adjusted variance       10408.10

Ho: s_conf~m(groups==1) = s_conf~m(groups==4)
                 z =  -0.539
     Prob > |z| =   0.5898
```

```
. ranksum s_conf_dm if groups==2 | groups==3, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           2 |       40         2127.5        1620
           3 |       40         1112.5        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -719.49
                        ---------
adjusted variance       10080.51

Ho: s_conf~m(groups==2) = s_conf~m(groups==3)
                 z =   5.055
     Prob > |z| =   0.0000
```

```
. ranksum s_conf_dm if groups==2 | groups==4, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           2 |       40         2136.5        1620
           4 |       40         1103.5        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -740.51
                        ---------
adjusted variance       10059.49

Ho: s_conf~m(groups==2) = s_conf~m(groups==4)
                 z =   5.150
     Prob > |z| =   0.0000
```

```
. ranksum s_conf_dm if groups==3 | groups==4, by(group)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

      groups |      obs       rank sum    expected
-------------+---------------------------------------
           3 |       40         1588.5        1620
           4 |       40         1651.5        1620
-------------+---------------------------------------
    combined |       80           3240        3240

unadjusted variance     10800.00
adjustment for ties      -471.65
                        ---------
adjusted variance       10328.35

Ho: s_conf~m(groups==3) = s_conf~m(groups==4)
                 z =  -0.310
     Prob > |z| =   0.7566
```

Annex 5: Experiment effect

Self-confidence decision-making	*REGRESSION 1*	*REGRESSION 2*	*REGRESSION 3*	*REGRESSION 4*
Control vs treatment	-.048 (.160)	-.048 (.160)	-.053 (.160)	-.054 (.163)
Time	.123 * (.067)	.123 * (.067)	.150 * (.086)	(.137) .088
Control vs Treatment #Time (interaction term)	1.439 *** (.245)	1.439 *** (.245)	1.444 *** .245	1.374*** (.238)
Experience	.035 * (.018)	.034 * (.018)	.036 ** (.018)	.039** (.020)
Edu &Training	.051 ** (.022)	.050 ** (.023)	.055 ** (.028)	.060** (.028)
Age	.043*** (.014)	.039** (.017)	.039 ** (.017)	.035* (.019)
Gender	.0974 (.139)	.092 (.142)	.090 (.145)	.050 (.151)
Culture: 4 vis-à-vis 1	.564 ** (.268)	.539 ** (.278)	.561 ** (.265)	.516** (.269)
Culture: 10 vis-à-vis 1	.742 * (.413)	.743 * (.422)	.743 * (.421)	.702* (.394)
Profession : EA vis-a-vis FM	.189 (.216)	.185 (.220)	.195 (.217)	.237 (.225)
Profession : KM vis-a-vis FM	.041 (.205)	.044 (.207)	.050 (.207)	.116 (.216)
Profession : PPM vis-a-vis FM	-.148 (.171)	-.136 (.179)	-.133 (.176)	-.050 (.194)
Individual Self-esteem	.521 *** (.091)	.519 *** (.090)	.521*** (.090)	.511*** (.091)
Mentoring role		.126 (.261)	.079 (.286)	.227 (.306)
Relation duration at time 0			-.054 (.105)	-.056 (.105)
Relation quality at time 0				.145* (.080)
Mentoring engagement				
R-squared	*.8289*	*.8292*	*.8295*	*.8335*
Root MSE	*.69268*	*.69458*	*.69637*	*.69079*
No. observations	*160*	*160*	*160*	*160*
VIF	*2.38*	*2.68*	*2.71*	*2.73*

*Standard errors are reported in parentheses. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively*

Annex 6: Hypothesis testing 1a and 1b – expertise building

	Hypothesis 1a – learning			*Hypothesis 1b - teaching*		
Self-confidence decision-making	***REGRESSION 1***	***REGRESSION 2***	***REGRESSION 3***	***REGRESSION 4***	***REGRESSION 5***	***REGRESSION 6***
Control vs treatment	-.049 (.163)	-.074 (.164)	-.075 (.165)	-.054 (.150)	-.053 (151)	-.054 (.152)
Time	.119 * (.067)	.135 ** (.069)	.135 ** (.070)	(.061) .065	-045 (.079)	.042 (.082)
Control vs Treatment #Time (interaction term)	1.377 *** (.254)	1.216 *** (.245)	1.218 *** .256	.961*** (.284)	.941*** (.283)	.962*** (.299)
Experience	.036 * (.019)	.033 * (.018)	.033 * (.018)	-.007 (.018)	-.006 (.019)	-.007 (.019)
