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ORIGINAL RESEARCH

When rational decision-making becomes irrational: a critical assessment and re-conceptualization of intuition effectiveness

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Abstract Intuition can lead to more effective decision-making than analysis under certain conditions. This assumption can be regarded as common sense. However, dominant research streams on intuition effectiveness in decision-making conceptualize intuition inadequately, because intuition is considered either detrimental or as a form of analysis. Current findings in general intuition research show that intuition is a holistic form of information processing that is distinct from analysis and can be superior in some cases. To reconcile this mismatch, this article first critically assesses dominant conceptions on intuition effectiveness and then offers a re-conceptualization that builds on current findings of general intuition research. Basically, the article suggests the structuredness of the decision problem as the main criterion for intuition effectiveness, and proposes organization information processing theory to establish this link conceptually. It is not the uncertainty but the equivocality of decision problems that call for an intuitive approach. The article conclusively derives implications for further research and discusses potential restrictions and constraints.

Keywords Rationality · Intuition · Analysis · Decision-making effectiveness · Intuition effectiveness · Equivocality · Organization information processing theory

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1 Introduction

In managerial decision research, there is a steadily growing interest in the role intuition plays in decision-making (Sadler-Smith 2016). Whereas research initially focused on the shortcomings of intuition in the decision-making process, the focus has slightly shifted towards the benefits of intuition, assuming that, under certain conditions, intuition may be as good as or even superior to analytical thinking (Aczel et al. 2011; Burke and Miller 1999; Dane et al. 2012; Dane and Pratt 2007). Although the concept of intuition suffered for a long time from a lack of definitional clarity (Salas et al. 2010), a widely accepted and commonly shared definition of intuition in the context of decision-making stems from Dane and Pratt (2007) who define intuition "as affectively charged judgments that arise through rapid, non-conscious, and holistic associations" (p. 33). This definition differentiates intuitive from analytical decisions as slow, conscious and sequential deliberations. It is consistent with the growing consensus that intuitive and analytic approaches refer to two distinct types of information processing systems (Dane et al. 2011; Dane and Pratt 2007; Epstein 1994; Evans 2010; Hodgkinson and Clarke 2007), implying that intuition cannot be reduced to a shortcut to deliberation (Betsch and Glöckner 2010). A recent meta-analysis indicating that intuition and analysis are two independent constructs strongly supports this view (Wang et al. 2017). Intuition must, therefore, be considered as a distinct capacity with its own strengths and weaknesses.

Research on intuition effectiveness is essentially based on the assumption that intuition is not inferior to analysis and can lead to effective decisions (Dane 2011). Intuition effectiveness is tied to the ecological rationality of an intuitive approach, which refers to the degree a decision-making approach is adapted to the structure of the environment (Gigerenzer and Gaissmaier 2011; Gigerenzer and Todd 1999; Todd and Gigerenzer 2007). The concept of ecological rationality draws on Simon's metaphor of rationality as a pair of scissors "whose two blades are the structure of task environments and the computational capabilities of the actor" (Simon 1990: 7). Accordingly, intuition is regarded as ecologically rational if it matches the structure of the environment more adequately than an analytical approach. In this case, intuition effectiveness is assumed to be higher than analysis effectiveness, and analytically approaching the decision problem is assumed to be irrational. Rationality should, therefore, be understood as something distinct from analysis, even though rational behaviour is often explicitly defined as analytical, logical and conscious (Dane et al. 2011; Dane and Pratt 2007; Denes-Raj and Epstein 1994; Epstein 1994; Evans 2010; Kaufmann et al. 2014; Reber et al. 2007). Otherwise, rational decision-making could be considered as being (ecologically) irrational in some cases, which creates a paradoxical constellation and should, therefore, be avoided. Besides, equating analysis with rationality implies that analysis is rational by definition (Evans and Stanovich 2013), although it is exactly this often implicitly held assumption that should be questioned in research on intuition effectiveness. Unfortunately, dominant conceptions on intuition effectiveness do either assume

that intuition is not fundamentally different from analysis or that intuition can at best coincide with the analytically derived optimal solution.

Against this background, the aim of the present paper is to critically assess dominant conceptions about intuition effectiveness, namely Simon's concept of intuition, the *heuristics and biases program* and the *fast and frugal heuristics program*, to re-conceptualize intuition effectiveness in a way that corresponds to current findings of general intuition research in a better way. The paper suggests the structuredness of the decision problem as the main criterion for intuition effectiveness. *Organization information processing theory* is introduced as a promising frame to further study intuition effectiveness. As the theory considers the equivocality of an environment as being distinct from its uncertainty, the article shows that it is equivocality and not uncertainty that determines intuition effectiveness. The article conclusively derives implications for further research and discusses potential restrictions and constraints.

In general, the term intuition can refer both to a process and an outcome. As the focus lies on the distinction between intuition and analysis as types of information processing, the article follows a process view of intuition which is sometimes referred to as intuiting (Crossan et al. 1999; Dane and Pratt 2007; Gore and Sadler-Smith 2011; Sadler-Smith 2016; Sadler-Smith and Sparrow 2008; Sinclair 2010). Through this, we follow the argument "that researchers should concentrate on investigating the processes underlying intuition first before making strong claims about its performance" (Glöckner and Witteman 2010: 13).

