The Motivated Mind

The Selected Works of Arie W. Kruglanski

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4 Intuitive and deliberate judgments are based on common principles

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At times, people's judgments seem intuitive: They come to mind quickly and effortlessly, seemingly popping out of nowhere, without much conscious awareness of their origins or of the manner of their formation. Other judgments seem deliberate: They arise from a lengthy and painstaking thought process that is transparent and accessible to awareness. These two types of judgments have been treated separately in the cognitive sciences, with analytic philosophy, economics, and decision theory focused on deliberate, reflective decisions and psychoanalysis and social psychology dealing also with intuitive, spontaneous behavior. Following this division of labor among disciplines, psychologists have proposed that the mind is similarly divided. Over the last 3 decades, a considerable number of models have been premised on the assumption that judgments can be formed via two qualitatively distinct processes or systems.[1] Such dual-systems models characterized intuitive and deliberate judgments in terms of several, presumably aligned, aspects: Intuitive judgments have been assumed to be associative, quick, unconscious, effortless, heuristic, and error-prone. Deliberative judgments have been assumed to be rule based, slow, conscious, effortful, analytic, and rational. The claims for the existence of two separate systems (or processes)[2] of judgment were buttressed by a variety of empirical findings interpreted in support of the dualistic distinction (for reviews see Evans, 2008; Kruglanski & Orehek, 2007).

Though the dualistic paradigm has enjoyed considerable popularity in social cognition, judgment, and decision-making domains (e.g., Chaiken & Trope, 1999; Epstein, Lipson, Holstein, & Huh, 1992; Kahneman, 2003; Sloman, 1996; Strack & Deutsch, 2004), it has not gone unchallenged (e.g., Gigerenzer, 2009; Gigerenzer & Regier, 1996; Kruglanski, Erb, Pierro, Mannetti, & Chun, 2006; Osman, 2004). Recently, Keren and Schul (2009) offered a particularly detailed and incisive critique of the dual-systems theories. They noted that contrary to the dualistic premises, (a) dimensions assumed to distinguish the two systems (e.g., judgmental speed, ease, or resource-dependence) are continuous rather than dichotomous,[3] (b) these dimensions are unaligned rather than aligned,[4] and (c) the dimensions fail the isolability requirement that the putative separate systems of judgment operate independently of each other.

In concluding their critique, Keren and Schul (2009, p. 546) urged judgment and decision-making researchers to explore "the natural complement of dual-systems theories, namely, a unimodel." Accordingly, in the present note, we sketch a unified theory of judgment intended as a general alternative to the dualistic paradigm. This theory represents a convergence of our separate research programs and their potential integration: Kruglanski's unimodel work is complemented by Gigerenzer's work on heuristics (their function, origins, and ecological rationality); the latter is extended by the unimodel's emphasis on individual and situational differences in motivation and cognitive resources as these interact with judgmental task demands. Our theory is unified in its focus on features that different instances of judgment share. These common features include cues, processing by rules, selection of a rule, and (perceived) ecological rationality of rules.

As a preview of what is to come, we first outline our framework and discuss its properties, including questions of rule selection and ecological rationality. We show how the present approach affords an alternative interpretation of findings adduced in support of the dual-system and dual-process models and how it enables novel predictions, corroborated in specific studies.

A sketch for a unified theory of judgment

1. Judgments called intuitive and deliberative are both based on rules. These rules can be of the optimizing or satisficing (heuristic) kind. Moreover, intuitive and deliberative judgments need not be based on different rules: The very same rules can underlie both.
2. There exists a rule selection problem for both intuitive and deliberative judgments. How do individuals select a rule from their adaptive toolbox for a given problem? We argue that there are (at least) four factors involved: The task itself and individual memory constrain the set of applicable rules, whereas individual processing potential and (perceived) ecological rationality of the rule, given the task, guide the final selection from that set.
3. When two or more rules have nearly equal ecological rationality, rule conflict may occur. In such cases, proper application of a given rule may suffer interference from other competing rules.
4. Rules are based on core cognitive capacities, such as recognition memory. Individual differences in these capacities, trait or state, influence the speed and the accuracy with which a rule is executed. Moreover, the same factors also impact the selection of rules for a given task. Thus, there is no general relation between the type of rule and its difficulty of application. Rules typically characterized as intuitive (e.g., heuristics based on learned stereotypes) may be easy or difficult to apply, depending on their degree of routinization and their momentary accessibility, so may rules considered deliberative (e.g., rules of logic or mathematics).
5. There is a reciprocal relation between the difficulty of rule application and individuals' processing potential: The greater such difficulty, the more processing potential is needed for application. Consequently, when processing potential is

limited, only easy-to-apply rules will mediate judgments. In contrast, when processing potential is high, both easy and difficult rules will be considered and selected in accordance with their (perceived) ecological rationality.

6. The accuracy of both deliberate and intuitive judgments depends on the ecological rationality of the rule for the given class of problems. Accordingly, more complex rules are not necessarily more accurate than simpler ones, nor are statistical rules necessarily more accurate than heuristic rules.

In the subsequent sections, we examine the various features of our proposed framework in some detail.

Intuitive and deliberative judgments are rule based

The rule concept

By rules, we mean inferential devices for categorization, estimation, paired comparisons, and other judgmental tasks that go beyond the information given. The rule concept denotes an if–then relation of the type *if (cues) then (judgment).* The rule-based manufacture of judgments can be thought of as syllogistic. The rule itself constitutes the major premise. Rule instantiation can be thought of as the minor premise; it affords the application of the preexisting rule to a specific judgmental context. The if–then relation between cue and judgment can be probabilistic (McGuire, 1960; Wyer, 1970). In other words, the rule might affirm that if cue, or given combination of cues (X), appears then judgment (Y) is indicated with a given probability.

Some rules constitute explicit algorithms that are consciously applied; others constitute implicit, unconsciously applied associations; and yet others have been described as retrieval based (Logan, 1988; Rickard, Sin-Heng, & Pashler, 2008) or instance based (Medin & Ross, 1989), and so on. We recognize that all these mechanisms differ in numerous ways. Yet for our purpose of depicting the essential process of judgment, what matters is the conditional, if–then link generally embodied by such devices.

