How to measure knowing without knowing? A systematic bibliometric mapping and visualization of relationships between the psychometric properties of rational and intuitive decision-making styles

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How to Measure and Enhance Knowing Without Knowing? A Systematic Bibliometric Mapping and Visualization of Relationships between Rational and Intuitive Decision-Making Styles To Explore Training Methods

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Abstract. In this work, we investigate rational and intuitive decision-making styles via a literature review by taking advantage of advanced bibliometric analysis techniques. The aim of this mapping and clustering analysis is to systematically explore organizational research dedicated to cognitive styles to discover how the phenomenon of intuition shapes and is shaped by individuals in organizational contexts. This work aims to inspire future research, in particular for measuring intuitive decision making – that is, the unconscious form – with a particular focus on the organizational framework. The data examined from the Web of Science and Scopus databases comprise 20,582 peer reviewed documents published through the end of 2019. Based on this research review of decision-making styles across research domains and entrepreneurship literature in particular, this first systematic bibliometric mapping and visualization study offers insights and inspiration on how to measure and enhance intuition with a particular focus on the unconscious mind to investigate knowing without knowing with new approaches in the context of organizations.

Keywords: Rational decision making; intuitive decision making; unconscious; systematic bibliometric mapping; bibliometric visualization

Introduction

Recent years have seen notable advances that culminated in a comprehensive understanding of decision-making styles (Wang, Highhouse, Lake, Petersen, & Rada, 2017). Intuition and rationality represent the two baselines of cognitive processing theories (Epstein, Pacini, Denes-Raj, & Heier, 1996; Stanovich & West, 2000b). Based on Epstein et al.'s (1996) cognitive-experiential self-theory, a dual process theory of personality, individuals manage knowledge in two analogous, cooperating, simultaneous, and mutually influential systems (Sinclair, 2011). Dual process theories build on the notion that we make decisions based on two complementary but dissimilar processes: System 1, an intuitive-experiential approach that is automatic, reflexive, and effortless, and System 2, an analytical-rational thinking style that is intentional, reflective, and effortful. These systems have been extensively discussed in the academic discourse (e.g., Jung, Baynes, & Beebe, 2016; Kahneman & Frederick, 2012; Wang et al., 2017). We know that System 2 does not guarantee rational decision making and that System 1 does not automatically produce irrational decisions (Grayot, 2020; Leach & Weick, 2018). Research has shown that intuition complements rationality in an effective decision-making approach (Carter, Kaufmann, & Wagner, 2017), which can create paradoxical tensions that may be fruitful in the organizational context (Calabretta, Gemser, & Wijnberg, 2017). Measuring how the two approaches unfold while taking consciousness and unconsciousness into account represents a global scientific challenge with far-reaching impact across disciplines (Aczel, Lukacs, Komlos, & Aitken, 2011), particularly as it is a crucial source for expertise in the real-world context of any organization (Dreyfus & Dreyfus, 2005).

There are three meta-analyses related to the difference between decision-making styles. The first, with a sample of 17,704 participants, was undertaken by Phillips, Fletcher, Marks, & Hine (2016). Intuition was negatively correlated with performance depending on the framework of the specific decision task but positively correlated with experiences such as speed and enjoyment.

Wang et al. (2017) published two additional meta-analyses (N = 27,501) concluding that intuition and deliberation can be viewed as independent constructs. The third meta-analysis (Wang et al., 2017) found also a near-zero correlation between intuition and rational analysis (N = 511). These meta-analyses highlight the crucial nature of embracing a balance between the two decision-making styles when organizations consider strategic courses of action, as scholars have discussed for decades (Calabretta et al., 2017; Schwenk, 1984; Smith, 2014).

There is a broad consensus that decision-making styles and their performance depend significantly on the environment in which a given decision is taken (Phillips et al., 2016). This vibrant environment is shaped by societies, cultures, and organizations. While some argue that deliberation provides better outcomes in specific environments related to confidence (e.g., Koriat, Lichtenstein, & Fischhoff, 1980), others argue that in complex situations intuition obtains better results (Gigerenzer, 2007). For instance, in entrepreneurial adventures intuition is more effective and efficient than the conscious mind (Aczel et al., 2011). Furthermore, entrepreneurs tend to trust intuition more than the analytical mind (Huang and Pearce, 2015). As our organizational world becomes more complex, shaken by crises, and characterized by uncertainty, time pressure, ambiguity, and instability, balancing intuition and analytics is of ever-growing importance (Akinci & Sadler-Smith, 2019; Calabretta et al., 2017; Harteis & Gruber, 2008; Sadler-Smith, 2016; Sinclair & Ashkanasy, 2005; Tissington & Flin, 2005). In such situations, experts use their prior experience to categorize situations quickly (Sinclair, 2011). Intuition is also viewed as a cognitive shortcut to enable entrepreneurs to make improved choices (Busenitz & Barney, 1997; Manimala, 1992; Shepherd, Williams, & Patzelt, 2015).

Intuitions have been depicted as quasi-miraculous occurrences of understanding something without realizing how (Epstein, 2010). Successful decision making based on intuition has received significant attention across research domains. For instance, in the health sector, greater use of

intuition has been correlated with higher clinical competence (Benner & Tanner, 1987; Tilden & Tilden, 1985). Overall, studies emphasize the importance of gaining intuitive experience and expertise across domains (e.g., Dane & Pratt, 2012; Eubanks, Murphy, & Mumford, 2010; Hoffrage & Marewski, 2015; Iannello, Colombo, Germagnoli, & Antonietti, 2020; Kahneman & Klein, 2009; Lufityanto, Donkin, & Pearson, 2016; Myers, 2007; Raio, Carmel, Carrasco, & Phelps, 2012; Salas, Rosen, & Diaz-Granados, 2010; Mikels, Maglio, Reed, & Kaplowitz, 2011): security (e.g., Klein, Calderwood, & Clinton-Cirocco, 2010; Okoli, Watt, Weller, & Wong, 2016; Tissington & Flin, 2005), health (e.g., Gobet & Chassy, 2008; Quirk, 2006; Ruth-Sahd & Hendy, 2005), and management (e.g., Bierly & Gallagher, 2007; Brody & Trad, 1997; Hogarth, 2002; Sadler-Smith & Shefy, 2004; Simon, 1987). Although Lufityanto et al. (2016) provide evidence that nonconscious information can boost decision accuracy, increase self-confidence, and speed up answer times, in line with previous studies (e.g., Mikels et al., 2011), it remains unclear how this unfolds in the organizational context.