2 A critical assessment of dominant conceptions on intuition effectiveness

2.1 Herbert Simon's view on intuition

Arguably, Simon proposed one of the most influential views on intuition in the context of decision-making (Akinci and Sadler-Smith 2012; Epstein 2010; Frantz 2003; Sadler-Smith 2016). Among others, it serves as a basis for the *naturalistic decision-making approach* (Klein 1998; Lipshitz et al. 2001) and the *fast and frugal heuristics program* (see below). Simon refers to intuition as subconscious information processing directly related to pattern recognition. As pattern recognition, intuition reflects the ability to recognize familiar patterns within an instance, for example, when recognizing the familiar face of a friend (Simon 1983). The key to this understanding of intuition is the experience of the decision maker leading to intuitive expertise over time. Through the long experience of a decision maker, familiar patterns emerge in a situation suggesting a specific solution. This can be a possible move for a chess player, a medical diagnosis for a medical doctor or a financial risk for a manager. Specific associations evolve over time and persist depending on their contribution to success in the past (Prietula and Simon 1989).

For Simon, intuition and analysis do not represent two distinct types of information processing. He views intuition as analysis "frozen into habit and into the capacity for rapid response through recognition" (Simon 1987: 63). He

explicitly denied "that there is analytic thinking and intuitive thinking" (Simon 1993: 405). For him, intuition "is a sophisticated form of reasoning based on chunking that an expert hones over years of job-specific experience. Intuition grows out of experiences that once called for analytical steps" (Prietula and Simon 1989: 122). Intuition as a process, therefore, does not operate independently of analysis. Rather, intuition and analysis are two essential complementary components of the same kind of thinking process (Simon and Gilmartin 1973). The main difference between intuition and analysis is that the former operates subconsciously while the latter does not, "but there is no difference in the logic being applied" (Simon 1987: 61). Consequently, intuition and analysis are equally constrained by the bounded rationality reflected in the cognitive limitations of the decision maker. In this sense, both can be ecologically rational, as long as "it turns out that the behaviour prescribed is well adapted to its goals—whatever those goals might be" (Simon 1993: 393).

To understand Simon's view on analytic and intuitive information processing, one needs to look at his work in the field of artificial intelligence. Simon regarded the nature of human and computer information processing as being very much alike. According to Simon and Newell, both depend upon the same type of information processing leading to pattern recognition (Frantz 2003; Newell and Simon 1972; Simon 1978; Simon and Newell 1964). Comparing humans and computers, Simon and Newell assumed that there is a strong "similarity in their capacities for executing and organizing elementary information processes" (Simon and Newell 1964: 282). Just like a computer, the human information processing system "operates almost entirely serially, one process at a time, rather than in parallel fashion" (Simon 1978: 273). The computed units are explicit (i.e., discrete, countable and combinable), and the process can be decomposed into smallest units: the so-called *elementary information processes*.

The problem with such a view is that it denies the fact that real decision problems are often open to multiple interpretations. Decomposing a situation into the smallest units to serially compute them is only possible when ambiguity has already been reduced to an unambiguous interpretation. This neglect of ambiguity is one of the main criticisms of Simon's conception of human information processing. For example, Mumby and Putnam (1992) point out that there is no space for ambiguity in Simon's view: instead of tolerating or embracing ambiguity to simultaneously recognize divergent or contradictory positions, ambiguity must be reduced to zero, leading to zero ambiguity tolerance. Similarly, Dreyfus (1999) emphasized in critical response to Simon that the human ability "to deal with situations which are ambiguous without having to transform them by substituting a precise description" (p. 107) is an implicit form of information processing that is fundamentally different from the formalizable logic of analysis. In general, implicit forms of information (or knowledge) that cannot be fully converted to explicit forms of information (or knowledge) have no room in Simon's worldview (Foss 2003; Miller 2008).

Simon's view on intuition does acknowledge that intuitive decisions are based on rapid and unconscious processes, but it fails to accept that such processes are able to compute information holistically instead of sequentially. However, if intuitive and

analytic thinking are assumed to apply to the same logic, the question of their respective effectiveness within certain environmental structures can hardly be answered (Hammond et al. 1987). The only reason why Simon did not view intuition as irrational is because it represents analyses, whether it is frozen into habit or not. Pattern recognition in the sense of Simon emerges solely from reproducing previous solutions that are strictly rule based, which is in stark contrast to recent works linking pattern recognition to holistic and parallel forms of thinking (Baldacchino et al. 2015; Betsch and Glöckner 2010; Sadler-Smith and Sparrow 2008). Beyond this, intuition is more than just reproduction. It also combines elements to produce new and creative solutions, making intuition a unique human ability (Akinci and Sadler-Smith 2012; Gobet and Chassy 2009; Sinclair 2010).

2.2 The heuristics and biases program

When it comes to the detrimental use of intuition in decision situations, the *heuristics and biases program* of Kahneman and Tversky is arguably the most prominent line of research and the main foundation of the behavioural decision theory. The behavioural decision theory questioned the assumptions of normative decision theory by showing that people in real decision situations have unstable and ambiguous preferences (Slovic et al. 1977). The basis of this descriptive shift in decision theory was essentially based on the demonstration of three judgmental heuristics: representativeness, availability and anchoring (Kahneman and Tversky 1972, 1973; Tversky and Kahneman 1973, 1974). Representativeness, for example, states that people evaluate probabilities by the degree to which an object resembles a class. When representativeness is high, the probability that the object originated from this class is judged as high, although this might not be the case (Tversky and Kahneman 1974). Kahneman and Tversky used the term heuristics to refer to the intuitive use of such mental shortcuts that "are quite useful, but sometimes they lead to severe and systematic errors" (Tversky and Kahneman 1974: 1124). These intuitively used heuristics are simple rules of thumb people use to make a fast decision in an uncertain environment and to reduce the complexity of the task of assessing probabilities and expected outcomes (Cristofaro 2017).