Our suggestion that judgments are rule based is not unique. Other authors, across diverse domains of psychology and cognitive science, have been making similar proposals (for a review see, e.g., Hahn & Chater, 1998). Rule following has been assumed to play a key role in linguistic behavior (e.g., Chomsky, 1986), animal learning (e.g., Rescorla & Holland, 1982), and perceptual phenomena (e.g., Rock, 1983), among others. Examples from the latter two domains illustrate the ubiquity of rule-based judgments.

Perceptual inferences

Hardly anything can be considered more intuitive or automatic than the visual illusions to which the human eye falls prey. Yet, students of perception have compellingly argued that these are based on (hardwired) propositional rules that our brain uses. Consider Figure 1. The dots on its left appear concave; they recede

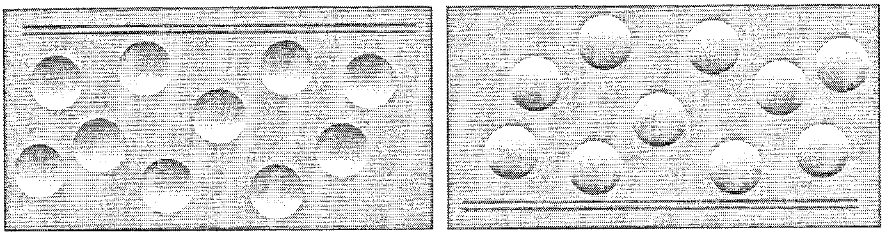

Figure 1 Unconscious inferences by a simple heuristic: convex and concave perceptions as function of shading.

into the surface and away from the observer. In contrast, the dots on the right of the figure seem convex; they appear to bulge and extend toward the observer. Intriguingly, these appearances reverse when the page is turned upside down. Now, the previously concave dots appear convex and vice versa. What explains these effects? The visual illusion appears to be based on an inferential rule that bets on two properties of the environments (Kleffner & Ramachandran, 1992).

The brain assumes a three-dimensional world and uses the shaded parts of the dots to guess in what direction of the third dimension they extend. To make a good guess, the brain assumes that:

1. Light comes from above (in relation to retinal coordinates).
2. There is only one source of light.

These two structures describe human (and mammalian) history, when the sun and the moon were the only sources of light, and only one operated at a time. The brain exploits these assumed structures by using a simple rule of thumb: If the shade is in the upper part then the dots recede into the surface; if the shade is in the lower part then the dots project up from the surface.

This visual illusion illustrates that unconscious, fast, and effortless intuitive processes can follow rules, specifically heuristic rules. It also illustrates that the rationality of the rule is ecological; that is, it resides in the match between rule and environment. If there is a three-dimensional world with the two properties described, the rule leads to good inferences; however, if this is not the case, as in the two-dimensional picture in Figure 1, the rule leads to a visual illusion. Systematic errors that are due to a reasonable bet on the environment but that fail due to specific, unexpected circumstances are "good" errors. Our point is that good errors are characteristic of every intelligent system (Gigerenzer, 2005). Intelligence means to take risks and to make bets or, to use a phrase of Jerome Bruner (1973), to go beyond the information given.

The idea that even the most basic perceptual judgments are rule based receives support from research in psychophysics (Pizlo, 2001). Whereas Fechner (1860/1966) posited that the percept is a result of a causal chain of events emanating from the object, subsequent approaches provided evidence that the percept involves an *unconscious* inference (Helmholtz, 1910/2000) from an associated bundle of sensations. An approach recently developed within the computer vision community treats perception as the solution of an inverse[5] problem that depends critically on innate constraints, or rules, for interpreting proximal stimuli (e.g., the retinal images). According to this view "perception is about *inferring* [emphasis added] the properties of the distal stimulus X given the proximal stimulus Y" (Pizlo, 2001, p. 3146). Finally, in a recent *Annual Review of Psychology* article, the investigators treated object perception as a visual inference problem and proposed that "the visual system resolves ambiguity through built in knowledge of . . . how retinal images are formed and uses this knowledge to automatically and unconsciously *infer* [emphasis added] the properties of objects" (Kersten, Mamoassian, & Yuille, 2004, p. 273).

Associative processes

Investigators in domains of classical and evaluative conditioning have agreed that rules play a key role in these patently associative processes. This notion was originally advanced by Edward Tolman (1932) in his sign learning theory of classical conditioning, a paradigmatic example of associative learning. In Tolman's theory, the conditioning procedure sets up an expectancy that a given sign or cue will be followed by some event (or significate). Such expectancy has been thought to represent a conditional rule of the if–then variety. Contemporary theorists of classical conditioning concur in that conclusion (Holyoak, Koh, & Nisbett, 1989; Rescorla, 1985; Rescorla & Wagner, 1972). The same assessment was reached with regard to evaluative conditioning, which consists of associating a valenced unconditioned stimulus (say, a smiling face) with a neutral conditioned stimulus (say, a neutral face). "We find clear support for the role of propositional process in learning. In stark contrast, little unambiguous support is found for an automatic link formation mechanism" (Mitchell, DeHouwer, & Lovibond, 2009, p. 185).

Rule following or rule conforming?

An important distinction in cognitive science has been between rule following, and rule conforming behavior (Chomsky, 1986; Hahn & Chater, 1998; Marcus, Brinkman, Clahsen, Wiese, & Pinker, 1995). Phenomena describable by rules need not reflect rule following, in that the latter, but not necessarily the former, involves mental representation of the input and output classes and of the conditional relation between them. For instance, an apple falling to the ground displays a rule-describable behavior characterized by Newton's laws, yet the apple obviously does not possess a mental representation of laws of any kind. In contrast, authentic rule following is exhibited by the behavior of an individual who decides to get out of bed on the sound of her alarm clock. In this case, the person has mental representation of the alarm, and its significance: Simply, she or he is following a rule whereby *if the alarm sounds, it is time to get up.*

Our conception of judgment formation clearly refers to rule following rather than to rule conforming.[6] Unlike the rigid nature of rule conforming, rule following can be flexible and varied. Depending on their current degree of accessibility (Higgins, 1996), rules can be primed or activated from memory (D. G. Smith, Standing, & deMan, 1992). Rules are potentially malleable; they can be learned and unlearned; they can be forgotten and retrieved. None of these characteristics applies to rule conforming, in which the entity in question behaves as a passive object at the mercy of external forces whose specific characteristics it neither registers nor recognizes.