While scientific evidence for the existence of intuition in the organizational context is scant, its training methods are even rarer. Prior studies are characterised by a limited methodological focus on survey-based techniques and interviews (Pretz et al., 2014). Self-reporting techniques capture participants' perceptions of intuition rather than their actual ability to make use of nonconscious information to make decisions (Lufityanto et al., 2016). Furthermore, as they do not focus on organizational contexts, it remains unclear how intuition unfolds in organizations. Moreover, the measurements and scales employed use pre and post assessments or involve laboratory experiments that do not reflect the complexity of real environments within an organization, with their multiple complex variables such as complicated organizational contexts, cross-cultural effects, and societal power. Thus far, analysis of how decision makers in organizational settings such as entrepreneurial frameworks use their intuition lacks an operationalization of the intuition construct (Carter et al.,

2017). Therefore, our knowledge about the real effect of intuition on real-world success is limited. There remains a scarcity of data to verify entrepreneurial intuition, which by default is supposed to be more effective than the analytical approach due to environmental complexity. Thus, our review reflects how we can undertake a deeper analysis of measurements and evidence in this context to provide fresh insights how to potentially enhance it in a deliberately way.

Scholars have not yet had access to an interdisciplinary systematic bibliometric mapping that is dedicated to different cognitive thinking styles and incorporates clustering methods. Specifically, bibliometric mapping using clustering techniques that present scientific knowledge visually to shape and interpret investigation clusters. Only a few entrepreneurial studies use bibliographic mapping (e.g., Fellnhofer, 2019; Phan Tan, 2021). Thus, our work offers a richer understanding of intuitive decision making, and our accompanying review provides material for future research into decision-making styles from a holistic perspective that is particularly valuable for the organizational context. Using normative assessments of different cognitive decision-making styles, this review aims to enrich Shepherd et al.'s (2015) insights into what we know about how entrepreneurs make decisions that helps answer Miller's (2007) call for new empirical approaches. We explore current measurements from other disciplines to provide ideas to bridge science and practice and make organizations more aware of such comprehensions (e.g., Banks et al., 2016), with a particular focus on building a natural bridge and balance for paradoxical thinking in organizations that can enrich future strategic pathways (Calabretta et al., 2017). Thus, this systematic mapping study delivers an outline of clusters regarding cognitive decision-making styles by systematically discovering and visually organizing the full range of existing research through both co-citation investigations and bibliometric coupling methods to visualize influential relationships and gaps and recommend future research, especially investigations that focus on how to measure intuition from an organizational perspective using new ideas from different disciplines.

The work is organized as follows. The next section elaborates the theoretical framework, after which the methodological approach is discussed. After presenting the results, we critically reflect on and discuss the results before addressing implications for future research and acknowledging limitations.

Theoretical Framework

The cognitive-experiential self-theory for an organization of thought approach

We follow the processual approach, enriching existing theories related to intuition by thinking not about organizations directly but rather an 'organization of thought' approach (Chai, 1996; Nayak, 2008). This approach uses intuition to reveal realities in organizations by embracing the dual process model of cognition (Epstein, 1994; Epstein et al., 1996) as a fundamental step in enriching organizational theories with actors' intuitive and analytical mind at the centre. This model is at the heart of the cognitive-experiential self-theory and holds that human behaviour is dominated by two separate information processing systems: experiential and rational. While the former is preconscious, automatic, and entwined with intuition and affect, the latter is conscious, controlled, logic-based, and largely free of affect. There are two approaches within the experiential system: naturalistic decision making that concentrates on expert intuition, and the heuristic and biases approach that encourages adopting an unconvinced attitude toward expert judgment. The naturalistic decision-making community is generally made up of practitioners, including those in organizations, who use techniques like cognitive task analysis and field observation to focus on questions of real-world judgments and decision making. By contrast, the heuristic and biases approach focuses on intuitive judgments based on simplifying heuristics that are not as precise and are more prone to systematic biases (Kahneman & Klein, 2009).

The cognitive-experiential self-theory model shares features with the System 1 and 2 model proposed by Stanovich and West (2000a). While intuitive decisions are made by dual-cognitive System 1 operations in an automatic, unintentional, and effortless way, deliberate decisions are controlled, voluntary, and effortful in System 2. For instance, we need System 2 to perform calculations within the organizational context or simply to read maps (Kahneman & Klein, 2009). The System 1 and 2 approach proposes that intuitive processing using System 1 is automatic and must be consciously ignored by the rational System 2. The rational system is intentional, analytic, primarily verbal, and relatively free of affect; it operates primarily at the conscious level. The experiential system is automatic, preconscious, holistic, associative, primarily nonverbal, and intimately associated with affect (Epstein et al., 1996). Stanovich and West (2000a) claim that the impact of the intuitive System 1 is minimized for individuals with higher cognitive capacity. The literature reveals a common distinction as to decision making between System 1 (fast, automatic, associative, heuristic, and intuitive) and System 2 (rule-based, analytical, and reflective; Wang et al., 2017), and its paradoxical but positive impact in the organizational context was introduced by Calabretta et al. (2017).

The role of different cognitive styles in the organizational context

Calabretta et al. (2017) concluded that organizational leaders need to prepare the ground for paradoxical thinking by accepting the contradictory elements of rational and intuitive decision making. This requires a neutral balance between intuitive and rational practices to be embedded in the organization's culture and processes in a sustainable way and is true for both small and large international organizations, as the dual process difference between rationality and intuition is valid cross-culturally (Witteman, Van Bercken, Claes, & Godoy, 2009). In the organizational context a paradoxical framework for the intuition–rationality tension is formed by accepting and embracing the simultaneous existence of those contradictory forces (Smith & Tushman, 2005). Intuitive and

rational approaches in decision making are combined in the organization. For instance, intangible values such as brands are merged with tangible sales expectations, which shapes the management of financial and nonfinancial objectives that appear to be paradoxical but can positively contribute to each other (Calabretta, Gemser, & Wijnberg 2017a). With this in mind, we build our review on the following definitions of decision-making styles (Epstein, 1991: Epstein et al., 1996; Jung et al., 2016):

Rational decision-making style comprises a logical evaluation of alternatives.