The focus of the *heuristics and biases program* lies on well-structured problems from which optimal solutions can be unequivocally derived. Accordingly, heuristics represent inferior strategies, which at best coincide with the optimal solution, but in many cases deviate from the 'rational norm'. This deviation is referred to as bias (Artinger et al. 2015). While the correct answer is given by a formal rule, bias occurs as the discrepancy between the correct and the actual answer (Montibeller and von Winterfeldt 2015). Because, according to Kahneman and Tversky, heuristics are mainly used intuitively, intuition is unilaterally used to emphasize the downfalls of intuitive decision-making, as opposed to analytical decision-making. The latter is equated with rationality, because rationality is strictly understood as reasoning following the rules of probability theory (Chase et al. 1998). Hence, the results of the *heuristics and biases program* have often been interpreted as showing that intuitive decision-making is inferior to analytical decision-making (Kahneman 2011; Myers 2010; Nisbett and Ross 1980).

The picture becomes less clear, however, when one looks at how Kahneman and Tversky defined intuition. Much of their work leaves the term undefined, and different articles seem to apply different meanings (Hogarth 2010; Sturm 2014). Kahneman and Tversky (1982: 124) call a judgment "intuitive if it is reached by an informal and unstructured mode of reasoning, without the use of analytic methods or deliberate calculation". Later, Kahneman (2002: 449) defined intuition as "thoughts and preferences that come to mind quickly and without much reflection". Nevertheless, it was not until the early 2000s that Kahneman started to explicitly subscribe to a dual-process theory of intuition, according to which two systems or processes of decision-making are distinguished (Kahneman 2003, 2011; Kahneman and Frederick 2002, 2005). Following Stanovich and West (2002), these two systems are referred to as system 1 and system 2. Whereas "system 1 quickly proposes intuitive answers to judgment problems as they arise", "system 2 monitors the quality of these proposals, which it may endorse, correct, or override" (Kahneman and Frederick 2005: 267). System 1 follows intuitive heuristics, which are often faulty, and system 2 applies rules of logic and leads to correct solutions. System 1 operates effortlessly, automatically and fast. System 2, in contrast, is effortful, controlled and slow.

Although Kahneman and Tversky initially viewed their work as being "consistent with the conception of bounded rationality originally presented by Herbert Simon" (Tversky and Kahneman 1986: S272–S273), their understanding of intuition is quite different. As outlined above, Simon rejected the idea of two independently operating systems. For Simon, intuition can be rational, because intuition is analysis (frozen into habit); for Kahneman and Tversky, intuition cannot be (boundedly or unboundedly) rational, because it is fundamentally different from analysis ascribed to rationality (Griffin et al. 2012). For the latter, intuition is only regarded as effective when people lack formal models for computing the probabilities in the face of uncertainty (Tversky and Kahneman 2002). However, this intuition effectiveness is based solely on the decision maker's ignorance.

Nevertheless and despite their differences, neither Simon's nor Kahneman and Tversky's approach is capable of incorporating intuition as a distinct type of information processing able to trump analysis under certain conditions. Kahneman and Tversky's approach is, if at all, only valid in well-structured environments, whereas intuition is often said to be effective especially in ill-structured environments (Dane and Pratt 2007; Hogarth 2010; Magnusson et al. 2014; Pretz 2011; Sadler-Smith and Sparrow 2008; Salas et al. 2010). This focus on well-structured problems is often linked to the fact that Kahneman and Tversky mainly derived their insights from experiments with clear settings, which lack the equivocality of real life decision problems (Bowers et al. 1990; Chase et al. 1998; Felin et al. 2017; Hodgkinson et al. 2008; Shapira 2008).

2.3 The fast and frugal heuristics program

The *fast and frugal heuristics program* is often contrasted with the *heuristics and biases program* emphasizing the benefits of intuition instead of its detriments. According to Gigerenzer et al. (1999) and Gigerenzer and Gaissmaier (2011),

decision makers can make effective decisions by intuitively relying upon heuristics or, synonymously, rules of thumb. Heuristics are conceptualized as simple serial rules that ignore part of the information. They are opposed to complex strategies that consider more information and apply more complex methods. Comparing heuristics and complex strategies, the *fast and frugal heuristics program* assumes that the use of heuristics can be quicker, more frugal and/or accurate (Gigerenzer and Gaissmaier 2011). The use of a heuristic within an environment is ecologically rational when there is a match between the heuristic and the environment. With their heuristic toolbox, Gigerenzer and colleagues specified several heuristics that might be applied to make adaptive decisions in specific environments (Gigerenzer and Selten 2001; Gigerenzer and Todd 1999; Mousavi and Gigerenzer 2014). For example, the take-the-best heuristic relies only on the most valid cue, and is ecologically rational in environments where a most valid cue can be unequivocally identified. On the other hand, the tallying heuristic gives the same weight to different cues, and is, therefore, ecologically rational in environments with several similarly valid cues (Fiedler and Sydow 2015).

Although intuition and heuristics are closely linked to each other in the *fast and frugal heuristics program*, they are not synonymous. For Gigerenzer (2008: 16), intuition refers "to a judgment (1) that appears quickly in consciousness, (2) whose underlying reasons we are not fully aware of, and (3) is strong enough to act upon". This definition apparently follows the assumption that intuition is rapid and unconscious. A heuristic, on the other hand, is a strategy that can be used both consciously and unconsciously. However, only the "unconscious use of a heuristic is called an intuition" (Mousavi and Gigerenzer 2014: 1673). This implies that within the *fast and frugal heuristics program* and unlike the *heuristics and biases program*, a structural difference between intuition and analysis is not made. Rather, Gigerenzer et al. view themselves as direct followers of Simon's view on intuition and analysis (Gigerenzer et al. 1999; 2002) and reject the idea of dual-process theories in which intuition and analysis refer to distinct types of information processing systems (Gigerenzer 2010; Gigerenzer and Regier 1996; Kruglanski and Gigerenzer 2011). The problems already outlined regarding Simon's view on intuition in this context apply here accordingly. As a consequence, Gigerenzer et al. do not essentially contrast the effectiveness of intuition compared to analysis, but of using simple compared to complex rules.

