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Dual-Process Models in Social and Cognitive Psychology: Conceptual Integration and Links to Underlying Memory Systems

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Models postulating 2 distinct processing modes have been proposed in several topic areas within social and cognitive psychology. We advance a new conceptual model of the 2 processing modes. The structural basis of the new model is the idea, supported by psychological and neuropsychological evidence, that humans possess 2 memory systems. One system slowly learns general regularities, whereas the other can quickly form representations of unique or novel events. Associative retrieval or pattern completion in the slow-learning system elicited by a salient cue constitutes the effortless processing mode. The second processing mode is more conscious and effortful; it involves the intentional retrieval of explicit, symbolically represented rules from either memory system and their use to guide processing. After presenting our model, we review existing dual-process models in several areas, emphasizing their similar assumptions of a quick, effortless processing mode that rests on well-learned prior associations and a second, more effortful processing mode that involves rule-based inferences and is employed only when people have both cognitive capacity and motivation. New insights and implications of the model for several topic areas are outlined.

When people perform tasks as diverse as solving logical problems, evaluating persuasive arguments, and forming impressions of other persons, they can make use of different processing strategies. People can (and in everyday life often do) use a sort of "quick-and-dirty" approach, arriving at usually reasonable answers efficiently and effortlessly. For example, they may agree with an argument because a quick glance reveals that it is presented by an expert source and contains statistical data. People also, when adequately motivated and given enough time and freedom from distraction, can try hard to think deeply about these tasks, sometimes arriving at qualitatively different answers. The expert's arguments, on close examination, may prove specious, the statistics biased.

In recent years, researchers working in numerous areas of social and cognitive psychology have developed models that follow these general lines: *dual-process models,* as we label them here (Chaiken & Trope, 1999). Such models contain three major components. They provide accounts of how people process in quick-and-dirty fashion, how they process when willing and able to engage in extensive thought, and what conditions encourage such effortful processing. In this article, we provide a new integrative model that promises to account for much of the existing evidence in diverse content domains. Our new conceptual model also links the two processing modes to theory and research on memory systems. After presenting the new model, we review a number of existing dual-process models and point out how the new model accounts for the broad patterns that have been empirically observed and interpreted with the aid of these various domain-specific theories. Thus, the new model serves the purpose of conceptual integration, bringing apparently disparate findings under a common umbrella and highlighting previously unrecognized parallels. Finally, we argue that our model also yields important new insights in many of these domains, points to key conceptual questions that need to be resolved, and opens up new empirical areas for investigation.

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Structural Basis of Dual-Processing Modes: Two Memory Systems

In this section, we first present our view of the structural basis of the two processing modes, two memory systems with systematically different properties. We review several types of evidence that support this distinction and then describe how the two processing modes draw on these underlying memory systems.

In recent years, numerous theorists have advanced generally similar proposals focused on the idea that humans have two separate memory systems with distinct properties (Alvarez & Squire, 1994; McClelland, McNaughton, & O'Reilly, 1995; Milner, 1989; Murre, 1995; O'Keefe & Nadel, 1978; Sherry & Schacter, 1987; Tulving, 1983; for additional discussion, see Schacter & Tulving, 1994). In this context, a "memory system" is defined as a set of acquisition, retention, and retrieval mechanisms that follows certain rules of operation (Sherry & Schacter, 1987). The claim that there are two memory systems means that these systems use fundamentally different rules or principles of operation, not simply that they store different types of information (e.g., visual vs. verbal information).

Why should there be two memory systems rather than just one? The fundamental reason is that human memory must meet two conflicting demands that are functionally incompatible (McClelland et al., 1995; Sherry & Schacter, 1987). One demand is to record information slowly and incrementally so that the total configuration in memory reflects a large sample of experiences. This is important so that general expectancies and long-term stable knowledge can be based on the average, typical properties of the environment. This function requires a slow-learning memory system, which could be termed "schematic" because it matches the typical properties assumed for schema in social and cognitive theories (see Fiske & Taylor, 1991; Rumelhart, Smolensky, McClelland, & Hinton, 1986). A second demand is for rapid learning of new information so that a novel experience can be remembered after a single occurrence. After all, people can at least sometimes learn things by being told once. This function requires a "fast binding" system that can store episodic records of the details of specific experiences, including the context. However, the requirements of slow and fast learning are incompatible.