Intuitive decision-making style depends on feelings and hunches.

Analytical thinking style describes a preference for analysing information consciously and intentionally.

Experiential thinking style describes a preference to think preconsciously, automatically, and holistically.

Preference for deliberation defines relatively slowly elaborated and cognition-based decisions.

Preference for intuition defines comparatively fast and even spontaneous decisions.

Linear thinking style relies on an analytical method by breaking information into parts and assuming unidimensional and linear relationships between variables.

Nonlinear thinking style relies on a holistic method to link parts together and assumes nonlinear and multidimensional relationships.

Methodology

A systematic mapping study

This study uses bibliographic coupling and co-citation mapping. The term *bibliometric* refers to analysing bibliographic information by the use of statistical measurements and quantitative methods (Braun, 2005; van Leeuwen, 2004). By grouping more than 90% of the scientific body

(Boyack & Klavans, 2010), direct (co-)citation analyses and bibliographic coupling are a highly accurate and effective path to map the research literature dedicated to cognitive decision-making styles. As a bibliometric technique, co-citation analysis stresses high reliability by intellectually mapping connections that indicate the "distances" between works (White & Griffith, 1981). In particular, co-citation grids recognize "invisible colleagues" (Gmür, 2003). In a co-citation systematic mapping study, paired or co-cited research documents are weighed and statistically scaled (Osareh, 1996; Pilkington & Teichert, 2006).

Bibliographic coupling using the VOSviewer text analysis software tool is used for presenting vast bibliometric maps of multidimensional scaling (van Eck & Waltman, 2009). Its modularity-based clustering algorithm is a weighted and parameterized mapping technique (Waltman, van Eck, & Noyons, 2010). Robustly linked publications show closely interrelated schools of thought and are positioned closed to one another on the map. Van Eck et al. (2009) stress that VOSviewer maps deliver more informative illustrations of data than diagrams created with other established methods. The algorithm applied has already generated consistent and acceptable outcomes (van Eck & Waltman, 2009, 2010, 2014). The greater degree to which identical references are quoted in articles, the stronger the bibliographic link between these articles will be (e.g., Boyack & Klavans, 2010; Zhao & Strotmann, 2008).

Primary data and data processing

This bibliographic mapping and visualization analysis followed these steps to identify relevant studies for future ideas regarding innovative methodological approaches.

Step 1: Review of decision-making styles across research domains to identify key thinkers

1. *Identification of peer reviewed publications*. We collected all publications in the primary database Web of Science (WoS) including (rational decision-making) or (intuitive decision-making) or (analytical thinking) or (experimental thinking) or (linear thinking) or (nonlinear

thinking) or (gut feeling) or (intuition) or (deliberation) in the document. A total of 20,582 peer reviewed documents were discovered through the end of 2019. Those papers contain 428,343 references.

2. *Quality checks*. Next, the dataset was double-checked against Scopus,[1] EBSCO, and ScienceDirect to identify missing papers. Furthermore, we eliminated papers that used the word "intuition" only to formulate their assumptions. For instance, the word "intuition" is often used in an introductory phrase (e.g. "A common intuition is," "Counter to intuition"; e.g., Reimer, Wegewijs, Nestmann, & Pletyukhov, 2019). We also searched frequent synonyms for "intuition," such as "gut feelings," "hunches," and "my heart." Finally, the word "intuition" is also often used in philosophy, where it has a different and specialized meaning (Andow, 2015).
3. *Map creation and cluster identification*. VOSviewer classified the documents into five clusters; 42 references met the threshold of 100 as the minimum number of citations for a reference, out of 428,343 references from 20,582 documents. Thus, 42 authors represent the driving thinkers in cognitive decision-making styles across research domains.
4. *Cluster interpretation*. The papers in each cluster were assessed using the VOSviewer tool for similarities to identify the focus of that cluster.

<u>Step 2: Review of decision-making styles in a specific organizational context: The entrepreneurship literature</u>

5. *Identification of key peer reviewed publications regarding decision-making styles used in the entrepreneurship literature*. We collected all publications in WoS that included the phrases (rational decision-making) or (intuitive decision-making) or (analytical thinking) or

[1] (TITLE-ABS-KEY (intuition) OR TITLE-ABS-KEY (gut AND feeling)) AND (TITLE-ABS-KEY (measure*) OR TITLE-ABS-KEY (assess*) OR TITLE-ABS-KEY (quantify)).

(experimental thinking) or (linear thinking) or (nonlinear thinking) or (gut feeling) or (intuition) or (deliberation) and (entre*).[2] In total, 541 peer reviewed documents were defined as relevant after we read each paper's abstract to ensure that we selected only articles that were indeed relevant to decision-making styles. Using CitNetExplorer, a software tool for visualizing and analysing citation networks, we used an algorithmic, historiographic approach to examine the development of this research field in entrepreneurship by finding the most important publications over time.

6. *Cluster identification and interpretation*. Again using CitNetExplorer, we identified five clusters; five was set as the minimum cluster size, meaning that small clusters were merged. As to optimization parameters, the random starting value is one, ten is the number for iterations, and one was chosen as the random seed. Finally, we identified the 35 most important publications for the different decision-making styles over time.
7. *Textual analysis of titles and abstracts*. Using VOSviewer, a textual analysis of the titles and abstracts was performed to identify trends when analysing the entrepreneurship literature on decision-making styles. Eliminating common words[3] enabled us to discuss streams.

Step 3: Review of measuring intuition across research domains

8. *Identification of peer reviewed publications for measuring intuition via new interdisciplinary approaches*. In this step, we collected all publications in WoS covering the words (intuition) or (gut feeling) or (intuition) or (gut feeling) and (measure) or (assess) in either topic or title.[4]

[2] ((ALL=(Rational decision-making) OR ALL=(Intuitive decision-making) OR ALL=(Analytical thinking) OR ALL=(Experimental thinking) OR ALL=(Linear thinking) OR ALL=(Nonlinear thinking) OR ALL=(gut feeling) OR ALL=(intuition) OR ALL=(deliberation)) AND ALL=(Entre*)).