Furthermore, the shift of emphasis from Simon's view of intuition as pattern recognition to the definition of intuition as the use of heuristics is also problematic. The opinion that "good intuitions must ignore information" (Gigerenzer 2008: 85) contradicts the widely held view that, due to parallel processing, intuition is able to handle a huge amount of information (Betsch 2008b; Betsch and Glöckner 2010; Dijksterhuis 2004; Dijksterhuis and Nordgren 2006; Hensman and Sadler-Smith 2011; Lieberman 2000). Intuition is said to be more effective in complex decision situations precisely because the amount of information is too huge to be processed deliberately, but can be processed unconsciously. This implies that intuition relies on a different process than simply using low effort heuristics (Sinclair 2010). As simple rules, heuristics should rather be considered as shortcuts to deliberation than

as intuitive thinking. As Betsch (2008b: 11) puts it: "if one equates intuition with heuristic processing, one would neglect the nature and the power of intuition".

Although it should not be ruled out that a simple rule may be the outcome of intuition, heuristics do not shed much light on the underlying process (Chater et al. 2018: 815). Even in theory, explaining the intuitive process as using heuristics leads to a *homunculus problem* (Dreyfus 1999; Kenny 1971), because it is not sufficient to apply a heuristic—it also has to be decided which heuristic to choose in a specific context. Although Gigerenzer et al. have identified so-called meta-heuristics (i.e., heuristics to decide which heuristic to use) (Goldstein et al. 2001), this just shifts the problem to a different level, raising the problem of how someone decides how to decide which heuristic to use (and so on), eventually leading to an infinite regress. Instead, it should be assumed that the understanding of which information to ignore or generalize is guided by a process that operates holistically and goes far beyond considering some simple rules. As Dreyfus (1999) states, (expert) decision makers have an intuitive grasp of a situation and zero in on the relevant aspects of the problem without going through a range of alternatives.

3 Re-conceptualizing intuition effectiveness

3.1 Implicit and explicit information processing

As the previous chapter has shown, the dominant conceptions on intuition effectiveness are insufficient to adequately address the merit of intuitive decision-making and to account for intuition as a holistic form of thinking. From the perspective of these conceptions, intuition is either seen as a form of analysis (denying holistic forms of thinking) or it is under a general suspicion (being detrimental). However, when intuition is accepted as operating independently from analysis, both have to be distinguished from each other. In general, dual-process or dual-system theories assume that human information processing is accomplished by two substantially different, yet complementary, systems. Although terminology varies between the approaches, it is more or less agreed that one system operates analytically and the other intuitively (Sadler-Smith 2016). Regarding the interaction of both systems, a default-interventionist and a parallel-competitive view can be distinguished (Evans 2008). According to the first view, both systems operate in sequence. The intuitive system produces judgments by default that must be endorsed by the analytic system to correct or override faulty outcomes (Evans 2006; Stanovich and West 2000). This view is also reflected in the dual-process view adopted by Kahneman (see above). In contrast, the parallel-competitive view assumes that there are two forms of information processing: implicit and explicit information processing. The intuitive implicit information processing system deals with implicit information that is processed holistically. The analytic explicit information processing system sequentially processes explicit information (Epstein 1994; Sloman 1996; Smith and DeCoster 2000). This article adopts the parallel-competitive view for two reasons. First, it is consistent with growing evidence from neurological and experimental studies (Alós-Ferrer and Strack 2014; Healey et al.

2015; Kuo et al. 2009; Lieberman 2007). Second, only the parallel-competitive view seems to be capable of comparing the effectiveness of intuitive versus analytical decision-making, because the hierarchical default-interventionist view seems, as in the *heuristics and biases program*, to overemphasize the deficiency of intuition while simultaneously overrating analysis.

The link between intuition and implicit information processing has long been recognized. It is generally assumed that people draw on implicit knowledge when making intuitive decisions (Brunsson and Brunsson 2017; Dane and Pratt 2007; Harteis and Billett 2013; Hodgkinson et al. 2008; Kaufman et al. 2010; Müller 2011; Nonaka and Takeuchi 1995; Polanyi 1964; Reber 1989; Sadler-Smith and Sparrow 2008). Nonaka and Takeuchi (1995: 9), for example, state that "the subjective and intuitive nature of tacit knowledge makes it difficult to process or transmit the acquired knowledge in any systematic or logical manner". Implicit knowledge is acquired through experience, stored in long-term memory, and can be seen as the input to implicit information processing in intuitive decision-making (Betsch 2008b; Betsch and Glöckner 2010; Pretz and Totz 2007). From a process view, intuition "is the end product of an implicit learning experience" (Reber 1989: 232). Empirically, implicit learning has been shown to positively correlate with intuitive preference (Woolhouse and Bayne 2000) and lack of deliberation (Kaufman et al. 2010). However, implicit knowledge alone is not sufficient to constitute intuition as long as no affectively charged sense of a 'hunch' regarding the correct solution is involved. Unlike analysis, intuition always relies on a subjective or phenomenological experience that is not preceded by inference (Reber et al. 2007).