We assume that the formation of both intuitive and deliberative judgments reflects rule following. Indeed, we suggest that examples of specific deliberative and intuitive judgments juxtaposed in the dual-systems literature often involved the operation of different rules (i.e., rules of different contents). Judgments characterized as deliberative have been often linked to statistical or logical rules (e.g., Kahneman, 2003; Kahneman & Tversky, 1973). Judgments classified as intuitive have been linked to different rules, for example, stereotypic rules about characteristics of different professions (e.g., lawyers and engineers); rules related to source characteristics, such as expertise; rules related to the ease with which instances of a category come to mind; and rules based on the fluency experience. For instance, Kahneman (2003, p. 699) classified as intuitive the various heuristics that people use (e.g., the representativeness heuristic or the availability heuristic). Yet heuristics have been generally defined as rules of thumb, displaying a propositional structure. In fact, Kahneman (2003, p. 699) himself asserted that the extensional (i.e., analytic) and prototypical (i.e., representativeness based, or intuitive) judgments are "governed by characteristically different logical *rules* [emphasis added]," suggesting that both judgmental processes are rule based. In this vein, too, Osman (2004, p. 1001) concluded from studies on tutoring aimed to increase people's use of the conjunction rule (when such rule was deemed appropriate) that such increases "occur when participants supplement one type of *rule-based* [emphasis added] reasoning . . . for another."

Intuitive and deliberative judgments can be based on the same rules

Inferential rules come in a wide variety of contents and can be stated at different levels of generality. A key distinction is between optimizing and satisficing (heuristic) rules. Bayes' rule and the maximization of expected utility are examples of optimizing rules, whereas Table 1 gives 10 examples of heuristic rules (see Gigerenzer & Brighton, 2009). Unlike Bayes' rule, a heuristic is a rule that ignores part of the information and does not attempt to calculate the maximum or minimum of a function. Optimizing rules, such as Bayes' rule and Neyman-Pearson decision theory (also known as signal detection theory) have been proposed for both intuitive and deliberative judgments (Gigerenzer & Murray, 1987). Similarly, each of the ten heuristics in Table 1 can underlie both intuitive and deliberate judgments, when deliberate denotes judgments rendered with forethought and cognitive effort. Thus, intuitive judgments not only are based on rules but also can be based on the very same rules as deliberate judgments.

Consider first the recognition heuristic that can be highly successful if there is a correlation between recognition and criterion in the environment. Based on Adaptive Control of Thought–Rational theory (ACT-R; Anderson, 1983), the

Table 1 Ten heuristics that are likely in the adaptive toolbox of humans

Heuristic	*Definition*
Recognition heuristic: Goldstein & Gigerenzer (2002)	If one of two alternatives is recognized, infer that it has the higher value on the criterion.
Fluency heuristic: Jacoby & Dallas (1981); Schooler & Hertwig (2005)	If both alternatives are recognized but one is recognized faster, infer that it has the higher value on the criterion.
Take-the-best: Gigerenzer & Goldstein (1996)	To infer which of two alternatives has the higher value, (a) search through cues in order of validity, (b) stop search as soon as a cue discriminates, and (c) choose the alternative this cue favors.
Tallying: Unit-weight linear model, Dawes, 1979	To estimate a criterion, do not estimate weights, but simply count the number of positive cues.
Satisficing: Simon (1955); Todd & Miller (1999)	Search through alternatives, and choose the first one that exceeds your aspiration level.
$1/N$; equality heuristic: DeMiguel et al. (2009)	Allocate resources equally to each of N alternatives.
Default heuristic: Johnson & Goldstein (2003); Pichert & Katsikopoulos (2008)	If there is a default, do nothing.
Tit-for-tat: Axelrod (1984)	Cooperate first, and then imitate your partner's last behavior.
Imitate the majority: Boyd & Richerson (2005)	Consider the majority of people in your peer group, and imitate their behavior.
Imitate the successful: Boyd & Richerson (2005)	Consider the most successful person, and imitate his or her behavior.

Note: Each heuristic can underlie both intuitive and deliberate judgments.

recognition process is described by if-then rules, and the recognition heuristic is another rule that exploits this process (Schooler & Hertwig, 2005). The process of recognition is clearly not a deliberate one, and reliance on the recognition heuristic is often also not deliberate, but both reaction time and functional magnetic resonance imaging studies suggest that it could be a default setting of the brain (Pachur & Hertwig, 2006; Volz et al., 2006). Yet, the same heuristic can also be used deliberately, for instance, as a strategy for investing in stocks suggested by analyst Peter Lynch and tested by Ortmann, Gigerenzer, Borges, and Goldstein (2008) or as a strategy for predicting the outcomes of sports events. In this vein, deliberate reliance on mere name recognition could predict the winners of the 128 Wimbledon Gentleman Singles matches as well as or better than relying on official statistics such as the Association of Tennis Professionals (ATP) rankings and as good as or better than the seeding of the Wimbledon experts (Scheibehenne & Bröder, 2007; Serwe & Frings, 2006). These results demonstrate that heuristics need not be linked to automatic, intuitive processing or to error-prone judgments. More information about this is provided later.

The same argument can be made for each of the other heuristics, to different degrees. The fluency heuristic may represent the case in which it is rather rare that people rely deliberately on what came first to mind, but such cases may exist, for instance, when a person requesting advice for a choice between A and B is impressed by how quickly the responder answered A and takes this speed as clear evidence for A. The take-the-best heuristic is relied on both intuitively (Bröder, 2003; Rieskamp & Otto, 2006) and deliberately when designing decision systems without trade-offs. Deliberate use may occur for reasons of simplicity and transparency, which in turn increases safety and a feeling of justice. For instance, the contest rules of the International Federation of Football Associations rely on the take-the-best heuristic to decide which teams in a group can move ahead. The cues are ordered (total points, difference in number of goals, etc.), and decisions are made sequentially, without trade-offs. The same type of rule governs right-of-way in traffic (police officer's hand signs, traffic light, traffic sign, etc.), to which people apply it purposely to increase safety (Gigerenzer, 2007).

