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Partitioning the Domain of Social Inference: Dual Mode and Systems Models and Their Alternatives

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Abstract

Recent decades of theorizing about social inference phenomena have seen a variety of models that partitioned the underlying processes into two qualitatively distinct types whose specific nature was depicted differently in the different frameworks. The present article reviews major such partitioning efforts as well as their proposed alternatives, and discusses their unique features, their commonalities, and the conceptual and empirical issues that they raise.

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INTRODUCTION

The 1986 edition of Webster's dictionary defines inference as "the act of passing from one proposition, or judgment to another whose truth is assumed to follow from that of the former." In this sense, inference constitutes the act of reaching a judgment on the basis of information treated as evidence for its veridicality (Kruglanski & Thomson 1999a). It is, quintessentially, the act of going "beyond the information given" (Bruner 1973) to the conclusion that such information is seen to imply. Whereas in the 1960s, social cognition theorists attempted to model the

mechanisms of inference, e.g., in Bayesian (Edwards et al. 1963), "probabilogical" (McGuire 1960), or quasi-statistical (Kelley 1967) terms, in the 1970s, the focus shifted to demonstrating the shortcomings of human judgment (Nisbett & Ross 1980). In part, the latter were tied to the cognitive miser metaphor, whereby ". . . people are limited in their capacity to process information. . . Consequently, errors and biases stem from inherent features of the cognitive system" (Fiske & Taylor 1984, p. 12).

In subsequent decades, social cognition researchers adopted a more nuanced view,

guided by the "motivated tactician" metaphor. As Fiske & Taylor (1991, p. 13) characterized it, "the social perceiver... might best be termed the motivated tactician, a fully engaged thinker who has multiple cognitive strategies available and chooses among them based on goals, motives, and needs. Sometimes the motivated tactician chooses wisely, in the interest of adaptability and accuracy, and sometimes the motivated tactician chooses defensively in the interest of speed or self-esteem...."

Unlike the cognitive miser model, in which people are viewed as generally unwilling or unable to process information thoroughly, the motivated tactician perspective assumes a flexible process wherein the availability of motivational and cognitive resources may vary across persons and situations. Too, the motivated tactician metaphor implies a dichotomy between suboptimal and optimal inferential modes. This distinction has inspired a variety of dualistic models of judgment that have dominated the field in the past two decades. As a general characterization, these dual-process models draw a distinction between a brief and superficial mode, often assumed to operate under limited resource conditions, and a more thorough, resource-dependent mode.

Following other authors (cf. Gawronski & Bodenhausen 2006), we draw a distinction between dual-mode and dual-systems formulations. The earlier dual-mode formulations were typically domain specific, whereas the dual-systems formulations were more general and assumed to apply across domains. Furthermore, the dual-mode formulations were information focused; they typically coordinated the two proposed modes to two different types of information (e.g., peripheral cues versus message arguments, social categories versus personality attributes). The more recent dual-systems models, in contrast, were process focused, and they didn't relate their binary systems of inference to distinct information types. Critiques of the dualistic formulations have been voiced, and alternative ways of conceptualizing human inference

have been proposed. Our present purpose is to review some of the major dual-process models of social inference and to consider their alternatives.

DUAL-MODE FORMULATIONS

We begin our review of the dual-mode models by considering the influential persuasion models of this type, namely the Elaboration Likelihood Model (ELM; Petty & Cacioppo 1986) and the Heuristic Systematic Model (HSM; Chaiken et al. 1989). Space limitations prevent a more exhaustive review of the dual-mode models; thus, we direct the reader to recent Annual Review articles (Crano & Prislin 2006, Fazio & Olson 2002, Macrae & Bodenhausen 2000, Wood 2000). The ELM and the HSM can be considered information focused because they distinguish between two types of information: information contained in the message and information unrelated to the issue, yet capable of producing persuasion under some circumstances.

The Elaboration Likelihood Model

The ELM's central mode pertains to a thorough processing of message or issue information. A special feature of the ELM is the notion that the same variable is capable of serving different functions. What function will be served is assumed to depend on the elaboration likelihood, i.e., the likelihood that the information will be processed extensively. When the elaboration likelihood is low, a variable (say, source attractiveness) could serve as a cue; when the elaboration likelihood is high, the same variable could serve as a message argument. When the elaboration likelihood is intermediate, this variable could determine the elaboration likelihood itself (e.g., an attractive source may prompt a more extensive processing of her message). Peripheral processing is based on a wide variety of cues whose commonality is not explicitly identified. The ELM accords a major role in this regard to the elaboration likelihood continuum, suggesting

that the peripheral route will be taken when the elaboration likelihood is low and the central route when the elaboration likelihood is high. The two modes are assumed to coexist in inverse relation to each other. Thus, as one moves toward the low end of the continuum, one should find an increasing proportion of peripheral relative to central processing and vice versa as one moves toward the high end.

Commentary

The ELM distinguishes between a cue function and a message argument function. However, it does not specify what the cue function is and how it differs from the argument function. Furthermore, the notion of the elaboration continuum has an ambiguous implication. It refers both to the extent of processing and to the type of information processed. Specifically, the low end of the continuum denotes both limited processing and the processing of peripheral information, whereas the high end denotes both extensive processing and the processing of message information. The current notion of the elaboration continuum seems to confound the type of information processed with the way it is processed, namely, briefly versus extensively.

The Heuristic Systematic Model

The HSM's systematic mode pertains to a thorough processing of all the available information, that is, of message as well as of heuristic information. The HSM's "heuristic" mode is defined more precisely in terms of general rules of thumb of the kind "experts are correct" or "friends are to be trusted." The "heuristics-as-rules" notion affords the additional implication that heuristic processing would be more likely to the extent that the heuristic rules were more cognitively accessible. The HSM proposes a "sufficiency threshold" constituting an acceptable level of confidence an individual may require concerning a

given judgment. Moreover, the "least-effort" principle was proposed as a guiding mechanism of inference formation. When the sufficiency threshold is low, the individual is assumed to employ heuristic processing. When it is high, systematic processing is assumed to kick in because the heuristic mode is assumed to afford relatively low levels of confidence. Systematic processing is assumed to take place only if the heuristic mode failed to deliver the desired level of confidence. The heuristic and the systematic modes may interact in three different ways: (a) Heuristic and systematic processing may augment each other if they lead to similar conclusions, (b) systematic processing may reduce the judgmental impact of heuristic processing when it leads to opposite conclusions, and (c) heuristic processing may affect the direction and extent of systematic processing. Finally, the HSM regards heuristics as general knowledge structures that are applied in a top-down manner, whereas systematic processing is assumed to reflect bottom-up responding to arguments presented and a use of the arguments to construct (more abstract) conclusions.

Commentary

The HSM implies that heuristic cues are generally processed first, whereas message and issue information is processed only when the heuristic processing fails to yield a sufficient level of confidence. This reasoning seems to assume that the processing of heuristic information is generally easier and therefore is preferable to the processing of message information. It isn't clear why this should be generally true, unless one defined heuristics as easy-to-process information. Yet, if the latter definition were adopted, this would preempt the definition of heuristics as general beliefs unrelated to the message contents, because heuristics need not be universally easy to process. Such a definition would render problematic the juxtaposition of heuristics to message arguments that might be also quite easy to process.