[3] The following words were excluded: age, antecedent, area, assessment, chapter, collaboration, conception, conceptual framework, consequence, consideration, construction, contribution, control, course, discipline, entrepreneur, entrepreneurship, future research, gap, goal, group, hypothesis, i.e., implementation, importance, improvement, increase, interpretation, kind, knowledge, lack, level, limitation, literature review, methodology, notion, paper, practical implication, research limitations implication, student, study, theoretical framework, today, university, word, and year.

[4] ((TI=(intuition) OR TS=(intuition) OR TI=(gut feeling) OR TS=(gut feeling)) AND (TI=(measure*) OR TS=(measure) OR TI=(assess*) OR TS=(assess*) OR TI=(quantify) OR TS=(quantify))) AND DOCUMENT TYPES: (Article).

In total, 241 peer reviewed documents through the end of 2019 were defined as relevant after we read each paper's abstract to ensure that articles were germane to measuring intuition.

9. *Categorization of measurements based on approach*. The publications were categorized into measurements based on Buckley, Buckley, and Chiang (1976), and we applied the usual standards for classifying literature reviews (Atkinson and Shaffir, 1998; Buckley et al., 1976). Figure 1 illustrates the methodological approach.

Insert Figure 1 here

Bibliometric Analyses and Results

Bibliographic map of decision-making styles across research domains

Using bibliographic mapping and clustering, Figure 2 illustrates the 2,728 most frequently cited sources in the research literature published between 1977 and 2019. It presents the five central clusters, based on citation scores across different disciplines, of the literature review which discuss different cognitive styles, such as (rational decision-making) or (intuitive decision-making) or (analytical thinking) or (experimental thinking) or (linear thinking) or (nonlinear thinking) or (gut feeling) or (intuition) or (deliberation).

Insert Figure 2 here

Using WoS data, Table 1 lists the 42 most frequent cited references, based on co-citation.

Insert Table 1 here

Figure 3 presents the five research clusters; 42 references met the minimum threshold of 100 citations of a given reference, out of 428,343 references from 20,582 documents.

Insert Figure 3 here

Cluster 1 is characterized by individual differences, intuition versus analysis, and dual processes. For instance, individual variations in rational reasoning have been analysed (Stanovich and West, 2000a, 200b). Sloman (1996) and Epstein et al. (1996) discussed individual preferences for intuitive relative to analytical information processes. Pacini and Epstein's (1999) investigated their relationship. Awareness (Evans & Stanovich, 2013) and social cognition (Evans, 2008) provide insights into intuition versus analysis. Kahneman laid the foundation through his *Thinking, Fast and Slow* (2012), his perspective on judgment and choice (2003), and his attribution of change in intuitive decisions (Kahneman & Frederick, 2012). Epstein (1994) discussed the combination of the intellectual and psychodynamic unconscious. This cluster highlights the role and impact of individuals' mindsets within organizations, especially how attitudes such as belief in intuition (e.g., Evans, 2003) can shape decisions, which is crucial for decision makers in leading positions.

Cluster 2 is characterized by documents related to emotional and moral judgements, fairness, feeling, and brain research. For instance, Rawls (1971) provided a theory of justice, and Damasio (1994) stressed Descartes's error in relation to emotion, reason, and the human brain. According to Nisbett and Wilson (1977), verbal reports on mental processes inform us more than we typically realize. Furthermore, moral psychology has received enormous attention via new synthesis (Haidt, 2007), a map (Graham et al., 2011), a functional magnetic resonance imaging investigation of emotions in moral judgments (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001), cognitive

conflict and control in moral choices (Greene, Nystrom, Engell, Darley, & Cohen, 2004), and different sets of moral decisions (Graham et al., 2009). Cushman, Young, & Hauser (2006) discussed the role of conscious rationality and intuition in moral decisions. Additionally, how intuitions intrinsically generate cultural merits has been examined (Haidt & Joseph, 2004). This cluster emphasizes how ethics and culturally variable virtues (Haidt & Joseph, 2004) are of growing importance to decision-making processes in the organizational context, which can be especially crucial for international businesses.

Cluster 3 is dedicated to conditions for intuitive decision making as a skill and implicit learning approach, social intuition, and diseases. For instance, the roles of emotion and intuition when making management decisions have been explored (Simon, 1987). In a similar vein, an intuitive executive has been proposed to understand and apply gut feelings when making decisions (Sadler-Smith & Shefy, 2004). Dane and Pratt (2007) explored intuition and its role in organizational decisions, which also relates to the role of intuition in strategic decision making (Khatri & Ng, 2000). Intuition has been also studied using a social cognitive neuroscience approach (Lieberman, 2000), and Kahneman and Klein (2009) discussed the conditions for intuitive expertise. Intuition has been explored in the context of discovery (Bowers et al., 1990) and how it can be taught (Hogarth, 2002). With respect to organizational research, this cluster focuses on intuitive decisions of executives (Sadler-Smith & Shefy, 2004), taking strategic decision making for organizations (Khatri & Ng, 2000) and innovation-driven activities within organizations into particular account (Bowers et al., 1990).

Cluster 4 focuses on epistemic intuition and cognition; it tends to be driven by theory. For instance, Cappelen (2012) and Williamson (2008) studied philosophical facets. Fundamental work regarding normativity and epistemological intuitions (Weinberg, Nichols, & Stich, 2001), semantics, cross-cultural style (Machery, Mallon, Nichols, & Stich, 2004), naming and necessity

(Kripke, 1981), and the cognitive science of folk intuitions (Nichols & Knobe, 2007) also enriched this research cluster. The cross-cultural aspect and the differences it both does and does not cause in terms of intuition are crucial for dynamic international organizations.

Finally, *Cluster 5* involves articles involving frugal heuristics and their environment. For instance, fuzzy sets have been discussed (Zadeh, 1965). Tversky and Kahneman (1981) studied the framing of decisions and the mindset of choice, heuristics, and biases during judgment under ambiguity (Tversky & Kahneman, 1974) and later provided the fundamental prospect theory regarding assessment of decision under risk (Tversky & Kahneman, 1974). Gigerenzer and Goldstein (1999) offered effortless heuristics. This cluster centres on how intuition is unfolded in uncertainty and risk. As our organizational world becomes more complex, shaken by crises, and characterized by uncertainty, time pressure, ambiguity, and instability, this is particular important for organizational decision makers facing those situations.