Because of this functional incompatibility, humans and other animals are believed to have evolved two separate memory systems to serve these two functions.[1] This idea may seem unparsimonious, but many types of psychological and neuropsychological evidence point to the existence of two memory systems with properties that correspond to slow-learning and fast-learning systems (McClelland et al., 1995; Sherry & Schacter, 1987). The evidence suggests that the fast-learning system is mediated by the hippocampal region of the brain. Among the major points are these:

1. Damage to the hippocampal region causes deficits in new learning, in both humans and other animals. Deficits particularly affect the rapid learning of new associations among objects or events and their context. For example, the ability to learn new associations between unrelated pairs of words is impaired in amnesiacs (Scoville & Milner, 1957). Also, there are marked deficits in explicit or intentional retrieval of information (Schacter, 1987).

2. Hippocampal lesions produce not only impairments in new learning but also deficits in retrieving earlier memories (retrograde amnesia). The amnesia is temporally graded, with more recently learned material suffering more than more remote material (Squire, 1992; Zola-Morgan & Squire, 1990).

3. Other types of cognitive performance, however, are relatively unimpaired by the same types of lesions. The first systematic observations of this type of dissociation in humans were striking to the researchers (Scoville & Milner, 1957). The patient HM, who had large parts of his hippocampal system surgically removed, could not learn new facts or explicitly recall anything that occurred after a point several months prior to his surgery. Still, he could recall more distant memories. Moreover, his performance on intelligence tests and his social skills were relatively unimpaired, and he could carry on a more or less normal conversation.

4. Not only general intellectual abilities but also some forms of new learning are relatively unimpaired. These include the learning of skills (e.g., reading reversed print; Cohen & Squire, 1980). In addition, patients with hippocampal damage remain able to extract what is common in a set of stimulus items. Although they might not be able to recall any of the items on a previously studied list, they may perform about as well as normals on the task of judging whether new stimuli were generated from the same prototype as the studied items (Knowlton, Ramus, & Squire, 1992). In one of the few social psychological investigations of brain-damaged patients, Klein, Loftus, and Kihlstrom (1996) obtained a conceptually similar finding. Although their amnesic college student WJ could not recall any specific behaviors she had performed while at college, she could give personality trait descriptions of herself at college that by available criteria (such as agreement with ratings provided by her friends or with her own ratings after recovery from her amnesia) were as accurate as those of normal students. This finding resembles that of Knowlton et al. (1992) in that the woman could access the general gist or common properties (i.e., traits) from a set of specific stimuli (behavioral episodes) despite her inability to explicitly recall the latter.

All of this evidence, then, suggests that learning of general regularities can occur more or less independent of the ability to consciously recollect specific events;

[1]To avoid confusion, note that these proposed memory systems are not equivalent to short-term and long-term memory; both are long-term in nature. Most current models hold that short-term memory is not a separate store but is the activated portion of information held in long-term memory.

amnesia resulting from hippocampal damage greatly affects the latter ability (mediated in our view by the fast-learning memory system) and leaves the former ability relatively intact. A model featuring two separate but interacting memory systems can account for these sorts of evidence. The slow-learning system is a collection of overlapping systems that are involved in sensory, perceptual, and motor output processes. The operation of these systems generally does not depend on conscious awareness or attention. These systems are responsible for translating input representations (e.g., visual patterns of letters) to output representations (e.g., word meanings). They also function as memory systems. Learning takes place as the system processes each stimulus and involves small, incremental alterations of representations in ways that facilitate repetition of the same processing. As such changes accumulate over multiple episodes, this learning changes responses to future stimuli. In summary, slow-learning memory is responsible for forming stable, general representations of the typical properties of the environment (e.g., correspondences between word forms and word meanings) over many trials. These representations are then used preconsciously to process and interpret new information by categorizing, filling in unobserved details, and the like.

The fast-learning memory system is necessary because the effects of a single experience on the slow-learning system will generally not be large enough to allow for full retrieval of the details of that experience on a future occasion. The fast-learning system is responsible for rapidly constructing new representations (i.e., episodic memories) that bind together information about different aspects of an object or experience in its context (Wiles & Humphreys, 1993). This system mediates conscious, explicit recollection and depends on the hippocampus and related brain structures. In addition to differences in speed of learning and conscious accessibility, their differentiated functions mean that the slow-learning and fast-learning systems attend to different types of information. Slow learning is chiefly concerned with regularities, so it primarily records what is typical and expected. In contrast, the fast-learning system records the details of events that are novel and interesting, attending more to the unexpected and unpredicted.