Tallying is relied on both intuitively, typically only by a small proportion of people (e.g., Bröder, 2003), and deliberately, in designing unit-weighted scoring systems for IQ tests and in democratic elections systems in which every voter has the same vote. The equality heuristic, or $1/N$, has been used to describe how parents intuitively allocate their love, time, and attention to their children (Hertwig, Davis, & Sulloway, 2002) and share windfall money in the ultimatum game (Takezawa, Gummerum, & Keller, 2006) and how professional and lay investors deliberately try to diversify and reduce risk (DeMiguel, Garlappi, & Uppal, 2009). A person who relies on the default heuristic ignores all information concerning an issue, such as organ donation, and just follows the legal default, which appears to be the major factor in the strikingly different rates of potential organ donors between countries (Johnson & Goldstein, 2003). Finally, imitation rules are known to be relied on automatically, as research on children testifies (Tomasello, 2000), and thoughtfully and purposefully, as in educational training in which children are instructed to copy, from drawing letters to skills in sports (Boyd & Richerson, 2005).

In summary, we argue that intuitive and deliberative judgments are both based on rules and can even be based on exactly the same rules. The important questions for research are what are these heuristics, when are they applied, and in which situations are they successful?

Where do rules come from?

Rules and the appropriate situations for their use can be acquired through personal experience, social development, and acculturation. This applies to both intuitive and deliberate judgments. We assume that every rule exploits core capacities and that the specific capacities determine the set of rules a species or an individual can execute in a reliable way.

Evolved core capacities

We use the term core capacity to designate an ability for which a species has the potential, enabled by its genes, although the individual typically needs to exercise this potential in order to express and master it. One example is long-term memory, which the human genome enables, but which the individual can master to various levels of competence, as illustrated by the stunning ability to recite long poems and sagas in oral traditions compared with the relative loss of this capacity in modern societies.

To execute a rule properly, an organism needs specific evolved capacities. This holds for rules in animals and humans alike (Hutchinson & Gigerenzer, 2005). Because humans and animals have common ancestry and related sensory and motor processes, they share common core capacities, which are exploited by common rules. For instance, ball players of various sorts (e.g., a baseball outfielder, or a cricket player) rely on simple rules to catch a ball. The simplest is the gaze heuristic, which works if the fly ball is high up in the air: Fix your gaze on the ball, start running, and adjust the running speed so that the angle of gaze remains constant (see Gigerenzer, 2007). This heuristic ignores all the information necessary for computing the trajectory of the ball. The same heuristic is applied by various animal species to catch a prey. In pursuit and predation, bats, birds, and dragonflies maintain a constant optical angle between themselves and their prey, as do dogs when catching a Frisbee (Shaffer, Krauchunas, Eddy, & McBeath, 2004). Among the core capacities needed for this heuristic is the ability to track visually moving objects against a noisy background, an ability no robot has today as well as a human being or a dog.

The same evolved capacity is needed when the rule is used in (what has been described as) an intuitive way or a deliberate way. For instance, sailors are taught to rely on the gaze heuristic deliberately when they fear that another boat is on a collision course: Fixate your eye on the other boat, and if the optical angle remains constant, change course because otherwise a collision will occur. Similarly, whether one of the heuristics in Table 1 is used consciously or unconsciously, the core capacities needed appear to be exactly the same. These include recall memory, recognition memory, and the ability to imitate the behavior of others.

Rule acquisition

Experience. Personal experience constitutes an important source of rule acquisition. Individuals learn to associate specific cues with specific states of affairs so that when a cue is registered, the state of affairs is inferred. For instance, a child may learn that snow is cold (*if snow then cold*), that water is wet, and that disobeying one's parents results in punishment. In conditioning work, the conditional link between the stimulus (the cue) and the response (the criterial judgment) may be established through a pairing of the stimulus and the response, followed by a reinforcement (in the instrumental learning paradigm) of the conditioned stimulus and the unconditioned stimulus (in the classical learning paradigm; Holyoak et al., 1989), and so on.

Social development. Kruglanski et al. (2005) described how in the course of social development the child acquires rules that link given social sources with given types of knowledge, bestowing on them epistemic authority. Initially the child tends to ascribe epistemic authority to adult caretakers, primarily the parents, in all domains of activity exemplifying the *if parent (says so) then it is correct* rule. This is gradually replaced by distinctions among domains and ascription of differential epistemic authority to different sources (teachers, peers, one's self).

Source rules. Source rules bestowing epistemic authority on given agents may lend them the powers to instruct and enable them to act as teachers and tutors. In this vein, Osman (2004, pp. 997–998) reviewed tutoring studies in which participants' logical thinking in Wason's (1968) selection task improved considerably as a result of their being taught the pertinent logical rules. According to Osman (2004, p. 998), "large improvements in performance are the result of clarifying the task requirements," that is, getting participants to attend to the correct cues and to apply the appropriate rules in relevant task contexts.

Acculturation. Numerous inference rules are learned via socialization into a given culture (Chiu & Hong, 2006). For instance, stereotypes (e.g., related to gender, race, age, ethnic group or profession) are rules concerning properties implied by given category memberships. Beliefs that an engineer is likely to be interested in mechanical toys and mathematical puzzles or that a lawyer is articulate and well dressed (both cited in studies of the representativeness heuristic) are acquired through immersion in the specific shared reality of one's group that subscribes to these notions. Schooling and academic training impart to the students a variety of rules concerning the properties of things and the implications of concepts, including the rules of statistics and other formal disciplines. Thus, the same processes of rule acquisition pertain to rules depicted as intuitive and those depicted as deliberative.

Routinization of rules: Deliberation becomes intuitive

It has been long known that automatic phenomena involve a routinization of if–then sequences. A novice piano player may be engaged in a highly controlled, attention-demanding activity that following the "rules" of music requires, yet the accomplished concert pianist may follow those same rules without much conscious awareness. The notion that social judgments represent a special case of procedural learning (Anderson, 1983), based on practice that strengthens the if–then connections, has been generally accepted in the social cognition literature (cf. Bargh, 1996; Neal, Wood, & Quinn, 2006; E. R. Smith & Branscombe, 1988).