Models of Categorization and Stereotyping

Two dual-process models addressed person perception: Fiske's continuum model (Fiske & Neuberg 1990, Fiske et al. 1999) and Brewer's (1988) impression formation model. The most fundamental commonality was that both models distinguished between category-based and attribute-based processing and viewed them as qualitatively different. In both models, categorical processing was assumed to proceed in a top-down fashion, whereas attribute processing was assumed to proceed in a bottom-up fashion. Both models assumed that impression formation follows a fixed order, commencing with an automatic identification of the target in terms of some general categories to which it belongs.

Impression Formation Model

Brewer's (1988) model suggested that different stages have distinct types of cognitive representations: The initial stage, automatic identification, was assumed to consist of judgments represented as categories in multidimensional space. The second stage, category-based typing, was assumed to be represented via pictoliteral prototypes. In the third stage, individuation, the representation was assumed to depend on category subtypes. The final stage, personalization, was assumed to depend on the individual's schemata within a verbal, propositional, network. The Brewer model posits different decision rules following each stage of processing.

More recently, Brewer & Harasty Feinstein (1999) offered a re-evaluation of its postulates in light of known evidence. Importantly, Brewer & Harasty Feinstein (1999) denied priority to category-based processing over attribute-based processing. As they put it, "The distinction between the two modes revolves around what information is attended to and what prior knowledge is activated at the time the information is presented" (p. 258). Nor are Brewer & Harasty Feinstein (1999, p. 259) assuming that category-based versus person-based representations are correlated with effortless versus effortful processing modes. "On the contrary, both modes of person perception can be either heuristic or elaborated."

Continuum Model

Fiske's model assumes no qualitative differences in mental representation as a function of processing stages. At both the categorization and the individuation stages, mental representations are assumed to form a network in which both verbal and visual representations may be included. In the Fiske model, an initial interest/relevance judgment and the degree of informational fit apply at each processing stage. "For example a target can be a good or poor fit to an initial category, a good or a poor fit to a subtype, a good or poor fit to an exemplar" (Fiske 1988, p. 70). The Fiske conception emphasizes a continuum. Thus, involvement affects each process along the continuum from confirmatory categorization, through recategorization, to piecemeal integration.

More recently, Fiske et al. (1999) summarized additional evidence for the continuum model. They cited research suggesting that people often use social category information to the extent "that the category is pragmatic in context" (Fiske et al. 1999, p. 236), that is, to the extent to which it is informative about the judgmental dimension of interest. Fiske et al. (1999) also cite evidence that people often recategorize social objects when the objects' attributes do not fit the original categorization, and that motivation increases attention to expectancy disconfirming information. Finally, evidence exists that the motivational effects on impression formation are mediated by attention paid to specific types of information, such as attention to the targets' attributes (Fiske et al. 1999, pp. 241–42).

Commentary

Statements by Fiske et al. (1999) and Brewer & Harasty Feinstein (1999) represent interesting developments in their respective models. Both sets of authors agree that categories will be used to the extent that they are known, accessible, and informative. This conclusion represents an increased flexibility in their perspective and a relaxation of their original assumption of a fixed sequence running from categorization to individuation. In stressing the commonalities of process shared by category and attribute information, the recent theorizing represents less clearly dualistic formulations than did the original models.

DISPOSITIONAL ATTRIBUTIONS

Gilbert (e.g., 1989) and Trope & Alfieri (1997) proposed a pair of attributional dual-mode models.

Gilbert's Correction Model

Gilbert's (1989, p. 193) model of attributional inferences views "causal attributions as the net result of a chain of events." Additionally, Gilbert's model draws qualitative distinctions between informational contents. Specifically, the model suggests that dispositional inferences are arrived at automatically, in a resource-independent mode impervious to disruption, whereas controlled processes that are resource dependent handle situational information. Situational information is considered in a controlled correction process designed to overcome the potential biases induced by the initial, automatic, characterization. Nonetheless, Gilbert allows for a range of automaticity among dispositional inferences. As he states, "all behaviors are not equally easy to analyze, and . . . fewer resources might be required to draw dispositional inferences from nonverbal than from verbal behavior" (p. 201). "Thus . . . although characterization is in general a relatively auto-matic process, characterizations from nonverbal behavior may be *more* automatic than characterizations from verbal behavior" (p. 202). Finally, Gilbert's model suggests that dispositional and situational information is processed in a specific order. In this connection, he cites Quattrone (1982) as having "shown that . . . perceivers *first* draw dispositional inferences about others and *then* correct these inferences with information about the situational forces" (Gilbert 1989, p. 193).

Commentary

Gilbert's (1989) model involves the assumptions that dispositional attributions are automatic, whereas situational attributions are controlled, and that dispositional judgments typically precede situational judgments. However, cross-cultural research conducted by Nisbett and others (see Nisbett et al. 2001) suggests that participants in collectivist cultures are automatically and initially more likely to make situational rather than dispositional attributions. This is likely due to different cultural norms that place a premium on either dispositional or situational inferences. Moreover, Webster's (1993) work demonstrated that situational requirements may determine whether dispositional or situational inferences come to mind initially or are made only upon subsequent inquiry. Finally, Gilbert suggests that verbal and nonverbal information types are generally processed at different levels of automaticity. However, if attending to verbal communication becomes highly routinized (say by a person with a visual impairment), inferences utilizing verbal information could be more automatic than nonverbal information. Such a claim suggests a continuum of automaticity, as proposed by Bargh (1996), incompatible with a dichotomous separation between controlled and automatic processes (see also Moors & De Houwer 2006). The degree of routinization need not be tied, necessarily, to any informational type or content. Any inference can become highly routinized.

Trope's Integration Model

Trope and colleagues offered a sequential dual-mode model of causal attribution (Trope 1986, Trope & Alfieri 1997, Trope & Liberman 1996). Trope (1986) departed from the assumption that before it can be attributed to the person or the situation, an actor's behavior needs first to be identified. Thus, the stage of behavior identification was assumed to precede that of dispositional attribution. Trope & Alfieri (1997) expanded these notions to a dual-process model wherein contextual constraint information affects behavior identification and dispositional inference in qualitatively distinct ways. At the identification stage, the incorporation of contextual constraints was said to be effortless, automatic, and independent of cognitive resources. By contrast, at the dispositional inference stage, the influence of context was portrayed as controlled, deliberative, and capacity demanding (Trope & Alfieri 1997, p. 663).

Trope & Gaunt (2000) juxtaposed their integration model to Gilbert's (1989) correction model by showing that situational constraint information can exert its subtractive effects (discounted) under load, something denied by Gilbert's formulation, provided it is sufficiently activated and hence is easy to process. Their research demonstrated that the dispositional inference stage can be independent of cognitive load. Finally, Chun et al. (2002) found that behavioral identifications can be undermined by load when the contextual information is nonsalient; hence, its incorporation into the behavior identification is made difficult.

Commentary

Trope & Gaunt's (2000) and Chun et al.'s (2002) findings suggest that the behavior identification stage, even though it logically precedes the dispositional attribution stage, isn't qualitatively distinct from it as far as cognitive resources are concerned. Depending on informational saliency or accessibility, either

can be more or less dependent on cognitive resources. This suggests that the need for cognitive resources depends on the difficulty of information processing. The behavior identification and the dispositional attribution stages seem to differ in the contents of the judgmental question (comprising the "what" question in the case of behavior identification and the "why" question in the case of dispositional attribution), but do not seem to differ in their dependence on resources.