It is now widely accepted that explicit information processing is rule based, while implicit information processing is holistic (Baldacchino et al. 2015). The intuitive system can process a large amount of information simultaneously, although this kind of information processing is mostly beyond conscious control and is often difficult to articulate. In contrast, the analytic system strictly operates in a logical step-by-step manner, whereas the sequence and direction of information processing can be consciously and deliberately controlled (Betsch and Glöckner 2010). Intuitive decisions follow an overall impression of the decision problem, and analytic decisions rest upon logically decomposing the decision problem and sequentially recombining its elements (Hogarth 2010). The notion of holistic information processing is traditionally based on the Jungian concept of seeing the big picture (Sinclair and Ashkanasy 2005), and is also consistent with the basic assumptions of Gestalt theory that perception is intrinsically organized in a holistic manner (Glöckner 2008; Wagemans et al. 2012). As Betsch and Glöckner (2010) point out in this context, the holistic aspect of information processing is reflected in the perception of pattern coherence. When the degree of perceived pattern coherence is high, it is easy for people to make an intuitive decision. To detect the coherence in a pattern, scholars assume that implicit information processing results in the acquisition of complex and holistic schemas organizing the perception of a decision problem (Dane and Pratt 2007). However, such a view also implies that heuristics do not belong to the intuitive system at all, because they represent explicit rules, simple though they may be (Betsch and Glöckner 2010; Evans 2010;

Thompson 2014), although in some cases overall impressions and simple rules may lead to the same result.

3.2 The structuredness of the decision problem

Comparing the intuitive and the analytic system, their relative effectiveness is a matter of fit between the type of information processing and the structure of the decision problem at hand. When explicit information processing is more capable of handling problem-relevant information, analytic decision-making is more effective and thus ecologically rational. The reverse case applies if problem-relevant information is best processed via the intuitive system. In the latter case, intuitive decision-making is assumed to be ecologically more rational than analytical decision-making, whereby intuition effectiveness increases with the relevance of implicit information processing. In this context, research strongly suggests that the structuredness of problems plays a crucial role in determining the appropriateness of intuitive decision-making. The less a problem can be decomposed and approached sequentially, the more important intuition becomes. In ill-structured problems, the advantage shifts to intuition, making intuitive decisions more effective (Dane et al. 2012; Dreyfus 1999; Hammond et al. 1987; Inbar et al. 2010; Magnusson et al. 2014; Sadler-Smith and Sparrow 2008; Shapiro and Spence 1997).

Most prominently, Shapiro and Spence (1997) offered a continuum of problem structuredness. At one end lie well-structured problems, in which decision rules can be unequivocally applied to handle the problem (e.g., accounts receivable). At the other end are ill-structured problems for which there are no clear and widely accepted decision rules (e.g., R&D planning). According to the authors, ill-structured problems are conducive to an intuitive approach, because the decision maker copes with the problem without relying on rules. Because intuition operates holistically, the disparate elements of an ill-structured problem can be integrated into a coherent pattern guiding the decision maker towards a solution (Dane and Pratt 2007). Due to its parallel nature, the intuitive system is able to handle a huge amount of information to integrate complex sets of cues (Salas et al. 2010).

Although Simon also distinguished between well-structured and ill-structured problems (Simon 1973, 1997), he considered both as being analysable and stated that "the underlying processes used to solve ill-defined problems are not different from those used to solve well-defined problems" (Simon 1997: 128). For example, Simon describes chess, which is strictly rule based, as ill-structured. Similarly, the *fast and frugal heuristics program* does consider ill-structured problems, but focuses on simple rules as coping strategies that in fact ignore the ill-structuredness. In contrast, the *heuristics and biases program* only accounts for well-structured problems (see above). Furthermore, structuredness should not be confused with complexity. As long as the complexity of a decision problem is fully computational, the decision problem is well-structured and should be solved analytically, regardless of its complexity (Sadler-Smith and Sparrow 2008). Some scholars even regard complexity as something that is inherently well-structured (Wood 1986; Zack 2007). The same applies to the uncertainty of a decision problem: As long as the uncertainty of a decision problem is computable, an analytical approach should be

favoured. This is, for example, the case when explicit information can be acquired and systematically processed to reduce uncertainty (Daft and Lengel 1986).

As Dane and Pratt (2007) point out, the distinction between well-defined and ill-defined problems is also captured in the distinction between intellective and judgmental tasks suggested by Laughlin (1980). In intellective tasks, there is "a definite objective criterion of success within the definitions, rules, operations, and relationships of a particular conceptual system". In judgmental tasks, on the other hand, "there is no objective criterion or demonstrable solution". Such tasks "involve political, ethical, aesthetic, or behavioural judgments" (Laughlin 1980: 128). Examples for such non-decomposable judgments are entrepreneurial judgments (Foss and Klein 2012), judgments about the morality of behaviour (Haidt 2001; Sonenshein 2007), the quality of a piece of art (Julmi and Scherm 2015) or in negotiation (Eden and Ackermann 2013). As Dane and Pratt (2007) further explicate, intuition effectiveness increases with the judgmental character of a task, whereas intellective tasks are best solved analytically.

3.3 Introducing organization information processing theory

Despite the circumstance that the link between intuition effectiveness and the unstructuredness or judgmental character of a task is widely accepted, relatively little effort has been made to conceptually establish this link (Dane and Pratt 2007). To our view, *organization information processing theory* seems particularly promising to frame intuition effectiveness as depending on the type of information to be processed. *Organization information processing theory* views organizations as open social systems that have to process information to complete or coordinate their tasks. The design of information processing is seen as effective when it is capable of handling the amount and type of information in the context of a given task. Effectiveness thus requires a fit between information requirements and information processing capacities, whereby it is assumed that different decision contexts require different kinds of information processing (Daft and Lengel 1986; Tushman and Nadler 1978).