Music and sports are examples of how skills are learned in a deliberate fashion but at some point become intuitive; that is, attention is no longer directed to the movements and people cannot explain how they do what they do. As a consequence of this transition, when experienced golf players were instructed to pay attention to the sequence of movements in their swing, their performance decreased, although the same intervention increased the accuracy of novices (Beilock, Bertenthal, McCoy, & Carr, 2004; Beilock, Carr, MacMahon, & Starkes, 2002).

Similarly, the judgments of experienced handball players were better when they had no time to think than when they could inspect a game scene for 45 seconds (Johnson & Raab, 2003). In general, many, but not all, skills are learned deliberately and then become intuitive or turn into gut feelings. There are, however, exceptions when a skill is learned by observation rather than by instruction, and the nature of the skill, the cues and rules, are never represented in language (Gigerenzer, 2007). The transition from deliberate to intuitive rules is a valuable process given that attention is a scarce resource. In the words of Alfred North Whitehead (cited in Egidi & Marengo, 2004, p. 335):

> It is a profoundly erroneous truism, repeated by all copy-books and by eminent people when they are making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of operations which we can perform without thinking about them.

Some principles of rule selection

Consideration set of rules

Unlike the hardwired rules that mediate perceptual inferences, rules that mediate higher cognitive judgments are typically selected from a rule set in the individual's adaptive toolbox (Gigerenzer & Selten, 2001). We propose that such selection follows a two-step process: First, the task and individual memory constrain the set of applicable rules, resulting in a consideration set; and second, difficulty of instantiation, individual processing potential, and (perceived) ecological rationality of the rule guide the final choice of a rule from that set.

Task type constrains the consideration set of rules. Because rules are specialized, not every rule can be included in the choice set for a given task. For instance, if an individual faces a two-alternative choice task, the first four heuristics in Table 1 are in the choice set; the others cannot be applied (assuming there are no other individuals present to imitate). A mathematical task may constrain the set of rules differently for a seasoned mathematician and a novice, so may a chess problem for a master and an amateur player, and so on.

Memory constraints on the consideration set of rules. To be represented in the consideration set, a rule (or major premise of the syllogism) needs to be accessed from memory, which can be facilitated by priming (Higgins, 1996). Too, the input to the rule (the minor premise) may need memory input (Marewski & Schooler, 2010). For instance, consider again the first four rules in Table 1. If one alternative is recognized and the other not then the recognition heuristic is in the choice set, but the others are not. If both are recognized then the recognition heuristic is no longer applicable, but the other three are. If no additional information about cue values in this situation is obtained then the fluency heuristic remains in the choice set, whereas if such cue knowledge is obtained then experimental evidence suggests that take-the-best and tallying are preferred over the fluency heuristic.

It is important that immediate memory constraints are not absolute; what comes immediately to mind can be expanded by an intensive memory search. In other words, although some rules may be difficult to access or retrieved from memory in a given situation, they might still be accessed through an effortful attempt. Such an attempt might be enabled if the individual possessed sufficient processing potential, as elaborated subsequently.

Rule selection

If the consideration set includes more than one rule, a selection step is required, in which a given rule is chosen as a means for reaching judgment. The first factor affecting this step is difficulty of instantiating the rule in a specific context. Just as accessing a rule (the syllogism's major premise) from memory may be more or less difficult, so may be instantiating it in given conditions, that is, recognizing the rule-matching cue (the minor premise) in given circumstances. Contributing to such difficulty is noisiness of the judgmental environment and faintness of the cue, that is, a low signal to noise ratio. Again, overcoming the difficulty requires that the individual possess sufficient processing potential, which concept is discussed next.

Processing potential. Two aspects of processing potential are attentional capacity and processing motivation (e.g., Petty & Cacioppo, 1986; Tetlock, 1985). Individuals' attentional capacity may be taxed by cognitive load or busyness with other matters. Ability to focus attention may also depend on circadian rhythm (Kruglanski & Pierro, 2008), degree of mental fatigue (Webster, Richter, & Kruglanski, 1996), or alcoholic intoxication (Steele & Josephs, 1990). Processing motivation is often a function of the importance individuals assign to the judgmental task, their issue involvement (Petty & Cacioppo, 1986), and the magnitude of their accuracy, or accountability, goals in given circumstances (Tetlock, 1985). In addition, processing motivation is determined by individuals' stable motivational proclivities, such as their need for cognition (Cacioppo & Petty, 1982) or need for cognitive closure (Kruglanski, 2004; Kruglanski, Pierro, Mannetti, & DeGrada, 2006; Kruglanski & Webster, 1996).

An individual whose attentional capacity is depleted or whose processing motivation is low might be disinclined to conduct an extensive memory search or to invest extensive efforts in attempts to instantiate the rule, when this is difficult. Moreover, in such conditions, the individual may be loath to apply rules whose implementation requires laborious computational analyses. Consequently, individuals whose capacity or motivation are low may base their judgments on relatively simple inferential rules rather than on complex ones or may be less able to carefully assess the ecological rationality of a rule, that is, to properly estimate its validity in a given environment.

For instance, Petty, Wells, and Brock (1976) demonstrated that under capacity-depleting conditions, individuals were less sensitive to the quality of message arguments that tended to be relatively lengthy and complex and, hence, difficult to process. Consequently, under limited resource conditions, easy to use heuristics were used to a greater extent than more complex inferential rules. In this vein, Mata, Schooler, and Rieskamp (2007) reasoned that due to age-related decline in cognitive abilities, older adults more than younger ones would tend to use simple heuristics rather than more cognitively demanding strategies. Consistent with this hypothesis, Mata et al. (2007) found that older (vs. younger) adults instructed to infer which of two diamonds was more expensive tended to use the frugal take-the-best heuristic (Gigerenzer & Goldstein, 1996) or the take-two heuristic (Dieckman & Rieskamp, 2007) more and tended to use the more laborious weighted additive rule less. It was also found that the higher the magnitude of individuals' accuracy motivation, or their need for cognition, the greater their readiness to apply complex rules and to digest compound information (Kruglanski & Thompson, 1999a, 1999b; Petty & Cacioppo, 1986). By contrast, the higher the magnitude of their need for closure, the lesser their readiness to do so and the greater their tendency to rely on simple judgmental heuristics (Pierro, Mannetti, Erb, Spiegel, & Kruglanski, 2005).