DUAL-MODE MODELS OF SOCIAL INFERENCE: CONCLUDING COMMENTS

The dual-mode models of social inference exerted considerable influence on understanding a variety of phenomena in social cognition and made a significant contribution. A general conceptual issue for these formulations has stemmed from the fact that they typically tied the two modes to different contents of information and assumed that these are subject to qualitatively different processing. But insofar as the possible contents or types of information are vast, this approach might lead to an open-ended proliferation of processes. Possibly in recognition of this problem, some of the models (Brewer & Harasty Feinstein 1999, Fiske et al. 1999) relaxed their assumptions concerning differential processing of different information types. These developments are well considered and compelling, yet they reduce somewhat the models' dualistic character that has rested thus far on a differentiation between information types.

DUAL-SYSTEMS MODELS OF SOCIAL INFERENCE

In the category of dual-systems models belong frameworks that highlight the qualitatively distinct judgmental processes whereby social inferences can be reached and downplay the role of distinct informational contents highlighted in the various dual-mode models. Kahneman's (2003) recent framework

straddles the divide between the dual-mode and the dual-systems formulations.

Intuitive Versus Rational Systems of Inference

Kahneman (2003) distinguished two modes of cognitive function, labeled System 1 and System 2 processing. Intuitions were defined as "thoughts and preferences that come to mind quickly and without much reflection" (Kahneman 2003). What determines whether a thought or a preference would be considered intuitive is its accessibility. Kahneman further suggested that thoughts and preferences can be made intuitive "by prolonged practice" (Kahneman 2003, p. 699). Indeed, major theories of accessibility (e.g., Higgins 1996) have stressed that construct accessibility is a function of the frequency of activation. As Kahneman (2003, p. 698) described it, "The operations of System 1 are typically fast, automatic, effortless, associative, implicit (not available to introspection), and often emotionally charged; they are also governed by habit and are therefore difficult to control or modify. The operations of System 2 are slower, serial, effortful, more likely to be consciously monitored and deliberately controlled; they are also relatively flexible and potentially rule governed. ..." Kahneman also asserted that the extensional (i.e., rational) and prototypical (i.e., intuitive) judgments are assumed to be "governed by characteristically different logical *rules*" (Kahneman 2003, p. 713, emphasis added), implying that both processes are rule based in fact, albeit mediated by different rules.

Empirical Evidence

A critical aspect of Kahneman's dual-systems framework is that System 2 (versus System 1) operation amounts to a more extensive processing of the information given. For instance, Smith & Levin (1996) showed that framing effects are reduced in a between-subjects design for participants with high scores on the need for cognition because such participants apparently moved away from the initial framing they were given. LeBoeuf & Shafir (2003) did not replicate the between-participants' effect, but did show that individuals higher on the need for cognition exhibited lesser framing effects in a within-subject design where each respondent encountered two framing versions of a problem. Note, however, that the presence of a usable cue can be thought of as lying on a continuum of accessibility or retrievability. In those terms, individuals with a greater degree of processing motivation may be willing to engage in a more extensive search and ultimately retrieve less accessible items of relevant information than would less motivated individuals.

Commentary

A critical aspect of System 1 operation is that it is based on intuitions, defined as those that are highly accessible. Accessibility, however, "is a continuum, not a dichotomy" (Kahneman 2003, p. 700). In addition, however, System 1 operation is characterized by the use of heuristics that in prior work (e.g., Tversky & Kahneman 1974) was often juxtaposed to the use of statistical rules (e.g., based on base rates or conjunctive probabilities). If the use of the statistical rules characterizes System 2 operation, then the continuum discussed by Kahneman (2003) is characterized both by the degree of processing and the type of information processed, not unlike the confound obtaining in the ELM and the HSM formulations.

Alternatively, one could state that System 1 refers to a highly restricted processing operation in which only the highly accessible information is used, whereas System 2 refers to more extensive processing. More or less processing is a matter of degree; hence, such a framing stresses the continuum aspect of Kahneman's theory and virtually removes the need for a qualitative distinction between two separate systems.

Reflection Versus Reflexion

In a recent paper, Lieberman et al. (2002, p. 205) stated, "The idea that automatic processes are merely faster and quieter versions of controlled processes is theoretically parsimonious, intuitively compelling, and wrong." Their conclusion derives from the notion that different brain structures seem to be activated in automatic versus controlled behavior. More specifically, Lieberman et al. (2002) proposed that (what they refer to as) the X system, which includes the lateral temporal cortex, amygdala, and basal ganglia, is involved in automatic processing. The C system, related to activity in anterior cingulate, prefrontal cortex, and the hippocampus, seems activated when deliberative or controlled processing takes place.

Empirical Evidence

Lieberman et al. (2002, p. 214) cite numerous neuroimaging studies as suggestive evidence that the inferotemporal cortex is involved in automatic categorization. Neuroimaging studies also revealed that "rule-based processing... led to prefrontal, anterior cingulate and hippocampus activation, belonging with the C system" (Lieberman et al. 2002, p. 228). Yet, the fact that different brain structures have been involved in instances of automatic versus controlled processing need not be considered compelling evidence that automatic and controlled processes aren't "faster and quieter versions of controlled processes" (Lieberman et al. 2002, p. 205).

The notion that automatic and controlled processes lie on a continuum is widely accepted (see, e.g., Bargh 1996, Logan 1989, Posner & Rothbart 1989, Schneider & Shiffrin 1977), and the rule-like (if-then) nature of associative as well as controlled inferences also has been noted (Holyoak et al. 1989, Lovibond 2003, Williams 1995). Instead of assuming qualitatively different systems, one might argue that the different brain structures simply respond to processing difficulty such that beyond some threshold of difficulty, processing capability offered by X structures might not suffice, and other brain structures (e.g., those included in the C category) might need to kick in. This is akin to additional muscles getting involved when the weight one tried to lift exceeded a given threshold. In short, involvement of different brain structures in the processing of more versus less practiced (efficient) if-then rules (Bargh 1996, Uttal 2001) might merely indicate that the brain is responsive to resource requirements of different information-processing tasks.

Lieberman et al. (2002) assume that system X is designed to process identity information (e.g., identification of a given behavior as a member of a given category), whereas the C system is assumed to process causality information and hence yield inferences about the behavior's causal origins. Thus, the X system is assumed to be involved both in the processing of identity information and in automatic processing. Similarly, the C system is assumed to be involved both in the processing of causality information and controlled processing. However, there are reasons to believe that not all identity processing is automatic and that not all causality processing is deliberative or controlled. Trope & Gaunt (2000) showed that making the causal attribution task easier eliminated its sensitivity to cognitive load; this would put it in the category of automatic (efficient) processing. Michotte's (1963) classic work illustrates the immediacy with which causal attributions can be made when information about contiguity and temporal precedence is clear and salient, suggesting that causal inferences may be direct and efficient. In addition, Schneider & Shiffrin's (1977) classic task consisted of identifying letters and digits in a grid-like array. This represents an identity task par excellence, yet it took participants months to automatize. Furthermore, Chun et al. (2002) rendered the identification task controlled (and hence resource dependent) by decreasing the saliency of information pertinent to the identity inference.

Commentary

If system X is involved in automatic processing and not in controlled processing, it cannot be generally involved in identity processing because it can be automatic in some circumstances and controlled in others. Similarly, if system C is involved in controlled processing, it could not be involved in causal processing because the latter, too, could be automatic in some circumstances and controlled in others. Therefore, the dichotomy between the X and C systems does not offer strong evidence for a dual-systems model of attributional inferences in which the identification phase is automatic and the causal inference phase is controlled.