Different cognitive styles in the entrepreneurship literature

Figure 4 illustrates how work dedicated to cognitive styles evolves in the entrepreneurship literature. For instance, a small cluster is formed by the work of Eling Griffin, & Langerak (2014) on using intuition in fuzzy front-end decision making and the performance of merging rationality and intuition in making evaluation decisions (Eling, Langerak, & Griffin, 2015). Evaluation is a driving topic in organizations. A singular cluster is shaped by Peredo and McLean (2006), who undertook a critical review of social entrepreneurship. Another small cluster is formed by McKelvie, Haynie, & Gustavsson (2011), who illuminated the uncertainty construct with its implications for entrepreneurial activities, and Groves, Vance, & Choi (2011), who examined entrepreneurial cognition based on (non)linear thinking and its relation to success.

A comparatively strong cluster is formed by McCarthy, Schoorman, & Cooper (1993) on investment decisions by entrepreneurs and Carter, Gartner, & Reynolds (1996) on studying start-

up experience. Those two publications are in the same cluster as work by Zacharakis and colleagues, who focused on venture capitalists' decision making, such as the nature of their information source and overconfidence (Zacharakis & Shepherd, 2001, 2005) and whether they understand their decisions (Zacharakis & Meyer, 1998). This literature stream highlights the dominant role intuition can play in financial decision making in organizations that are rational at heart. Later, Bryant (2007) studied self-regulation and heuristics in entrepreneurial opportunity evaluation and exploitation, which was followed by Trevelyan's (2008) focus on optimism, overconfidence, and entrepreneurial activity. Haynie, Shepherd, & McMullen (2009) discussed the role of resources in opportunity evaluation decisions, and Grégoire, Shepherd, & Lambert (2010) examined opportunity recognition principles. This research stream emphasizes that especially during the uncertain beginnings of an organizational context, intuition plays an important role. In those early stages, according to Mitteness, Sudek, & Cardon (2012), specific angel investor traits affect whether perceived passion leads to superior assessments of funding potential. Gielnik, Frese, Graf, & Kampschulte (2012) studied creativity in the opportunity identification process and the moderating effect of diversity of information. "In user's shoes" by Prandelli, Pasquini, & Verona (2016) concerns an experimental design on the role of perspective taking in discovering entrepreneurial opportunities. While Huang (2018) focused on the role of investor gut feel in managing complexity and extreme risk, Huang and Pearce (2015) explained how to control uncertainty via the efficacy of early-stage investor gut feel in entrepreneurial investment decisions. This stream embraces the many positive effects of higher intuition such as tackling uncertainty (e.g., Waroquier et al., 2010;·Johnson & Raab, 2003), ambiguity (e.g., Klein, 2008;·Wally & Baum, 1994), complexity (e.g., Hodgkinson & Sadler-Smith, 2018; Mesterman, 1967; Nutt, 1999), promoting creativity (e.g., Hodgkinson, Sadler-Smith, Burke, Claxton, & Sparrow, 2009; Sinclair, 2020a, 2020b), opportunity identification (e.g., Burmeister & Schade, 2007; Huang, 2018; Kanze,

Huang, Conley, & Higgins, 2018), and better forecasting (e.g., Blume & Covin, 2011; Eling et al., 2014; Groves et al., 2011).

Insert Figure 4 here

Measuring intuitive decision making

Although intuition has received regular attention in recent years, the testability of a mechanism concerning fast and unconscious activities has faced limitations in previous contributions, such as post surveys and interviews (Sinclair, Ashkanasy, & Chattopadhyay, 2010). Table 2 summarizes the different measurement techniques.

Insert Table 2 here

Overall, the nature of intuition and how to measure its differences between individuals have generally been measured by commonly used questionnaires of constructs (Pretz & Totz, 2007). Wang et al.'s (2017) meta-analysis focuses on the well-established and most frequently used scales to measure decision-making styles. Examples include Betsch's (2004) preference for intuition and deliberation scale, Van den Broeck, Vanderheyden, & Cools' (2003) cognitive style indicator, Epstein et al.'s (1996), and Pacini and Epstein's (1999) various rational–experiential inventories. Groves, Vance, & Paik (2008) provide a linear–nonlinear thinking style profile. The Myers-Briggs Type Indicator (Myers & McCaulley, 1985) is used across different disciplines (Mitchell & Shuff, 1995). The AIM Survey assesses the relationship between managers' intuition and their performance (Glaser, 1995); finally, there is Mayring's qualitative content analysis (Fröhlich et al.,

2019). Other researchers designed the Free-Will Intuitions Scale to empirically measure folk intuitions in free will debates (Deery, Davis, & Carey, 2015).

The Cognitive Reflection Test (CRT, Frederick, 2005) is also a well-known tool for measuring intuitive–analytic cognitive styles. The CRT is a three-item, performance-based scale (Zhang, Highhouse, & Rada, 2016) that measures an individual's power to contain incorrect heuristics in favour of deliberation. Several studies have assessed intuition and deliberation using the CRT (e.g., Millet & Aydinli, 2019; Patel, Baker, & Scherer, 2019). For instance, Travers et al. (2016) deployed a mouse-tracking methodology with the CRT. Applying the CRT results suggests that financial traders prefer reflective thinking and use mental heuristics (Thoma, White, Panigrahi, Strowger, & Anderson, 2015). Furthermore, several questionnaire constructs are used in organizations in the health area (e.g., Use of Intuition by Nursing Students Scale and the Emotional Intelligence Level Assessment Scale developed by Turan et al., 2019; the Smith Intuition Instrument developed by Smith, 2007; Cognitive Task Analysis developed by Zehnder, Law, & Schmölzer, 2019; and the Intuitive Eating Scale developed by Duarte, Gouveia, & Mendes, 2016; Multiple Brain Preference Questionnaire developed by Soosalu, Henwood, & Deo, 2019).

Intuition has been predominately measured in the laboratory context and rather than in real-world situations in the organizational field (e.g., visual coherence task developed by Remmers, Topolinski, Buxton, Dietrich, & Michalak, 2017; semantic coherence task developed by Bowers et al., 1990, and applied by Bolte & Goschke, 2005; Topolinski & Strack, 2009a, 2009b, 2009c; Topolinski & Reber, 2010). Overall, people's ability to judge the veracity of their own intuitions is limited (Leach & Weick, 2018).