Whereas the use of simple, easy to process heuristics may be more likely under low resource conditions, the selection and use of complex, laborious to apply, rules may be more likely under high resource conditions—but only in situations in which they are more subjectively valid, or high in perceived ecological rationality. More information about this is provided later.

Ecological rationality. Besides processing capacity and motivation, an important factor in the selection of a rule is the (perceived) ecological rationality of a rule for a given task. The study of ecological rationality asks which rule will lead to a better outcome (e.g., higher accuracy) in a given task environment. This requires studying the match between rules and structures of environments. For instance, the redundancy and variability of cue weights in the environment can guide the choice between take-the-best and tallying heuristics (Table 1). Redundancy is defined as the correlation between cues, and variability measures the distribution of the weights of cues. If redundancy and variability are high, one can expect that take-the-best will be more accurate than tallying; if both are low, the opposite follows (Hogarth & Karelaia, 2007). There is evidence for adaptive strategy selection (for an early review, see Payne, Bettman, & Johnson, 1993). Dieckmann and Rieskamp (2007) showed that in environments with high redundancy, take-the-best is as accurate as and more frugal than naïve Bayes (a strategy that integrates all cues) and then experimentally demonstrated that in high-redundancy environments, take-the-best predicted participants' judgments best, whereas in low-redundancy environments, compensatory strategies predicted best, indicating adaptive strategy selection. Rieskamp and Otto (2006) showed that in an environment with high variability of cue validities, judgments consistent with take-the-best increased over experimental trials from 28% to 71%, whereas in an environment with low variability, they decreased to 12%. Bröder (2003) reported similar selection of take-the-best dependent on the variability or cue validities. Strategy selection theory (Rieskamp & Otto, 2006) provides a quantitative model that can be understood as a reinforcement theory in which the unit of reinforcement is not a behavior but a rule or a heuristic.

This model allows predictions about the probability that a person selects one rule from a set of rules based on its perceived ecological rationality.

Rule conflict

At times, two or more rules may appear of nearly equal ecological rationality, creating a psychological situation of rule conflict. In such circumstances, judgment yielded by a given rule may differ from judgment yielded by another rule. For instance, in Asch's (1946) classic study, epistemic authority accorded to one's vision (i.e., the rule *if my vision suggests it, it is probably correct*) may be contradicted by the consensus heuristic (i.e., the rule *if the consensus supports it, it is probably correct*). Typically, rule conflict is resolved in favor of the stronger of the competing rules, that is, the rule with greatest perceived ecological rationality. This may produce implicit biases and rule violations, that is, improper application of a given rule because of interference from other incompatible rules.

In summary, to understand both deliberate and intuitive judgments, we need a theory of rule selection. Here, we identified a two-phase selection process involving (a) formation of the rules' choice set considered by the individual and (b) selection of a rule from the set allowing for the possibility of rule conflict.

Selected empirical evidence

If it is to serve as an alternative to existing dual-systems models, the present framework not only should specify models of heuristic rules and of rule selection but also ought (a) to be able to reinterpret findings cited in their support and (b) to afford novel, empirically verifiable insights. To demonstrate our general approach, we discuss here selected evidence in each of these categories.

Reinterpretations

Belief biases. A major implication of our rule-following framework is the possibility of rule conflict, mentioned earlier. Such conflict offers a plausible reinterpretation of the phenomenon of belief bias (Evans, 2008), viewed as a major source of support for the dual-systems notion. Belief bias is said to exist when individuals' prior beliefs interfere with the proper logical derivations of conclusions from premises. For instance, in the study by Evans, Barston, and Pollard (1983) participants were presented with the (major) premise, "No addictive things are inexpensive," and the (minor) premise, "Some cigarettes are inexpensive." Evidence for a belief bias was inferred from the finding that 71% of the participants thought that these premises warranted the conclusion, "Some addictive things are not cigarettes," which does not logically follow.

The notion that beliefs in given states of affairs can interfere with the application of specific rules is readily explicable in terms of the concept of rule conflict. Simply, the real world belief that some addictive things are not cigarettes may have been previously deduced in a rulelike fashion from the appropriate evidence, for example, from one's general familiarity with the class of addictive things that includes noncigarettes (e.g. "If there exists an addictive substance that is not a cigarette then some addictive things are noncigarettes"; "cocaine is an addictive substance that is not a cigarette," therefore "some addictive things are noncigarettes"), undermining the proper deduction from the experimentally given premises (that "Some cigarettes are not addictive").

Our framework additionally suggests that in a clash between a focal rule (represented by the logical task given to participants by the experimenter) and a conclusion yielded by a prior rule (the so called biasing belief), interference from the latter will be reduced if the focal rule was well practiced or routinized and, hence, high in perceived ecological rationality. This derivation is consistent with the findings that (a) tutoring of research participants in various rules, for example, the conjunction rule, or the rule involved in Wason's (1968) selection task, considerably improves correct deductions from those rules (Osman, 2004, p. 998, p. 1001) and that (b) rules couched in participants' everyday experience, hence characterized by considerable ecological rationality, are applied more logically or consistently than are abstract rules detached from participants' familiar realities (Evans, 2008). Similarly, there is evidence that firmly held beliefs, understood here as beliefs deduced from ecologically rational rules, exert a particularly pronounced belief bias (Evans, 2008, p. 264). In the same vein, Reyna (2004) found that experts, that is, individuals with schemas (or rules) held with supreme confidence or a sense of ecological rationality, are more likely to apply those rules, which can lead to bias and error in novel judgmental situations.

Sloman's (1996) S-criterion. The phenomenon of rule conflict may also underlie Sloman's (1996) simultaneity, or S-criterion, for determining a systems separateness. Specifically, "A reasoning problem satisfies *Criterion S* if it causes people to believe two contradictory responses" (Sloman, 1996, p. 11). Consider Sloman's example of the statement that the "whale is a mammal." Whales are commonly perceived to resemble fish more than typical mammals, like dogs or cats. In this case, a person may need to deal with two contradictory beliefs, one derived from whales' outward similarity to fish and the other based on scholastic knowledge whereby whales are considered mammals. But as with Evans's (2008) evidence for belief bias, what we have here are two conflicting rules implying different conclusions. One rule is based on similarity, or the representativeness heuristic; namely, if X looks like a fish, swims like a fish, and lives like a fish then X is a fish. The other rule is derivable from alternative premises, for instance, known features of the mammal category, say breastfeeding of offspring, or from the epistemic authority of the source, namely, if a biologist claims that X (e.g., that whales are mammals) then indeed X. Thus, the simultaneity phenomenon need not attest to system separateness and is instead explicable in terms of the notion of rule conflict, discussed earlier.