Sloman's Two Systems of Reasoning

Sloman (1996) distinguished between associative and rule-based processes of reaching judgments. Sloman (1996) analyzed several examples of phenomenally experienced variation in an attempt to identify a substantial criterion for process distinctiveness. Sloman settled on the one criterion, Criterion S (for simultaneity), that he viewed as satisfactory in warranting a qualitative distinction between systems of reasoning: "A reasoning problem satisfies Criterion S if it causes people to simultaneously believe two contradictory responses."

Commentary

Because of the key importance that Sloman attaches to his Criterion S, it may be well to examine it carefully. Take Sloman's own example, the statement that a whale is a mammal. Whales are commonly perceived to resemble fish more than typical mammals. Thus, a knower may need to deal in this case with two contradictory beliefs, one derived from the whale's outward similarity to fish (assumed to constitute an associative process) and one derived from the "academic" knowledge that classifies whales as mammals (assumed to illustrate a rule-based process).

Yet, we may have here two distinct rules yielding opposite conclusions. One rule might be based on similarity, or the "representativeness" heuristic (heuristics have been generally defined as rules), e.g., "If the whale looks like a fish, swims like a fish, and lives in water, then the whale is a fish." The other rule may be based on other criteria for classification as a mammal, e.g., "breast-feeding of offspring" or, indeed, the source heuristic: If a biology text claims X (e.g., that whales are mammals), then X is the case.

A similar issue arises in Sloman's discussion of Kahneman et al.'s (1982) Linda problem, whereby the probability that Linda is both a bank teller and a feminist (after being provided evidence that she is likely to be a feminist) is judged more likely than the probability of her being a bank teller, in violation of the conjunction rule in probability calculus. However, intuitive heuristics have been defined as informal rules of thumb. Hence, the contradictory implications of these two rules need not be considered compelling evidence for two qualitatively distinct reasoning processes, in which only one is rule based.

Another of Sloman's (1996) examples concerns the Müller-Lyer illusion. Here, perception provides the answer that the lines are of unequal length, and a ruler demonstrates that they are equally long. Again, it is easy to understand this phenomenon in terms of two rules in which the individual happens to believe strongly and that lead to disparate conclusions. One of these rules is that one's visual perceptions are valid ("If my eyes inform me that X, then X it is"); the other, that application of a ruler yields valid answers.

In summary, Sloman's (1996) Criterion S is compatible with the notion that different rules (major premises) applied to the same evidence (minor premises) may yield different conclusions. Thus, incompatible, strongly held beliefs do not seem to warrant the postulation of a qualitative difference in the reasoning process. From this perspective, associations can

be thought of as conditional rules of the "if X then Y" variety that may come to mind very rapidly and effortlessly because of their strength—that is, the degree to which the individual is confident that X attests to Y—and their accessibility (Higgins 1996).

The Two-Memory-Systems Model

Smith & DeCoster (2000) hypothesized the existence of two qualitatively different memory systems: the slow-learning and the fast-learning systems. The slow-learning system is assumed to be associative and to learn general regularities gradually and through the accretion of instances. The fast-learning system is assumed to be rule based and to form representations of novel events quickly. Smith & DeCoster (2000, p. 110) define rules as symbolically represented and structured by language and logic: "Symbolic rules may constitute a formal system such as the laws of arithmetic or of logical inference that is accepted by social consensus in a way that goes beyond its inherent persuasiveness." Note that this definition is narrower than the presently advanced if-then conception of rules (see also Anderson 1983, Holyoak et al. 1989, Rescorla & Wagner 1972, Tolman 1932).

Commentary

Smith & DeCoster's (2000) definition of rules as formal structures has certain implications: If to qualify as a rule a cognitive relation needs to be stated in symbolic terms, and to be part of a formal system of explicit reasoning, then conditioning (animal or human) could not possibly be rule based. This is contrary to recent agreements that it is rule based (see De Hewour et al. 2001, Holyoak et al. 1989). Furthermore, in Smith & DeCoster's (2000) framework, informal heuristics such as "expertise implies correctness" or "careful manner of dressing and persuasive argumentation are typical of lawyers" could not qualify as rules even though they are generally defined as rules of thumb in the social judgment litera-

ture. In other words, the widely accepted definition of the rule concept in terms of its conditional if-then structure is broader than Smith & DeCoster's (2000) definition that characterizes the rule concept in terms of its (symbolic or formal) contents as well as in the degree of social consensus it commands.

Beyond definitional matters, the properties of rules proposed by Smith & DeCoster (2000) raise questions as to their generality. Thus, (symbolic) rules are assumed to be learned fast, yet we know from experience how slow and difficult can be the learning of statistical or logical rules (Kahneman 2003). On the other hand, the learning of what Smith & DeCoster (2000) would define as associations could be exceedingly fast. Taste aversion is one striking instance of such rapid learning (Garcia et al. 1968). Furthermore, evidence exists that evaluative conditioning can also occur in a minimal number of trials, even one (Baeyens et al. 1995, Martin & Levey 1994, Stuart et al. 1987). Thus, it is not necessary for associations to be built slowly over time and/or for rules to be acquired quickly. According to Smith & DeCoster (p. 112), "Rule based processing... tends to be analytic, rather than based on overall or global similarity, for example a symbolic rule may single out one or two specific features of an object to be used in categorization, based on conceptual knowledge of the category. In contrast, associative processing categorizes objects nonanalytically on the basis of their overall similarity to category prototypes or known exemplars."

The question, however, is whether phenomena, such as classical conditioning, that have been typically regarded as associative actually are based on perceptions of overall similarity or on specific features that seem to predict a given event (e.g., the onset of the unconditioned stimulus). Holyoak et al. (1989, pp. 320–321) argue that the latter is, in fact, the case: "Unless a feature is included in a candidate rule, nothing can be learned about its relation to other features or to appropriate behaviors... a complex environment may contain many features, few of which are likely

to be cues that would help form useful rules. For example, a rat may receive a shock while listening to an unfamiliar tone, scratching itself, looking left, and smelling food pellets. Intuitively, we might expect that the rule 'if tone, then expect shock' will more likely be generated in this situation than the rule 'If looking left, scratching, and smelling pellets, then shock.'"

In summary, the distinction between qualitatively distinct slow associative learning and fast rule learning (Smith & DeCoster 2000) may be questioned on several grounds. What has been traditionally viewed as associations can be learned relatively fast, whereas rules may be acquired slowly and with difficulty. The notion that associations are learned on the basis of global similarity and that rules are based on specific features has also been criticized (Holyoak et al. 1989). Finally, in classical conditioning, associations between the conditioned stimulus and unconditioned stimulus have been thought to represent if-then rules in which some term or category is contingently linked with another (Holyoak et al. 1989).

Unconscious Thought Theory

Recently, Dijksterhuis & Nordgren (2006) proposed a dual-systems model based on the distinction between judgments arrived via unconscious versus conscious modes of information processing. This model, referred to as the Unconscious Thought Theory (UTT), incorporates six basic principles. The first postulates the existence of "two modes of thought: unconscious and conscious. The two modes of thought have different characteristics, making them differentially applicable or differentially appropriate under different circumstances" (Dijksterhuis & Nordgren 2006, p. 96). The second principle asserts that conscious but not unconscious thought is constrained by cognitive capacity. "It follows that conscious thought by necessity often takes into account only a subset of the information it should take into account" (Dijksterhuis & Nordgren 2006, p. 96).