According to Daft and Lengel (1986), decision makers in organizations essentially face two information contingencies: uncertainty and equivocality. Uncertainty is defined as the absence of information and can, therefore, be reduced by collecting, gathering and processing information. As the amount of processed information increases, uncertainty decreases (Galbraith 1973). In contrast, equivocality is defined as the multiplicity of meaning conveyed by information about decision problems, whereas the different meanings cannot be simply merged or compromised. Information that is clear and leads to a single uniform interpretation is regarded as unequivocal; information that is ambiguous and refers to different and potentially conflicting interpretations is equivocal. Equivocality represents the multi-faceted nature of the problem and reflects the degree of undecidability as to how an event or condition is to be characterized (Daft and Macintosh 1981; Daft and Weick 1986; Putnam and Sorenson 1982; Weick 1979). Accordingly, when equivocality is high, "asking a yes–no question is not feasible" (Daft and Lengel 1986: 556). Instead, different interpretations have to be considered simultaneously,

calling for a both/and rather than an either/or approach in which the decision maker responds to the whole object, not just to some favoured or selected aspects (Ashforth et al. 2014). Mechanisms that reduce uncertainty are considered to be different from mechanisms that reduce equivocality. In this context, the amount and the richness of information are distinguished. Uncertainty can be decreased by considering additional information. In contrast, additional information does not necessarily decrease equivocality. In some cases, it can actually increase equivocality. The key factor in equivocality reduction is the ability to process rich information. Information richness refers to the ability of information to change someone's understanding within a certain range of time (Daft and Lengel 1984, 1986). It is assumed that the richness of information is determined by the degree of its tacitness (Gorovaia and Windsperger 2010).

To link uncertainty and equivocality with task characteristics, Daft and Lengel (1986) apply a model that differentiates tasks by variety and analysability (Daft and Macintosh 1981; Perrow 1970). Task variety is linked to uncertainty and represents the frequency of unexpected and novel events that occur during the accomplishment of the task. Low variety means that participants perceive a considerable certainty regarding the occurrence of future activities. High variety means that participants usually cannot predict future problems or consequences in advance. Task analysability as the second task characteristic reflects the way people respond to problems that occur. In tasks of high analysability, participants follow an objective and rule-based procedure to resolve problems. A correct response can be identified in most cases. In tasks of low analysability, no objective and rule-based procedure exists to resolve problems. Instead, participants have to find a solution beyond regular procedures. The analysability of a task is linked with equivocality. High analysability means low equivocality; low analysability means high equivocality. In tasks of high equivocality, "the situation is ill-defined to the point where a clear answer will not be forthcoming" (Daft and Lengel 1986: 557). Equivocality is, therefore, essentially tied to the structuredness of a decision problem. In well-structured problems, equivocality is low; in ill-structured problems, equivocality is high.

However, even if equivocality is generally tied to structuredness, different types of equivocality have to be taken into account. Some authors refer to equivocality only when individual interpretations themselves are unambiguous, but differ on a collective level (Rönnberg Sjödin et al. 2016; Zack 2007). This kind of socially induced equivocality may be referred to as *people-driven equivocality*. From this view, equivocality occurs when different backgrounds, roles, or cultures lead to different interpretations of a given problem (Rönnberg Sjödin et al. 2016). On the other hand, equivocality can also be inherent in the problem itself. This aspect is particularly evident in the so-called paradoxes that have recently attracted research (Bloodgood and Chae 2010; Calabretta et al. 2017; Putnam et al. 2016; Smith and Lewis 2011). Paradoxical decision problems consist of elements that are contradictory and interrelated at the same time, whereas these paradoxical tensions persist over time (Smith and Lewis 2011). In contrast to dilemmas or conflicts, low analysability is a defining element of paradox decision problems. Therefore, "paradoxical tensions demand a more holistic, dynamic, both/and approach, as a

one-sided or compromising response will be fleeting, and the tension will resurface, even intensify, over time" (Lewis and Smith 2014: 137). This kind of equivocality may be referred to as *task-driven equivocality*.

Although *organization information processing theory* considers information processing on the organizational level, its frame is also valid for the individual level. Whereas the information processing mechanisms to complete or coordinate tasks may be quite different on the organizational and the individual level, tasks can be characterized by uncertainty and equivocality on the individual level as well. In terms of uncertainty, this is widely accepted, but equivocality is also something that individuals have to deal with in decision-making. This is particularly evident for task-driven equivocality. However, people-driven equivocality may also occur on the individual level, if a decision maker is faced with different or even conflicting interpretations that have to be integrated into a coherent whole to make a sound decision. Regarding the information processing mechanisms, individuals can process explicit or implicit information and thus may follow an analytic or an intuitive approach. In this sense, analysis and intuition are decision-making tools (Sinclair and Ashkanasy 2005) to cope with uncertainty and equivocality, whereas the latter determines the effectiveness of either an analytical or intuitive approach. For example, Daft and Macintosh (1981) found that decision makers preferred equivocal information in ambiguous tasks and primarily relied on their experience to interpret these cues. Accordingly, both uncertainty and equivocality are relevant to adequately characterizing the context of a decision problem and should be treated as independent constructs.

What makes *organization information processing theory* particularly valuable is its implication that the key to intuition effectiveness is equivocality rather than uncertainty. The less a problem is analysable (i. e., equivocality is high), the less it can be solved analytically and the more intuitive decision-making becomes effective (Nutt 1976; Scherm et al. 2016). This stands in contrast to the majority of approaches linking intuition effectiveness with uncertainty while neglecting equivocality or seeing the latter as a feature of the former (Winkler et al. 2015). In fact, a Simonian perspective on decision-making is unable to account for equivocality as an independent construct from uncertainty, because it assumes that there is a deterministic, objective environment to which a decision maker must adapt. Restrictions arise solely from the inability to acquire and process all relevant information, leading to uncertainty (defined as the absence of information). To consider equivocality, it has to be taken into account that a decision maker not only adapts to the environment, but also shapes it. Information is not only acquired and processed, but also defined and brought into the world (Felin et al. 2017). Each representation of the environment yields different aspects and "even simple stimuli are characterized by indeterminacy and ambiguity" (Felin et al. 2017: 1055). Accordingly, Daft and Lengel (1986) regard equivocality as a feature that distinguishes human information processing from mechanical information processing. They clearly emphasize that rules and regulations are not designed to handle equivocality. Instead, they suggest that an increase in equivocality is associated with a decrease in the number of rules used to arrive at an interpretation. When, in addition, interpretations are conflicting, equivocality is likely to trigger