Novel insights

In what follows, we discuss three classes of novel findings afforded by our unitary framework and incompatible with implications of the dual-systems models. These concern evidence that (a) instantiation difficulty determines the amount of processing potential that a rule requires for it to be selected for use, (b) higher processing potential is not aligned with selecting more complex rules, and (c) less processing can lead to more accurate judgments. We consider these in turn.

Instantiation difficulty determines the amount of processing potential a rule requires

Typically, dual-systems and dual-process models have implied that heuristic rules are selected when the individuals' processing potential is low, whereas extensional rules (e.g., statistical or logical rules) are used when the individuals' processing potential is high. However, the present analysis suggests that the amount of processing potential required for selecting a given rule depends on the difficulty of rule instantiation in given informational ecologies. Take the expertise heuristic, *if expert then correct.* In much persuasion research (for reviews see Erb et al., 2003; Kruglanski and Thompson, 1999a, 1999b) the instantiation of this rule was easy to accomplish because the expertise information was conveyed via a single line of text. Under those conditions, the expertise rule was used predominantly under conditions of low processing potential. However, in several studies (Kruglanski & Thompson, 1999a, 1999b, Kruglanski, Erb, at al., 2006; Kruglanski, Pierro, et al., 2006) instantiation of the expertise rule was made difficult by presenting the expertise information in the form of a lengthy curriculum vitae from which (low or high) expertise could be effortfully gleaned. Under those conditions, use of the expertise heuristic occurred predominantly in the presence of ample processing resources.

In a similar vein, Chun and Kruglanski (2006) showed in a series of experiments that use of the base rate rule might require either low processing potential or high processing potential, depending on its instantiation difficulty. When the base rate information was given in an easy to use form, that is, simply and succinctly, the base rate rule was used (base rate neglect was minimized) under low processing potential (e.g., in the presence of cognitive load). However, when such information was made difficult to glean (as the overall base rates had to be concatenated from several subsamples), the base rate rule was used only in the presence of ample processing potential. These findings lead one to question prior suggestions that rules referred to as intuitive (i.e., heuristic rules) are used under low processing potential, whereas rules referred to as deliberative tend to be used under high processing potential. After all, any rule can be made more or less difficult to instantiate or retrieve from memory and, hence, be more or less exigent of processing potential. The very same rule can be made easy to apply, in which case its use would resemble intuitive judgment or be more difficult to apply, resembling deliberative judgment.

Higher processing potential is not aligned with selecting more complex rules

Beside instantiation difficulty, a major factor in rule selection is the rule's (perceived) ecological rationality. Considerations of such rationality additionally invalidate the alignment of simple rules with low processing potential and complex rules with high processing potential. Specifically, our analysis suggests that to the extent that a rule (whether simple or complex) is difficult to retrieve or instantiate, it will not be selected and used under insufficient processing potential. Crucially, however, the obverse of this relation does not hold. That is, more complex rules will not be necessarily selected under high processing potential. Instead, under high potential, considerations of ecological rationality will prevail, and the individual will be able to select the most ecologically rational rule currently available.

In support of these notions, Pierro, Mannetti, Kruglanski, and Sleeth-Keppler (2004) showed that under limited processing potential, the easy to process rule is selected even if a more ecologically rational rule is potentially available. By contrast, under ample processing potential, the most ecologically rational rule is selected, regardless of whether it is easy or difficult to process. These findings imply that under ample processing potential the individual is able to engender an extensive set of rules to choose from and is able to select the most rational rule from the set. In contrast, under limited processing potential, the individuals' rule sets might exclude from consideration the most ecologically rational rule if it is difficult to process.

Consistent with the foregoing analysis are findings that individuals classified as take-the-best users for tasks in which this heuristic is most ecologically rational showed higher IQs than did those who were classified as relying on more complex, compensatory rules, suggesting that cognitive capacity as measured by IQ "is not consumed by strategy execution but rather by strategy selection" (Bröder & Newell, 2008, p. 209). Further evidence for the hypothesis that under ample resource conditions individuals use the most ecologically rational (rather than complex) rules derives from a series of studies by Cokely, Parpart, and Schooler (2009).

Less effort can lead to higher accuracy

A major question about judgments concerns their accuracy. This is hardly surprising as accuracy is a valuable asset to possess. Beyond the intrinsic value of having a grasp on reality, accuracy affords predictability that may help individuals cope with their social and physical environments. For that reason, psychological researchers and theorists have expended considerable efforts to identify judgmental procedures that increase accuracy and those that may undermine it. In most analyses, simple heuristics have been depicted as suboptimal rules of thumb: Though often yielding reasonable estimates, they were considered inferior, by and large, to normative procedures (but see Evans, 2008). Accordingly, they have been often equated with judgmental biases giving rise to the ubiquitous heuristics and biases label. In this vein, Tversky (1972, p. 98) asserted that the heuristic of elimination-by-aspects "cannot be defended as a rational procedure of choice." Similarly, Keeney and Raiffa (1993, pp. 77–78) stated that the use of (lexicographic) heuristics "is more widely adopted in practice than it deserves to be [and] will rarely pass a test of reasonableness."

Related to the notion that heuristics constitute suboptimal shortcuts to normative calculations is the pervasive view that more information is better for accuracy.

Rudolph Carnap (1947) proposed the principle of total evidence, suggesting the advisability of using all the available evidence in estimating a probability. In many theories of cognition (e.g., the Bayesian model, or prospect theory), it is similarly assumed that all pieces of information are, or should be, integrated in the final judgment (Gigerenzer & Brighton, 2009). McArthur and Baron's (1983) suggestion that active perceivers are typically more accurate than passive perceivers could be interpreted in terms of the greater amounts of information that active exploration may afford. Too, these authors' notion of sins of omission refers to cases in which the perceiver misses part of what is afforded because of attentional selectivity or because the stimulus array is impoverished. Again then, errors are traced to limited information search.