The third principle states that " the unconscious works bottom-up or aschematically, consciousness works top-down or schematically" (p. 97). Moreover, "conscious thought is guided by expectancies and schemas" (p. 97), whereas "unconscious thought slowly integrates information to form an objective summary judgment" (p. 98). The fourth principle states, "The unconscious naturally weights the relative importance of various attributes. Conscious thought often leads to suboptimal weighting because it disturbs this natural process" (Dijksterhuis & Nordgren 2006, p. 99–101).

Principle 5 suggests that "conscious thought can follow strict rules and is precise. Unconscious thought gives rough estimates p. 101." Finally, the sixth principle states, "Conscious thought and memory search during conscious thought is focused and convergent. Unconscious thought is more divergent" (Dijksterhuis & Nordgren 2006, p. 102).

Empirical Evidence

To test the notion that unconscious processing can handle more units of information than conscious processing, Dijksterhuis (2004) had participants complete a judgmental task either immediately after the relevant information was presented, after listing reasons for making their anticipated judgment (conscious thought condition), or after being distracted (unconscious thought condition). In each of five studies, participants were presented with many more pieces of information than conscious thought was thought to be able to handle (based on the notion that conscious thought can handle seven, plus or minus two, pieces of information; Miller 1956). Consistently across studies, participants made more accurate judgments in the unconscious thought condition than in the conscious thought condition.

Dijksterhuis & Bos (manuscript submitted) set out to investigate the hypothesis (derived from UTT's third principle)

that conscious processing will lead to a schema-based judgment. Participants were given a "stereotypical expectation" ("You are now going to read information about Mr. Hamoudi, a Moroccan man"), followed by more detailed behavioral information. Some of the behavioral information was congruent with the stereotype, whereas other information was stereotype incongruent. Conscious thinkers judged the targets stereotypically and recalled more stereotype congruent (versus incongruent) information. Unconscious thinkers, however, made neutral judgments and recalled more stereotype-incongruent than stereotype-congruent information. Moreover, conscious thinkers recalled less information overall than did unconscious thinkers.

To test the prediction (derived from principle four) that unconscious (versus conscious) processing results in superior weighting of the available information, Dijksterhuis (2004, Study 3) had participants make judgments about roommates. Beforehand, participants rated how important the various attributes were for them in selecting a roommate. Conscious reasoning weighted the worst, whereas unconscious thinkers weighted the best, though differences between conditions were not statistically significant.

As evidence that the unconscious is not able to follow specific rules, but does integrate information appropriately (derived from principle 5), Betsch and colleagues (Betsch et al. 2001) asked participants to look at ads displayed on a computer screen. Simultaneously, information about the fluctuating prices of five stocks was displayed (75 units of information). Participants were not able to answer accurately specific questions about the stocks, but were able to determine the best and worst stocks.

Finally, Dijksterhuis & Meurs (2006) tested the notion (derived from principle 6) that unconscious thought is more divergent; hence, it affords greater creativity than does conscious thought. Participants were presented with a creativity task (to generate new names for pasta or to generate places starting with "A"). In the pasta experiment, participants were given five examples, each ending in the letter "i." Conscious thinkers almost exclusively listed names ending with "i," whereas unconscious thinkers listed names with other endings. In an experiment where participants were asked to generate Dutch cities and villages starting with "A," conscious thinkers listed highly accessible and obvious names such as Amsterdam, whereas unconscious thinkers listed a greater number of less well-known villages.

Commentary

Dijksterhuis & Nordgren's (2006) findings of wide-ranging differences between conscious and unconscious conditions are intriguing. Yet the underlying processes mediating these results aren't well understood as yet. For instance, the assumption that the conscious process constitutes rule following doesn't necessarily imply that it should lead to inferior judgments. Some rules are quite appropriate to various judgments and are quite warranted (e.g., rules of logic, mathematics). Thus, contrary to the UTT's implication, conscious processes might not universally lead to inferior judgments relative to unconscious processes.

In a certain sense, the UTT model seems contrary in its implications to major dual-process models in realms of persuasion (Chaiken et al. 1989, Petty & Cacioppo 1986), stereotyping (Brewer 1988, Fiske & Neuberg 1990), and judgment under uncertainty (Kahneman 2003, Kruglanski et al. 2006a). The latter models suggest that a high degree of processing motivation leads to a thorough (conscious) consideration of the information given, juxtaposed to the use of accessible heuristics. By contrast, the use of heuristics has been often likened to intuitive, associative, and unconscious processing (Smith & DeCoster 2000).

Above all, even though unconscious processing may require little cognitive capacity,

it is unlikely to suffice for solving truly complex problems without the assistance of conscious processing. That may be particularly true if conscious processing is abetted by various capacity-enhancing devices such as writing, printing, and computer programming. It would seem plausible that considerable advances in science and technology were enabled through the foregoing devices, whose implementation seems hardly unconscious. Thus, whereas unconscious processing may be very fast, its results may typically require a careful evaluation in the sobering light of consciousness. Finally, even though it may be quicker and more efficient than conscious processing, unconscious processing may well be carried through the same rule-following process, albeit in a highly routinized form, as conscious processing (James 1890; Kruglanski et al. 2006a,b; Kruglanski & Dechesne 2006; Logan 1992; Schneider & Shiffrin 1977).

The Reflective-Impulsive Model

Strack & Deutsch (2004) recently proposed a dual-process model based on a distinction between the reflective and the impulsive systems. These are depicted as governed by different principles of representation and information processing. Specifically, "... in the reflective system, behavior is elicited as a consequence of a decision process... knowledge about the value and the probability of potential consequences is weighed and integrated to reach a preference for one behavioral option. If a decision is made, the reflective system activates appropriate behavioral schemata through a self-terminating mechanism of *intending*. In contrast, the impulsive system activates behavioral schemata through spreading activation, which may originate from perceptual input or from reflective processes" (Strack & Deutsch 2004, p. 222; emphasis in original).

The reflective-impulsive model suggests that "both systems operate in parallel. However, an asymmetry exists between them such that the impulsive system is *always* engaged in processing (by itself or in parallel to opera-

tion of the reflective system) whereas the reflective system may be disengaged" (Strack & Deutsch 2004, p. 223; emphasis added). Engagement of the reflective system requires the allocation of attention to the stimulus. Thus, the investment of effort represents a fundamental difference between the two modes of thinking. Accordingly, "processes of the reflective system are disturbed more easily than those of the impulsive system" (p. 223).

Modes of representing and storing information additionally differ in the two systems. "In the reflective system, elements are connected through semantic relations. In the impulsive system, the relations are associative links between elements and are formed according to the principles of *contiguity* and *similarity*" (Strack & Deutsch 2004, p. 223; emphasis added). The associative links in the impulsive system form "over many learning trials," "bind together frequently co-occurring features and form *associative clusters*" (Strack & Deutsch 2004, p. 223; emphasis added). The associative clusters are conceptualized as "nonpropositional representations," whereas the reflective system is "capable of forming propositional representations by connecting one or more elements through the instantiation of relational schemata to which a truth value is attached" (p. 223).

Associations can be formed in the impulsive system as a result of frequent activation of nodes by the reflective system. "Thus, semantic concepts will emerge in the impulsive system through frequent propositional categorizations... [but] *are not assumed to have any semantic meaning by themselves*" (Strack & Deutsch 2004, p. 224; emphasis in original). Though absent propositional rules, "associative clusters in the impulsive system can be hierarchically structured and can differ in abstractness. As a consequence, *clusters may resemble* either concrete perceptual concepts or abstract *semantic concepts* or schemata" (Strack & Deutsch 2004, p. 224; emphasis in original).