ambivalence, which refers to the decision maker's evaluation of an issue or event as positive and negative at the same time. Instead of favouring one interpretation over another, ambivalent decision situations call for a holistic approach to maintain a complete picture of the problem (Ashforth et al. 2014). Ambivalence is characterized "by an overall emotional experience that arises from the integrated, holistic assessment of the issue" (Plambeck and Weber 2009: 994). Obviously, any decisions arising from such an experience are "affectively charged judgments that arise through rapid, non-conscious, and holistic associations", defined above as intuition. As interpretations are personal per se, equivocality also resides in the perceptions of the decision maker (Felin et al. 2017; Putnam and Sorenson 1982) and may be a necessary condition to properly understand the decision context (Daft and Macintosh 1981). Unlike uncertainty, equivocality is always subjectively perceived, interpreted, and felt (Martin 1992).

4 Implications for future research

To date, intuition effectiveness has not been explicitly studied for decisions under equivocality. The present paper highlights that the salience of equivocality is crucial for intuition effectiveness and identifies a significant research gap. The article thus encourages taking a closer look at this connection. As the contribution of the paper is theoretical, its findings remain partly speculative and further specification and evidence is required. The research design from Rusou et al. (2013) may serve as a reference point for further research. Although the authors do not especially account for equivocality, their experiments are designed to compare analysis and intuition effectiveness in well-structured and ill-structured tasks. In the first experiment, participants were confronted with pairs of photographed faces (as an ill-structured task) or arithmetical multiplications (as a well-structured task). Within each pair, the participants had to choose the face that seemed nicer to them or the multiplication that seemed larger to them, respectively. In the second experiment, participants were confronted with pairs of scene photographs (ill-structured task) or averages (well-structured task). As the ill-structured tasks involve aesthetic judgments, they are associated with high equivocality. In contrast, the well-structured tasks are associated with unambiguous optimal solutions and thus reflect low equivocality. As the former tasks lack unequivocal best solutions, the authors looked at transitivity in pairwise choices to measure and compare analysis and intuition effectiveness. They assumed that if individuals are prone to error in decision-making (i.e. make ineffective decisions), they will commit many violations of transitivity. Results showed higher intuition effectiveness for the ill-structured tasks (compared to analysis effectiveness), and higher analysis effectiveness for the well-structured tasks (compared to intuition effectiveness). To strengthen and extend these results, future research could conduct similar experiments to take a closer look at intuition effectiveness in decision problems that involve aesthetic, political, ethical, behavioural, entrepreneurial, creative or paradoxical judgments.

Another point future research should take a closer look at is whether different types of equivocality call for different types of intuitive coping strategies. Here, it is

suggested to differentiate whether intuition is used to reduce or embrace equivocality. Equivocality can be reduced, for example, through the use of face-to-face communication (Daft and Lengel 1986; Zack 2007), group interpretive processes (Crossan et al. 1999; Daft and Weick 1986), metaphors as interpretive schemes (Hill and Levenhagen 1995), or routines (Becker and Knudsen 2005). On the other hand, there are also strategies to embrace equivocality, such as asking reflexive questions (Lüscher and Lewis 2008), applying both/and thinking (Ashforth et al. 2014), or executing purposeful microshifts (Smith et al. 2016). In negotiation situations, for example, equivocality can foster effective decisions by maintaining social order without narrowing the communication flow. An analytically derived best solution may cause the parties to back away from negotiation, as room for interpretation is needed to individually claim having trumped the counterpart to 'save face' (Eden and Ackermann 2013). When equivocality is embraced, intuition can be linked to holism, which refers to "the complete, simultaneous, and typically conscious acceptance of both opposing orientations" (Ashforth et al. 2014: 1466). In the context of this article, holism represents the (conscious) acceptance of the (unconscious) intuitive system to take the lead in decision-making. Embracing equivocality seems to be especially important for task-driven equivocality. Obviously, when equivocality is constitutive for a decision problem, it cannot be reduced, but has to be embraced (Neill and Rose 2007). Nevertheless, embracing equivocality also seems a reasonable strategy when coping with people-driven equivocality, so these relationships should be further investigated. Regarding *organization information processing theory*, an examination should be carried out regarding which mechanisms of the organization to process equivocal information can be transferred to the individual, and to what extent organizational and individual mechanisms differ.

Of course, equivocality alone is not sufficient for intuition to be an effective and thus ecological rational strategy (Dane et al. 2012). There are several other variables potentially moderating intuition effectiveness in decisions under equivocality that should be taken into account. First of all, existing research indicates that the quality of intuitive decision-making depends on having sufficient implicit knowledge and domain-specific expertise to adequately understand the decision context (Betsch 2008b; Dane et al. 2012; Dane and Pratt 2007; Hodgkinson et al. 2008; Reber et al. 2007; Sadler-Smith and Sparrow 2008; Salas et al. 2010). This is also emphasized by *organization information processing theory*, in which it is assumed that sufficient experience is necessary to interpret equivocal cues (Daft and Macintosh 1981). In addition, it has been shown that people differ in their preference to either rely on intuition or analysis, and that such a preference or thinking style influences intuition effectiveness (Betsch 2008a; Phillips et al. 2016; Stanovich and West 2000).