Edu &Training	.052 ** (.022)	.042 * (.023)	.042 * (.024)	.048* (.022)	.047** (.022)	.049** (0.22)
Age	.041*** (.014)	.038*** (.014)	.038 *** (.014)	.039*** (.013)	.038*** (.013)	.039*** (.013)
Gender	.088 (.140)	.105 (.146)	.107 (.153)	.149 (.146)	.144 (.144)	.156 (.148)
Culture: 2 vis-à-vis 1		-.512 * (.297)	-.513* (.300)			
Culture: 4 vis-à-vis 1	.524 ** (.271)					
Culture: 10 vis-à-vis 1	.709 * (.408)			.672* (.401)		
Profession : EA vis-a-vis FM	.145 (.225)	.165 (.231)	.166 (.230)	.143 (.215)	.141 (.217)	.153 (.220)
Profession : KM vis-a-vis FM	.029 (.207)	.045 (.214)	.045 (.214)	.211 (.197)	.202 (.195)	.210 (.199)
Profession : PPM vis-a-vis FM	-.170 (.174)	-.136 (.183)	-.136 (.183)	-.051 (.175)	-.063 (.180)	-.058 (.180)
Individual Self-esteem	.502 *** (.099)	.487 *** (.109)	.487*** (.109)	.499*** (.080)	.490*** (.092)	.492*** (.091)
Attitude for learning	.062 (.067)	-.036 (.076)	.034 (.081)	.227 (.306)		
Learning and expertise building		-.209* (.093)	-.209* (.094)	-.056 (.105)		
Expertise building			-.003 (.084)	.145* (.080)		-.026 (.091)
Attitude for teaching				.350*** (.091)	.327*** (.108)	.329*** (.109)
Teaching and expertise building					.039 (.091)	.044 (.092)
R-squared	*.8299*	*.8367*	*.8367*	*.8522*	*.8525*	*.8526*
Root MSE	*.693*	*.68145*	*.68395*	*.64608*	*.64778*	*.64995*
No. observations	*160*	*160*	*160*	*160*	*160*	*160*
VIF	*2.40*	*2.52*	*2.67*	*2.66*	*2.84*	*2.91*

*Standard errors are reported in parentheses. *, **, *** indicates significance at the10%, 5%, and 1% level, respectively*

Annex 7: Hypothesis testing 2a and 2b – cognitive awareness

	Hypothesis 2a – analytical thinking			*Hypothesis 2b – intuitive thinking*		
Self-confidence decision-making	***REGRESSION 1***	***REGRESSION 2***	***REGRESSION 3***	***REGRESSION 4***	***REGRESSION 5***	***REGRESSION 6***
Control vs treatment	-.012 (.161)	-.004 (.161)	-.010 (.162)	-.037 (.158)	-.008 (154)	-.016 (.155)
Time	.116 * (.064)	.147 * (.062)	.146 ** (.062)	.118* (.068)	-073 (.072)	.081 (.072)
Control vs Treatment #Time (interaction term)	1.085 *** (.232)	.938 *** (.249)	.900*** .259	1.101*** (.274)	.970*** (.283)	.912*** (.295)
Experience	.027 * (.018)	.025 (.018)	.021 (.019)	-.028 (.078)	-.024 (.017)	-.018 (.017)
Edu &Training	.029 (.023)	.028 (.023)	.030 (.023)	.031 (.021)	.037* (.022)	.042** (.021)
Age	.035*** (.014)	.033*** (.013)	.034 *** (.013)	.040*** (.012)	.039*** (.012)	.039*** (.012)
Gender	.043 (.133)	.042 (.131)	.057 (.133)	.071 (.128)	.101 (.122)	.122 (.122)
Culture: 2 vis-à-vis 1						
Culture: 4 vis-à-vis 1				.504** (255)	.502** (.258)	.477 * (.274)
Culture: 10 vis-à-vis 1						.633 * (.371)
Profession : EA vis-a-vis FM	.002 (.217)	-.104 (.227)	-.083 (.223)	.401* (.214)	.297 (.220)	.235 (.225)
Profession : KM vis-a-vis FM	.061 (.205)	.085 (.182)	.081 (.180)	.102 (.194)	.147 (.189)	.130 (.187)
Profession : PPM vis-a-vis FM	-.103 (.174)	-.137 (.168)	-.119 (.170)	-.106 (.157)	-.076 (.158)	-.056 (.162)
Individual Self-esteem	.491 *** (.107)	.457 *** (.089)	.452*** (.085)	.475*** (.082)	.447*** (.077)	.441*** (.076)
Reliance on analysis	.295*** (.081)	-.229*** (.085)	.206** (.093)			
Analysis and cognitive awareness		-.235* (.100)	-.210** (.106)			
Cognitive awareness			-.069 (.096)			.120 (.091)
Reliance on intuition				.208*** (.059)	.085 (.076)	.041 (.082)
Intuition and cognitive awareness					.211** (.096)	.194** (.094)
R-squared *Root MSE* *No. observations* *VIF*	*.8437* *.66426* *160* *2.49*	*.8505* *.65203* *160* *2.57*	*.8512* *.65298* *160* *2.71*	*.8385* *.67535* *160* *2.51*	*.8454* *.66324* *160* *2.69*	*.8474* *.66132* *160* *2.82*

*Standard errors are reported in parentheses. *, **, *** indicates significance at the 10%, 5%, and 1% level, respectively*

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Decision-making between rationality and intuition: effectiveness conditions and solutions to enhance decision efficacy.

PHD Dissertation

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