Strack & Deutsch also coordinate the impulsive system to long-term memory and

the reflective system to temporary storage in which "the amount of information that can be represented at any given time is limited, and the representation will fade if it is not rehearsed" (p. 225). The impulsive system, Strack & Deutsch (2004) suggest, is limited in its ability to process certain types of information. Specifically, (*a*) it cannot process or store negation and (*b*) it cannot generate a time perspective. It follows that the reflective system "allows individuals to resist immediate rewards and strive for more valuable future outcomes" (Strack & Deutsch 2004, p. 228). From this perspective, judgment is defined as a necessarily reflective process. This assumes that products of impulsive thought must be translated to rule-based logic before they can be articulated.

The reflective-impulsive model incorporates affective, motivational, and cognitive principles ultimately producing behavior. A major motivational principle is that of relative deprivation, and a major informational principle is that of accessibility. Affect and cognition interact to yield behavior: "Positive or negative affect induces motivational orientations, preparing the organism to decrease (approach) or to increase (avoidance) the distance towards an object. Deprivation of a. . . need activates behavioral schemata that previously were successful in ending the state of deprivation. Therefore, when deprived (e.g., thirsty), need-relevant stimuli (e.g., water) are easier detected, and they are more easily approached. . . ." (Deutsch & Strack 2006, p. 5).

Empirical Evidence

To support the claim that the impulsive system cannot process or store negation, Strack & Deutsch (2004) cite research (Gilbert et al. 1990) in which participants attempted to learn novel vocabulary (e.g., a "waihas" is a fish). Each vocabulary word was tagged as true or false. When participants were distracted during the trials, vocabulary words tagged as false were more often erroneously remembered as true than were words tagged as true being remembered as false.

However, rather than assuming that these findings attest to the essential incapability of the impulsive system to process negation, it is possible that negation is more ambiguous than affirmation (e.g., knowing that "waihas" is not a fish is uninformative as to what "waihas" actually is), hence it is more difficult to learn than affirmation. This might explain why the learning of negation is interfered with under depleted resources. Furthermore, the goal of learning a vocabulary is that of learning affirmations. Participants may have regarded the learning of negations as less important than the learning of affirmations and may not have striven to accomplish it, particularly when doing so required considerable effort.

To support the claim that the impulsive system is incapable of generating a time perspective, Deutsch & Strack (2002) presented participants with a short negative or a short positive picture, followed by a delay in which there came a lengthier presentation of an oppositely valenced picture. It was found that in the absence of load, participants preferred the lengthier and delayed presentation of the positive picture. Under load, participants preferred the shorter and more immediate presentation of the positive picture.

Again, it is unclear whether such data require two qualitatively distinct systems for their explication. Load, after all, is a continuous variable, as is the extent of cognitive resources. It is possible that when the load is high relative to resources, individuals are unable to suppress the temptation of the positive picture or to engage in the kind of cognitive work required for self-control, something that they may be able to accomplish in the absence of load. It should follow that if the individuals had lesser resources they might prefer the immediate positive picture, even in the absence of load. Similarly, if the individuals had greater resources they might prefer the delayed positive picture, even under load.

Commentary

Strack & Deutsch's (2004) reflective-impulsive model (RIM) resembles in several respects alternative dual-systems' frameworks such as those of Sloman (1996), Smith & DeCoster (2000), and Dijksterhuis & Nordgren (2006). In all such models, an associative, efficient process is juxtaposed to a rule-following, resource-exigent process. The alternative dual-systems models differ from the RIM in that they aimed exclusively at the explication of judgments, whereas RIM also includes the explanation of behavior. Furthermore, the systemic alternatives to RIM were mute on the topic of affect, whereas in RIM, affect plays an important part in instigating cognitive and behavioral activity. Thus, the RIM is more of a "grand" psychological theory than are similar alternative dual-system frameworks in that it subsumes nearly all facets of psychological functioning.

The sweep of the RIM formulation, though creative and imaginative, constitutes also its problematic aspect as far as scientific theorizing is concerned. It seems to yield little in the way of unique predictions, and the empirical evidence cited in its support seems open to alternative interpretations.

DUAL-SYSTEMS FRAMEWORKS: CONCLUDING COMMENTS

The dual-systems frameworks leave several questions for consideration:

(*a*) Their fundamental distinction between rule following and associative processes needs to come to terms with the body of evidence suggesting that associations are actually rule-like (Holyoak et al. 1989).

(*b*) Their assumption that the associative process is independent of resources needs to account for the fact that in learning the association an actor must pay attention to a given aspect of the total situation to connect it associatively with another aspect. Presumably, the ability to pay such attention requires attentional resources.

(*c*) Their qualitative distinction between unconscious and conscious processes (assumed to characterize the associative/automatic and the reflective/deliberative processes) seems inconsistent with the notion that automaticity or consciousness lie on a continuum (Bargh 1996, Logan 1992, Posner 1990), that efficiency is a matter of routinization (Schneider & Shiffrin 1977), and that consciousness is removed as a function of routinization (James 1890, p. 496), suggesting that routinization too is continuous rather than discrete.

(*d*) Proponents of the associative/reflective dichotomy (e.g., Strack & Deutsch 2004) assert that contiguity and repetition are causally involved in the formation of associations. However, it is questionable whether repeated contiguity and repetition are necessary and sufficient for "associative clusters" to form. Single-shot associative connections can be formed as well. Additionally, temporal contiguity doesn't seem necessary for the formation of such conceptions. Indeed, "There are many demonstrations of classical and instrumental conditioning in which the delay between events is on the order of many seconds or minutes…" (Holyoak et al. 1989, p. 316).

In short, the dual-systems (versus dual-mode) models do avoid the assumption that some informational contents (peripheral or heuristic cues, social categories, etc.) are processed shallowly or briefly, whereas others are processed deeply or extensively, and they characterize general cognitive processes applicable across informational contents. Nonetheless, evidence-based arguments exist that the two types of processes they characterize as distinct share an important commonality related to the learning of rules and that the processes they address may represent

different points on the same quantitative continua (e.g., routinization) rather than representing qualitative dichotomies.

ALTERNATIVES TO THE DUAL-PROCESS MODELS

As the foregoing review illustrates, the dualistic partition between modes or systems of human inference has represented the dominant conceptual approach to this domain of phenomena. However, even though novel dualistic frameworks continue to be advanced (Dijksterhuis & Nordgren 2006, Strack & Deutsch 2004), alternatives to those formulations have been also advanced. Such alternative models either argue that the dualistic frameworks do not draw sufficiently fine distinctions between psychological processes (Conrey et al. 2005, Sherman 2006) or that the qualitative distinctions they make may be effectively reconceptualized in quantitative terms (Erb et al. 2003, Kruglanski et al. 2006a).

The Quad Model

Typically, multiple-process models have distinguished between two judgmental modes, one operating when judgments are made automatically, and another when they are made deliberatively. As an alternative, the Quad Model (Conrey et al. 2005, Sherman 2006) proposes four qualitatively distinct processes: two automatic and two controlled. The automatic processes are referred to as association activation and guessing. The controlled processes are referred to as overcoming bias and discriminability.

The association activation process reflects the likelihood that the stimulus will give rise to an association. The guessing process is derived from memory models in which familiarity is used as a cue only when attempts at recollection fail (e.g., Jacoby 1991, Mandler 1980). The discriminability parameter reflects the likelihood that the "correct" answer can be reached, and that sufficient resources will be available for the kind of controlled processing needed to arrive at a correct answer. In order to reach a correct answer, appropriate information must be available in memory or the environment. Moreover, sufficient cognitive capacity and motivation are needed to process the stimulus and to retrieve information.