Last but not least, the present article calls for a systematic exploration of cognitive biases that occur when equivocal situations are approached analytically. When the type of information processing and the degree of equivocality do not match, decision-making is supposed to be ineffective, which eventually is assumed to cause cognitive bias, defined as "systematic error in judgment and decision-making" (Wilke and Mata 2012: 531). In well-structured problems, intuition is less likely to pinpoint the optimal solution. As the optimal solution is unequivocal,

relying on intuition is error prone, leading to cognitive bias. This kind of bias—which mirrors the kind of biases within the *heuristics and biases program* (see above)—can be referred to as *intuition bias* (Kirkebøen and Nordbye 2017). However, there should also be an *analysis bias* when ill-structured problems are approached analytically. In this case, an analytical approach leads to a one-sided distortion of the problem by emphasizing certain aspects while simultaneously ignoring other aspects that are similarly relevant. When equivocality is an essential feature of a problem situation, an analytical precise approach improperly narrows the necessary room for interpretation. For example, the described findings from Rusou et al. (2013) indicate that trying to analytically approach aesthetic judgments causes analysis bias. Another potential analysis bias is the tendency to give into heuristic impulses. Research suggests that experiencing ambivalence tends to trigger cognitive discomfort, so people may try to prematurely reduce ambivalence despite its functionality (Guarana and Hernandez 2014, 2016). On the other hand, resisting such impulses is assumed to positively influence holistic and thus implicit information processing (Ashforth et al. 2014). As applying heuristics reflects a rule-based approach (see above), following an analytical instead of an intuitive approach may cause analysis bias when equivocality is high. In general, further investigation is required into the assumption that analysis bias occurs when problems are non-decomposable and not amenable to analytical solutions. While the phenomenon of intuition bias is well researched, the study of analysis bias is extremely underrepresented.

5 Restrictions and constraints

There are also some important restrictions and constraints. First of all, it may in some cases be difficult to decide whether specific aspects are uncertain or equivocal because, although uncertainty and equivocality are treated as independent constructs, they are undoubtedly related in real decision situations (Daft and Lengel 1986). For example, it seems that equivocality and uncertainty sometimes refer to different stages of the decision process and directly affect each other. Defining the situation may be a strategy to reduce equivocality, but may eventually increase uncertainty when subsequently choosing between alternatives (Lehner 1996). Intuition and analysis may accordingly be of different value in different stages of the decision process. As a result, the effectiveness of rule-based behaviour may be perceived differently depending on the stage under consideration in the decision process.

Another difficulty lies in the comparison between intuition and analysis effectiveness. When a given problem is ill-structured, no objective criteria can be derived that determine the degree to which a decision is correct or biased. It cannot be ruled out that an analytical approach leads to a better decision than a poor intuitive judgment even in ill-structured problems. It is impossible to determine an objectively best intuitive judgment when structuredness is low. Even in well-structured problems, the supposed standard of rationality is often subject to dispute (Hammond et al. 1987). Although, for example, the so-called “Linda-problem”

precisely prescribes the correct solution (Tversky and Kahneman 1983), the problem has inspired scholars to give alternative interpretations of rational responses (Chase et al. 1998; Epstein 2010; Frisch 2001). Hammond et al. (1987) suggest that, to evaluate intuitive versus analytical performance, a direct comparison of a person's use of intuition and analytical rules has to be done rather than an indirect comparison between a person's intuitive process and an analytically derived rule. This seems reasonable, and focusing on choice transitivity appears to be a promising approach in this regard (Lee et al. 2009; Rusou et al. 2013). However, when the intuitive system is supposed to be of advantage because it can process implicit information holistically, the question arises whether intuition can be superior to the information processing of high-performance computers in equivocal situations (Jarrahi 2018). While computers may be good at sequentially aggregating and processing single data units, intuition may be the only way to cope with the meaningfulness of equivocal situations (Sadler-Smith and Sparrow 2008). We do not follow the widely held assumption that 'big data' always trumps intuition (McAffee and Brynjolfsson 2012), so human intuition may as well be compared with nonhuman analysis, or at least with human analysis supported by analytical tools. The question whether intuition is preferable because too much explicit information leads to "analysis paralysis" (Leybourne and Sadler-Smith 2006) or whether intuition is preferable independently from human specific restrictions should be treated separately.

Although the present paper follows a process view of intuition, intuition effectiveness essentially depends on the value of its outcome. It may, therefore, be difficult to assess intuition effectiveness looking at the process only. Nonetheless, as the quality of a decision itself is subject to interpretation, we believe that a process view is especially helpful to predict the potential value of an analytic versus an intuitive approach under certain given constraints to prescribe an adequate way of approaching a decision problem. This should also include the possibility that intuition and analysis may work well together in semi-structured tasks (Shapiro and Spence 1997).

6 Conclusion

The aim of the article was to provide a starting point for future research on intuition effectiveness. In essence, it suggests that future research should be based on three general assumptions. First, to properly assess intuition effectiveness, dominant assumptions about the nature of intuition have to be revised in favour of a parallel-competitive view of human information processing. This not only reflects current findings in intuition research to a greater extent, but also allows a comparison of the intuitive and the analytic system without implicitly assuming the former as being somehow inferior or more error prone. Second, and in line with the literature, the article argues that the distinctive problem-dependent variable is the structuredness of the decision problem, whereby intuition effectiveness increases with a decrease of problem-structuredness. Third, the article suggests *organization information processing theory* as a promising framework to further explore this relationship,

because it focuses on equivocality as an indicator for intuition effectiveness instead of uncertainty. As a result, the article outlines a set of issues for further research resting upon these general assumptions, namely specifying the relationship between intuition and equivocality, examining the moderating effects of other variables, and devoting more attention to analysis bias.

At the heart of this article lies the assumption that rationality must not be confused with a deliberate or logical and thus analytic approach. In this regard, Simon's view on rationality remains valid: a decision-making approach is ecological rational to the degree it fits to the structure of the given problem to achieve a desired goal. Irrationality, in contrast, means poor fit (Simon 1993). In this sense, following an analytical approach when confronted with maximum equivocality is greatly suspected of being irrational.

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