One of the first types of evidence for less-can-be-more came for the tallying heuristic (Table 1). This simple rule, reminiscent of the use of tally sticks for counting and traceable back some 30,000 years, has probably survived for a very good reason. Following the pioneering work of Dawes (1979; Dawes & Corrigan, 1974), Czerlinski, Gigerenzer, and Goldstein (1999) compared the tallying heuristic with multiple linear regression in 20 studies. Tallying ignores all cue weights, whereas multiple regression estimates the optimal beta weights. The authors found that averaged across all studies, tallying nevertheless achieved a higher predictive accuracy than did multiple regression. This does not mean that tallying will outperform multiple regression in all circumstances. The challenge for researchers is to delineate the tasks, or informational ecologies (Fiedler, 2007), under which each of these inferential rules produces the more accurate predictions (see Einhorn & Hogarth, 1975).

Similar less-is-more effects have been found for several other rules. A most striking discovery was that take-the-best—which relies on only one reason and ignores the rest—can predict more accurately than linear multiple regression models and tallying (Czerlinski et al., 1999). Subsequently it was found that relying on one good reason often also resulted in more accurate predictions than complex nonlinear methods, including a three-layer feedforward connectionist network trained with the backpropagation algorithm, exemplar-based models (nearest-neighbor classifier), classification and regression trees (CART), and Quinlan's decision-tree induction algorithm C4.5 (Brighton, 2006; Chater, Oaksford, Nakisa, & Redington, 2003; Gigerenzer & Brighton, 2009). These results put heuristics on par with standard statistical models of rational cognition. This is not to say that relying on one good reason is always better, but it raises the question, in what tasks is relying on one good reason better than relying on all reasons? A formal answer has been found with the bias-variance dilemma (Gigerenzer & Brighton, 2009).

The notion that simple rules can yield accurate inferences in appropriate ecologies has been highlighted by various theories of social cognition and perception (Funder, 1987; McArthur & Baron, 1983; Swann, 1984). The ecological approach emphasizes that in their natural environments humans and animals generally draw accurate inferences, when accuracy is defined in pragmatist terms as that which works (James, 1907, 1909). Less-is-more effects are of primary importance for the argument that heuristics are not aligned with error-prone judgments, and complex statistical rules are not aligned with rational judgments. These alignments miss the ecological nature of judgment and run the risk of misinterpreting the adaptive use of less effortful rules as signs of limited capacities or even irrationality.

Conclusion

In this chapter, we presented a number of convergent arguments and empirical evidence for a unified theoretical approach that explains both intuitive and deliberate judgments as rule based, as opposed to the dual-systems approach of qualitatively different processes. Moreover, using a sample of heuristic rules (Table 1), we provided empirical evidence that the same rules can underlie both intuitive and deliberate judgments. Because there can be more than one rule, any theory of judgment needs to address the rule selection problem, which is hidden in dual-process accounts because the processes are not well specified. We proposed a two-step selection process, in which the task and the contents of memory constrain the choice set of rules an individual can consider, and processing potential and (perceived) ecological rationality determine the final selection of a rule.

Although the specific features of our theoretical framework need to be elaborated, one thing seems clear. The conceptual and empirical difficulties entailed by the partition between intuitive and deliberate judgments, and their alignment with multiple similar dichotomies have impeded a deeper examination of the psychology of judgment. It is time to move beyond imprecise dualisms and toward specific models of the judgmental process. These include models of heuristic inference rules, their building blocks, and their adaptations to task environments that humans confront. This chapter takes a step in that direction.

Notes

1 A distinction is sometimes drawn between dual-process and dual-system formulations (e.g., Gawronski & Bodenhausen, 2006; Kruglanski & Orehek, 2007). The dual-process formulations were typically domain specific (e.g., pertaining to the domain of persuasion or attribution), whereas the dual-system models were more general and assumed to apply across domains. Also, the dual-process formulations were information focused; they typically coordinated the proposed dual processes to two separate information classes (e.g., peripheral cues vs. message arguments, social categories vs. personality attributes). The dual-systems models typically purported to be process-focused and were somewhat less concerned with informational inputs. The terms dual modes and dual routes have also been used, and these various terms have also been treated interchangeably by some authors (for discussion see Keren & Schul, 2009). All dualistic models, however, regardless of type, draw a qualitative distinction between judgment formation that is accomplished easily and quickly and one that is slow, extensive, and arduous.

2 However, the Strack and Deutsch (2004) reflective–impulsive model does align both systematic and heuristic reasoning with processes in the reflective system and juxtaposes these to associative processes in the impulsive system.

3 Indeed, even if the dual-systems/dual-process model offered a weaker version of their position and assumed the (obviously) continuous nature of such characteristics, they would still need to define meaningful cutoff points on the relevant continua, a task never seriously undertaken.

4 Moreover, even if meaningful cut-offs were defined, assuming six dichotomies, one would end up with a $2^6 = 64$ cell matrix of which only two cells (those representing the conjunction of all six dichotomies) had entries. Again, this logical implication of the alignment assumption has never been considered seriously or tested empirically.

5 Inverse in the sense that the proximal stimulus (e.g., the retinal image) originally produced by the distal stimulus is now used to decode such stimulus, going backward as it were.

6 In cognitive science, a debate has ensued on whether human reasoning is based on rules or similarities (between specific instances of experienced events). Hahn and Chater (1998) have offered a comprehensive analysis of arguments on both sides of this issue, suggesting, "Possibly, these two classes are too broad to allow an overall empirical assessment" (p. 199). These authors also argued that the ample evidence adduced for the rule conception could be alternatively interpreted in terms of the similarity conception and vice versa. It is not our intention to enter here into this intricate debate. Nonetheless, it is noteworthy that both similarity and rule-based notions assume a mental representation of stimuli by the judging individual; hence, both fall outside the purview of mere rule conforming phenomena (Hahn & Chater, 1998). Furthermore, both imply a mentally represented input to output function. In that sense then, both assume a conditional if–then relation between input and output representations. Similarity determination, for instance, has entailments. A given degree of perceived similarity is informative; it goes beyond the information given and brings forth certain implications. Whereas the rule versus similarity debate is not presently resolvable, we find the rule-based formulation to be based on considerable data, as well as consistent with common experience and broadly plausible. Consequently, we adopt it in our analysis and explore its implications.

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