The overcoming-bias process occurs when the automatically activated association is inhibited through controlled endeavors. Therefore, overcoming bias is influenced by motivation and capacity constraints. If bias is overcome, then discriminability determines the judgment, whereas the automatic association determines the judgment when bias is not overcome.

The likelihood that each process will operate is conditionally dependent upon the preceding processes. For example, association activation and discriminability both must occur for bias to be overcome. Similarly, only if neither association activation nor discriminability occurs may guessing take place. Guessing may be the result of automatic or controlled response biases. For example, an automatic tendency to respond with the right hand may occur. Also, a "strategic bias," such as responding positively to black faces, may occur.

Empirical Evidence

In the first test of the Quad Model, participants were presented with a flowers-insects implicit association test (IAT) (Greenwald et al. 1998). Supporting the conceptualization of the association activation (AC) parameter, participants preferred flowers to insects. Discriminability of the stimuli (D) was high, indicating that participants were able to judge accurately the difference between a flower and an insect, as expected. The overcoming-bias (OB) parameter was estimated in a situation where oppositely valenced stimuli were experimentally associated (i.e., flowers with negative words, and insects with positive words). The rate of correct responses in these conditions was significantly greater than zero, indicating that the discriminability parameter plays an important role in judgment.

A second study manipulated the time given participants to respond to each item in a black-white IAT. Time constraints reduced discriminability and overcoming bias. However, they did not affect the automatic processes. The association activation parameter did vary as a function of the attitude measured, but importantly, did not vary as a function of time constraints. Also, right-hand guessing bias was found in both the time-constrained and unconstrained conditions.

In the third experiment, the number of unpleasant versus pleasant words was manipulated to determine the impact on the guessing parameter. A stronger right-hand bias was predicted and obtained when participants had to respond more often with the right-hand key (i.e., more pleasant words) than when they had to respond more often with the left-hand key (i.e., more unpleasant words).

The fourth experiment tested the Quad Model on a standard IAT to determine the relationships between IAT standard scoring and the Quad Model parameters. In accord with predictions, the association activation parameter was positively correlated with the standard IAT scores. Also, there was a negative correlation between overcoming bias and standard IAT scores. Sherman (2006) interprets these findings as suggesting, "to the extent that people have strong implicit associations, they show stronger bias and, to the extent that they are able to overcome their associations, they show weaker bias. This shows that IAT performance is influenced by controlled processes."

In the fifth experiment, Conrey et al. (2005) reanalyzed data reported by Lambert et al. (2003), which showed that an anticipated public context (making participants accountable) increased the extent of bias on the Weapons Identification Task (WIP). The reanalysis showed that D was diminished in the public condition and OB was enhanced. Thus, one type of controlled process was inhibited by an audience and another was enhanced by the audience. Moreover, the analysis showed that the AC parameter did increase in the public condition.

Commentary

The Conrey et al. (2005) data attest to the generative ability of the Quad Model. Nonetheless, at the conceptual level several questions remain. As with the other multi-system models, the Conrey et al. (2005) formulation needs to come to terms with evidence that associative processes may be actually rule based (e.g., Holyoak et al. 1989, Lovibond 2003). For instance, in an IAT-type task, the "association" could be of the form "if flower then good," and the experimentally acquired rule, "if flower then [press] the A key." Following the latter rule may represent the overcoming of bias and the attainment of discriminability, whereas following the former rule could represent a bias. Also, the former rule might be more practiced and automatic, and hence less vulnerable to resource depletion, yet it could be similar to it in form. In other words, exhibiting bias or overcoming bias might simply mean following different rules.

Second, it is unclear that the guessing parameter is qualitatively different from the association activation parameter. Specifically, the association activation parameter would seem to apply to the activation of rules in general, whereas the guessing parameter seems to apply to specific rules, such as "if a name feels familiar then it is famous." Thus, in the same way that associations in general are strengthened through repeated pairing, so may be the "guessing bias." For instance, in work by Conrey et al. (2005, Study 3), the right-hand "guessing" bias was enhanced through the number of instances in which the correct answer required a right-hand response. In present terms, a possible rule that "if stimulus then right response" might have been strengthened in this case by the number of instances in which a reinforcement (positive feedback) followed the pairing of a stimulus with a right-hand response.

Third, the overcoming bias notion carries the implication that previously formed associations were biased or incorrect, whereas the deliberative rule that overcomes those associations led to a correct response. However, there might be instances in which the original association was correct, whereas the deliberative judgment exercised via the application of considerable mental resources was incorrect.

Finally, the overcoming bias notion may be thought of as a clash between two rules, one more routinized than the other. But there could also exist a clash between two routinized rules (e.g., conflicting stereotypes of an Asian and a woman clashing in the example of an Asian Woman), or a clash between two conscious rules. In short, the interesting data of Conrey et al. (2005) could be reinterpreted in ways that do not require the postulation of four qualitatively distinct processes.

The Unimodel

The various multimode models (whether of the process or the system variety) assume that there exist qualitatively distinct ways of reaching judgments. In contrast, the unimodel (e.g., Erb et al. 2003; Kruglanski & Thompson 1999a,b; Kruglanski et al. 1999, 2006a,b; Pierro et al. 2004, 2005) assumes that the basic process of judgment is governed by several orthogonal parameters whose combinations at various values determine whether the information given exerts impact on judgments.

Rule following. The unimodel assumes that the judgmental process is essentially rule based, where rules are defined broadly as if-then contingencies that the organism "knows" (whether explicitly or tacitly). Judgments are based on "evidence," constituting an antecedent term in a conditional if-then premise stored in an individual's memory. For instance, the inference that one's overall life satisfaction is high might be based on one's momentary mood (Schwarz & Clore 2006). This requires that the individual subscribe to the inference "if my mood is good then my life satisfaction is high."

Kruglanski et al. (2006a,b) discuss various prior attempts to distinguish rule-based judgmental processes from putative alternatives processes, such as associative learning (Sloman 1996), pattern recognition (Lieberman et al. 2002), classical conditioning, or evaluative conditioning (Gawronski & Bodenhausen 2006). Drawing on various types of evidence, Kruglanski et al. (2006a,b) conclude that associative learning as well as pattern recognition represent instances of rule following rather than constituting alternatives to rule following. Thus, Holyoak et al. (1989) conclude their review of classical conditioning research by noting that "representations of the environment take the form of (IF THEN) rules that compose mental models (for instance) the rat's knowledge about the relation between tones and shocks might be informally represented by a rule such as "if a tone sounds. . . then a shock will occur" (p. 320). Also, whereas evaluative conditioning may not constitute signal learning, there are reasons to believe that it does constitute an instance of rule learning, e.g., involving a causal misattribution to the conditioned stimulus of affect engendered by the unconditioned stimulus.

Kruglanski et al. (2006a,b) note that the rules involved in conditioning may be applied with considerable ease and alacrity. The notion that automatic phenomena in the domain (motor or cognitive) skill acquisition involve a routinization of if-then sequences has been central to Anderson's (1983) atomic components of thought (ACT*) model, which Smith and his colleagues (1989, Smith & Branscombe 1988, Smith et al. 1988) generalized to the realm of social judgments. Their research has demonstrated that social judgments represent a special case of procedural learning based on practice that strengthens the if-then components, resulting in increased efficiency (automaticity) (cf. Bargh 1996).