Discussion

Previous researchers have claimed that well-known and frequently applied scales such as the CRT are a valid measure of reflective but not of intuitive thinking (Pennycook, Cheyne, Koehler, &

Fugelsang, 2016). Using a series of experiments, Lufityanto et al. (2016) were the first to provide evidence that nonconscious information can boost decision exactness, increase self-confidence, and speed up response times. Previous work has stressed that intuition can be improved unconsciously (Raio et al., 2012). However, Lufityanto et al. (2016) focused on a random-dot-motion task, which is not remotely close to a real-life environment. Thus, there is a need for innovation-driven instruments to measure intuition and its performance in real-life decision making in the organizational context. In this regard, our first cluster provides ideas to explore attitudes such as belief in intuition (e.g., Evans, 2003) that can shape one's preferences for intuitive decision making. Furthermore, those attitudes could be compared between cultures, decision contexts, organizational positions, and gender to explore their impact on decision makers and thus the organizations they serve.

Intuition plays a role in complex situations like entrepreneurship. Entrepreneurial trajectories—especially during the early years—represent insecure human challenges with a complex, nonlinear, iterative, and rapid decision-making nature (e.g., Fellnhofer, 2017). Questionnaire-based research may be influenced by recall negativity bias, so more prospective studies over a longer time horizon are needed. Cluster 2 provides ideas referring to the body as a central messenger of intuition. For instance, manual muscle testing (MMT) is a non-invasive evaluation tool that assesses muscular strength and neuromusculoskeletal integrity. Through muscle response testing (MRT), a specific type of MMT, muscles are tested for neural control and response to semantic stimuli such as spoken lies. MRT has regularly proven significantly effective at differentiating lies from truths when compared to both intuition and chance (Jensen, Stevens, & Burls, 2016). However, this technique has never been applied in any real-world organizational context. Furthermore, the technique of quantifying skin conductance responses showing peripheral

(bodily) signals related to emotions, decisions, and behaviours is another well-established, robust, widely used, and relatively inexpensive method that can be incorporated into organizational research (Christopoulos, Uy, & Yap, 2019). These body instruments could be used to measure intuition within organizational contexts to investigate how individuals know without knowing. For instance, skin conductance levels of managers or entrepreneurs could be tracked via the latest technological tools through online experiments over a longer period of time; their ventures' performances could be used for comparison. This could also be conducted at lower levels of responsibility, such as team leaders, which might radically increase our knowledge of how attitudes in different societies and cultures could impact intuitive decision making in the organizational context.

As to Cluster 3, seniority, leadership, and experts all play crucial roles in intuitive decision making. Tzioti, Wierenga, & van Osselaer (2014) stressed that following intuitive advice (e.g., someone says "my gut tells me so" or "this is what my intuition says") differs depending on advisor *seniority*. There is evidence that decision makers question a priori the worth of intuitive advice; however, intuitively justified advice from senior advisors is more often followed (Tzioti et al., 2014). Based on data aggregated from 28 studies (total N = 13,386) to assess the connection between character strengths and economically relevant behaviours, *leadership* is linked with inefficient, anti-social behaviours, risk taking, and trusting one's intuitions. These findings shed light on which types of individuals are likely to be most successful in which decision contexts (Jordan & Rand, 2018). The core idea of intuition is to trust one own's intuition and not others', as they could be subject to biases. However, we can expect some cultural differences. While most studies focus on Western cultures (Brady, Fryberg, & Shoda, 2018; Henrich, Heine, & Norenzayan, 2010), there are also inconsistent findings in intuition studies comparing Eastern and Western cultures (Allinson & Hayes, 2000; Hayes, Allinson, & Armstrong, 2004; Nisbett, Choi, Peng, &

Norenzayan, 2001; Norenzayan, Smith, Kim, & Nisbett, 2002; Savvas, El-Kot, & Sadler-Smith, 2001; Sinclair, 2020b). In this regard, Cluster 3 highlights the importance of training one's intuition on a regular basis to become familiar with one's skills in different (cultural or contextual) settings. Whether individuals' intuition improves over time within the organizational context if they focus on training their intuition for organizational questions has not yet been investigated. Such training could be rather simple; for instance, employees could guess daily sales numbers, customer reactions, and so on. This would be a natural outgrowth of the role play that is already a widely used technique in organizations large and small.

Our intuition allows us to see the bigger picture because it automatically operates in complex situations (Jung, 2014). In line with Cluster 4, the fundamental point of departure is Freud's frequently repeated statement that most decisions are made on an unconscious level. In his highly influential *The Interpretation of Dreams*, Freud emphasized the "royal" communication between our nonconsciousness and consciousness (Hisrich & Jankowicz, 1990; Rodríguez, 2001). Consequently, analysing how managers' or entrepreneurs' dreams are (or are not) correlated with their daily intuitively or analytically driven decision making should enrich our understanding even further. If people pay attention to their dreams, they will be able to tap into the mind's unconscious thinking processes or the intuitive part of the brain. Thus, dreams and hypnosis are potential future avenues to measure intuition's impact on decision making in the organizational context, perhaps through an intimate, intensive research approach with a qualitative focus using dream and day diaries. Such an approach could track and explore in detail how an individual's nonconscious already knows something before any particular event occurs, all without the individual's conscious knowing.

We can only fully analyse decision making if we also examine the unconscious. In line with Cluster 5, the study of magical frameworks shows potential alternative and innovative avenues

(Garcia-Pelegrin et al., 2020). In this regard, neuroimaging and neurophysiologic data from functional magnetic resonance imaging, electroencephalography, magnetoencephalography and electrocorticography for assessing brain networks during unconscious and conscious decision making with various connectivity measures, graph theory, and methods that reveal dynamics might lead to further valuable insights (Mashour & Hudetz, 2018). However, this is a cost-intensive option, and a more practical approach could involve analysing people's faces during decision making, because heart rate variability is an intuition receptor (Sinclair, 2020) that can be tracked via the latest remote tools (Alam et al., 2020; Oviyaa, Renvitha, & Swathika, 2020; Qiao, Zulkernine, Masroor, Rasool, & Jaffar, 2021; van der Kooij & Naber, 2019) using evidence accumulator models, as in previous work (e.g., Brunton, Botvinick, & Brody, 2013; Lufityanto et al., 2016). Such analysis could enrich our insights around how intuition unfolds, especially when making uncertain, complex, and risky decisions in organizations. In line with the results from the previous clusters, this research approach could track and explore how individuals' nonconscious knowing by examining micro-level bodily reactions. As our organizational world becomes more complex, shaken by crises, and characterized by uncertainty, time pressure, ambiguity, and instability, this knowledge will be even more important for decision makers.