The notion that rule-following behavior can be automatic and unconscious is supported by the notion of perception theorists

that vision depends critically on hard-wired inference rules for translating the retinal image into the experienced percept. In this vein, a recent Annual Review article "treats object perception as a visual inference problem" (Kersten et al. 2004) and suggests "the visual system resolves ambiguity through built-in knowledge of... how retinal images are formed and uses this knowledge to automatically and unconsciously *infer* the properties of objects" (p. 273, emphasis added).

Similarly, pattern recognition is compatible with, rather than constituting an alternative to, rule following. A pattern is a configuration of cues that collectively points to some judgment. In this sense, a pattern constitutes a conjunctive antecedent of an if-then rule. In Holyoak et al.'s (1989, p. 319) conception, for instance, "configural cues are... multiple-element conditions of rules." Indeed, Lieberman et al. (2002) allow that products of the X system, assumed to operate on the basis of pattern recognition, "can also be described as a result of executing... IF THEN statements" (p. 221).

The judgmental parameters. Based on the general assumption that judgments are rule based, the unimodel identifies a number of continuous parameters whose intersections determine the impact on judgments of the information given.

Subjective relevance. The degree to which the antecedent X implies a consequent Y in the "if X then Y" conditional may vary, constituting a continuous parameter. In some cases, the X-to-Y implication could be strong. If so, an encounter with X would create a strong sense that Y is to be expected. Put differently, knowledge that X is the case constitutes compelling evidence that Y is too. Strong inferences may be afforded by the way our perceptual system is hard-wired (Pizlo 2001). Nonetheless, perceptual learning of some sort may take place. As Bruner (1958, pp. 90–91) observed, "we learn... the probabilistic texture of the world, conserve this learning, use

it as a guide to tuning our perceptual readiness to what is most likely next. It is this that permits us to go beyond the information given."

Some inferential rules may be overlearned to the point of routinization (Schneider & Shiffrin 1977), whereas others may derive from a powerful single-shot experience (Garcia et al. 1968) or from a trusted epistemic authority (Kruglanski et al. 2005). With lesser degree of routinization, an experience with less impact, or a less trusted epistemic authority, the X-to-Y implication may be weaker and more tenuous. In those instances, the confidence in Y given X would be correspondingly feeble.

Gleaning difficulty. Judgmental contexts may vary in the degree of hardship involved in applying a given inference rule by a given individual seeking to answer a given question. Gleaning difficulty may be determined by external task demands and by internal states of the knower.

External task demands. The informational context may determine how easy or difficult it is to detect the specific information from which inferences can be made. The information may be highly complex and lengthy. It may contain considerable noise, and the relevant evidence may be faint or insufficiently salient to attract attention. The informational array may contain several relevant items, each fitting a different inference rule whose implications might clash with one another. The requisite discriminations (e.g., in the perceptual realm) might be exceedingly fine. All these may contribute to judgmental task difficulty. Placement of the relevant information in the sequence may also matter. A front-end placement may make the items easier to process, whereas a later placement may make them more difficult to process due to the depletion of cognitive resources by the early items.

As Kruglanski and colleagues (e.g., Erb et al. 2003; Kruglanski et al. 2006a,b) noted, across a variety of judgmental research some

information types (e.g., peripheral/heuristic, categorical) may have been presented to participants in a relatively easy format, whereas other information types (e.g., issue related, individuating) may have been presented to participants in a relatively difficult format. Different types of information are qualitatively distinct because they comprise distinct contents. It is therefore possible that the frequent claims for qualitatively different processes of judgment rest in part on the inadvertent confounding in prior research of information types with task difficulty.

Empirical evidence. Research in the unimodel framework has attempted to control for such confounds and examine how this affects phenomena previously understood from a dual-mode perspective. In the realm of persuasion, Kruglanski and colleagues (Kruglanski & Thompson 1999a,b; Pierro et al. 2005) demonstrated that the difficulty of processing, rather than the type of information processed, interacts with the availability of motivational and cognitive resources to determine persuasion. In the realm of attribution, Chun et al. (2002) found that the difficulty of information processing determines whether the assimilative influence of context on behavior identification requires resources. In the same vain, the claim that the subtractive effect of context on dispositional attributions is resource dependent was contravened by the findings of Trope & Gaunt (2000) such that it doesn't require resources when it is made easier to process.

Chun & Kruglanski (2006) obtained evidence that the well-known phenomenon of base-rate neglect (Kahneman 2003, Tversky & Kahneman 1974) can be partially accounted for by the interaction of difficulty of processing and the availability of processing resources. Both the use of statistical information and that of heuristic information (e.g., representativeness) is greater where such information is easy to process and the resources are restricted, or when it is relatively challenging to process and the resources are plentiful. Thus,

it was found that, ironically, the processing of statistical information was increased under cognitive load (!), provided such information was brief and easy to use, as compared with lengthier and more difficult to process heuristic information.

Finally, Pierro et al. (2004) obtained evidence that the often observed failure to use peripheral/heuristic information under conditions of high-processing resources is due to the fact that, as a category, such information is typically perceived as less relevant to the requisite judgments than is the message argument information. Thus, under high-resource conditions, a "relevance override" may take place such that the more relevant information tends to be relied on, whereas the less relevant information tends to be neglected.

Commentary

Thus far, the empirical research guided by the unimodel has concerned the confounds of processing difficulty and informational contents. The unimodel has not been empirically applied to the distinction between associative and rule-based processing central to the several dual-systems models. According to the unimodel, the so-called associations are if-then rules that humans (and animals) can learn, often to the point of routinization. Such routinization may render them relatively independent of mental resources, which removes the need to exercise conscious attention over their execution (Bargh 1996, Norman & Shallice 1986). The unimodel thus unpacks the "phenotypic" differences between instances of social inference in terms of the underlying if-then "genotypic" structure that they all seem to possess, and the differences in efficiency, consciousness, speed, etc. that they seem to exhibit.

CONCLUDING COMMENTS

The domain of human inference is diverse and multifaceted. First, inferences vary in the domain of content to which they belong.

Secondly, inferences vary in their speed and immediacy. Inferences vary also on the process-awareness dimension. Possibly driven by this multifarious variability, a plethora of models and theories has been advanced to identify the processes and mechanisms underlying human inference. In recent decades, such formulations have preponderantly adopted a partitioning approach distinguishing between qualitatively different manners of reaching inferences.

Our review reveals that in early dual-mode models, the critical partition often hinged on different types of information. Possibly in recognition of the open-ended variety of informational types or contents, the more recent dual-systems models tended to be "content-free." Such models typically adopted two categorical distinctions, namely those between (*a*) automatic versus controlled processes and (*b*) associative versus rule-based processes. The latter categorizations were assumed to coincide such that the associative processes were typically assumed to be automatic, whereas the rule-based processes were assumed to be controlled. The dual-systems models have been closely attuned to the prevalent Zeitgeist in social cognition apparent in their emphasis on automatic processes and their reliance on brain activity findings as evidence for their postulates.

Conceptual departures from the strict dualistic paradigms have also been noted. The Quad Model proposes to partition the basic automatic/controlled distinction further into its more specific subtypes. The unimodel parts ways with qualitative partitions altogether and proposes to account for the phenomena of human inference in terms of a number of intersecting quantitative continua. These latter departures challenge the prevalent dualistic approach to human inference and pose fundamental questions to be resolved, hopefully, via creative new research initiatives (for a recent debate on these issues, see Deutsch & Strack 2006; Kruglanski et al. 2006a,b; Sherman 2006).

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