Implications

The need to quantitatively measure intuition is crucial in many different fields and is especially vital in the organizational context. In workplace hiring, for instance, a new measurement tool for intuition could replace questionnaires that rely on people's opinions about their own feelings about intuition. Scholars stress that intelligence tests are ineffective at assessing appropriate candidates for employment. An intuition measurement could support human resource recruiting to assess candidates' intuition potential. For instance, Glaser (1995) provided evidence that intuition supports individuals working in research and development and that those who use it are more

successful than their colleagues. Furthermore, intuition can play an equally important role in employee performance (Richey, Harvey, & Moeller, 2010). For instance, career guidance and counselling as a component in life orientation are often based on intuition. New intuition measurement instruments could be used for training and staff development to empower employees and adequately prepare them for the new world of work (Dama, Mathwasa, & Mushoriwa, 2019).

Limitations

This work has certain limitations. First, it may be criticized for the enormous body of knowledge it covers and thus potential biases that it risks. Consequently, readers are asked to exercise caution regarding the methods applied. In particular, while bibliographic mapping and visualization have achieved significant acceptance in science, this review covers only peer reviewed publications in two major databases. Despite diverse quality cross-checks, contributions such as reports and books are not taken into account. Moreover, the cluster titles are based on qualitative interpretations, though with the support of quantitative methods. Cluster interpretation is difficult because the borders between clusters are almost inevitably vague, sometimes significantly so. However, by identifying and discussing these clusters, we refer to the most powerful thoughts in the research literature. The recognition of patterns requires further research. In spite of these limitations, this review is the first visualized appraisal and mapping of the research literature on different thinking styles. It emphasizes above all ideas for future research.

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APPENDIX A

TABLE 1
Top 42 most cited references across research domains

	Citations	Co-citation links	Cluster
Zadeh, 1965	100	5.00	
Tversky and Kahneman, 1981	105	287.00	
Tversky and Kahneman, 1974	259	796.00	5
Kahneman and Tversky, 1979	142	278.00	
Gigerenzer and Goldstein, 1999	100	328.00	
Williamson, 2008	143	255.00	
Weinberg et al., 2001	114	243.00	
Nichols and Knobe, 2007	112	156.00	4
Machery et al., 2004	131	264.00	
Kripke, 1981	134	140.00	
Cappelen, 2012	103	200.00	
Simon, 1987	115	570.00	
Sadler-Smith and Shefy, 2004	109	491.00	
Lieberman, 2000	129	546.00	
Khatri and Ng, 2000	142	540.00	3
Kahneman and Klein, 2009	170	727.00	
Hogarth, 2001	188	850.00	
Dane and Pratt, 2007	262	978.00	
Bowers et al., 1990	117	319.00	
Rawls, n.d.	195	256.00	
Nisbett and Wilson, 1977	121	348.00	
Haidt, 2007	110	425.00	
Haidt and Joseph, 2004	103	356.00	
Haidt, 2001	421	1320.00	
Greene et al., 2004	121	477.00	2
Greene et al., 2001	217	746.00	
Graham et al., 2011	100	282.00	
Graham et al., 2009	136	369.00	
Damasio, 1994	169	565.00	
Cushman et al., 2006	106	424.00	
Stanovich and West, 2000	221	1128.00	
Sloman, 1996	223	1030.00	
Pacini and Epstein, 1999	140	620.00	
Kahneman, 2011	349	1031.00	
Kahneman, 2003	219	954.00	
Kahneman and Frederick, 2002	120	594.00	1
Frederick, 2005	197	683.00	
Evans and Stanovich, 2013	162	651.00	
Evans, 2003	101	524.00	
Evans, 2008	232	984.00	
Epstein et al., 1996	193	794.00	
Epstein, 1994	201	1018.00	

Note. Citations and Co-citations scores are based on VOSviewer's bibliometric multidimensional scaling (van Eck & Waltman, 2009).

TABLE 2
List of measurement techniques for intuition

	Amount
Opinion - Individual - Survey	147
Analytic - Internal Logic - Mathematical modelling	32
Archival - Primary - Content Analysis	24
Empirical - Case - Observation	21
Empirical - Field - Time and Motion	5
Empirical - Laboratory - Simulation	5
Archival - Secondary - Sampling	4
Opinion - Group - Delphi	3
	241

APPENDIX B

FIGURE 1
Methodological approach

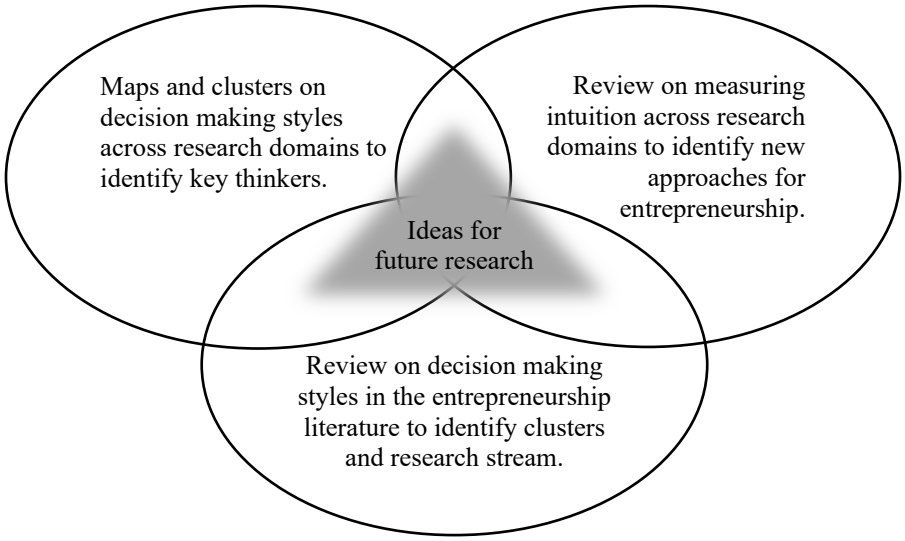


FIGURE 2
Results with five clusters based on citation scores (VosViewer)

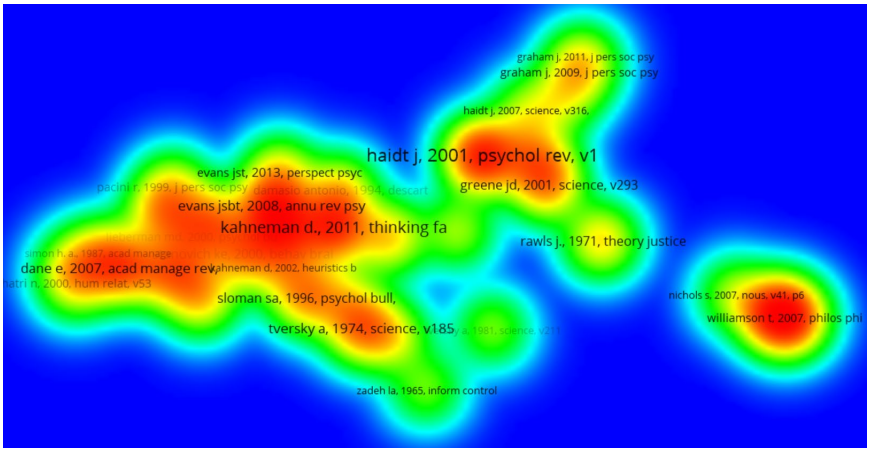
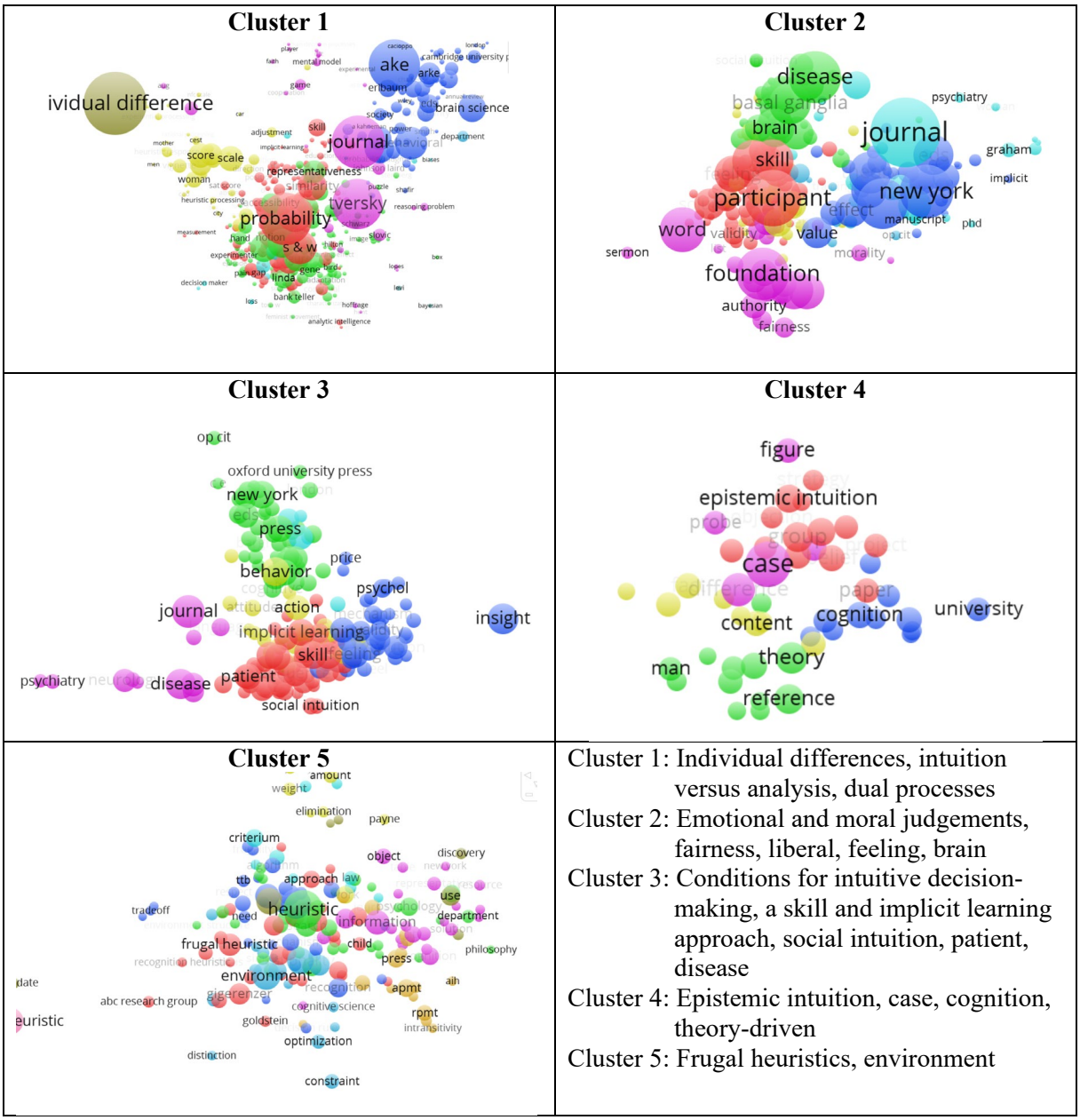


FIGURE 3
Research clusters from all literature dedicated toward cognitive decision-making styles



Cluster 1: Individual differences, intuition versus analysis, dual processes
Cluster 2: Emotional and moral judgements, fairness, liberal, feeling, brain
Cluster 3: Conditions for intuitive decision-making, a skill and implicit learning approach, social intuition, patient, disease
Cluster 4: Epistemic intuition, case, cognition, theory-driven
Cluster 5: Frugal heuristics, environment

FIGURE 4
Key authors regarding different cognitive style in the entrepreneurship discipline