The two memory systems interact in several ways (McClelland et al., 1995). Most important is the process of *consolidation,* by which a newly formed memory is transferred by repeated presentations from the fast-binding to the slow-learning system. Prior to consolidation, a representation of a new event is only maintained in the fast learning system, thus it is vulnerable to loss from hippocampal damage (point 2 of the evidence listed previously). After consolidation, the memory is no longer dependent on hippocampal structures for retrieval. Consolidation is known, on independent grounds, to take considerable time in humans—weeks to years—and McClelland et al. (1995) suggested that it is necessarily slow so that new information can be integrated into the stably structured representations maintained in the slow learning system without disrupting previous knowledge.

The empirical evidence on some aspects of the dual memory systems hypothesis is compelling, and numerous theorists have advanced basically similar views (Alvarez & Squire, 1994; McClelland et al., 1995; Milner, 1989; Murre, 1995; O'Keefe & Nadel, 1978; Sherry & Schacter, 1987; Tulving, 1983; see also Schacter & Tulving, 1994). However, this viewpoint is not universal, and other theorists (e.g., Craik, 1983; Kolers & Roediger, 1984) advocated unitary models of memory (i.e., a single general set of principles describing all operations of memory). Our purpose in this article is not to settle this theoretical debate. Rather, we consider the theoretical implications of a dual memory systems conception for many areas of social and cognitive psychology. We argue that numerous models of dual-processing modes can be integrated and interpreted in terms of the properties of two underlying memory systems and that this integration will lead to new insights and new predictions in several substantive areas of psychology. Of course, to the extent that our review and integration succeed in this purpose, it does serve as supportive (though not definitive) evidence for the dual memory system models.

Dual-Processing Modes

How are these two memory systems used as we make judgments and decisions in our daily lives? We believe that two distinct processing modes draw on the memory systems in fundamentally different ways. In brief, what we term the *associative processing mode* is based directly on the properties of the slow-learning system and operates essentially as a pattern-completion mechanism. After knowledge has been accumulated from a large number of experiences, this memory system uses that knowledge to fill in information, quickly and automatically, about the characteristics that previously have been observed or affective reactions that previously have been experienced, in situations that resemble the current one.

In contrast, the *rule-based processing mode* uses symbolically represented and culturally transmitted knowledge as its "program" (Smolensky, 1988). It rests on human linguistic abilities, which in turn draw on both underlying memory systems. Rules may be stored in either processing system, depending on such factors as how frequently they have been encountered (i.e., just one or two times vs. many times) and over what length of time (i.e., whether consolidation has had time to occur).

To forestall possible misunderstandings, we repeat: Although the associative processing mode draws solely on the slow-learning system, the rule-based processing mode uses both memory systems, not just the fast-learning one (see Table 1 for a summary).

Associative Processing Mode

Features of the associative processing mode. Associative processing takes the form of pattern-completion or similarity-based retrieval from the slow-learning memory system, cued by salient features of the input. Connectionist memories are well suited to perform these functions (Rumelhart et al., 1986; Smith & DeCoster, 1998). As a concrete example, someone may have built up, over years of experience with persuasive messages, an association between statistical charts and graphs and validity of the message. If the person is now confronted with a message having these features, the message characteristics may automatically activate this long-term association, yielding an intuitive impression that the message is probably valid. As another example, when an individual encounters a woman, the target's gender may elicit the retrieval of gender stereotypes, which for most people are well learned over a lifetime. Automatic activation of this stereotypic material may color perceptions of the person. This associative processing mode has several characteristic features.

1. One striking feature is how quickly and automatically it provides information. Associative processing operates preconsciously (Bargh, 1994), and we are generally aware only of the results of its processing. The associative mode generates what are experienced as intuitive and affective responses to objects or events. We may look at a mug and know that it is used to hold coffee, or we may look at a friend and feel warmth and affection.

2. Another feature is that associative processing can be termed reproductive rather than productive: It uses currently available cues to retrieve representations that were stored on past occasions when similar cues were present. Through associative processing, information that has repeatedly been linked to an object in the past is automatically brought to mind whenever we perceive or think about the object again. This information can fill in unobserved details or can even change the way people perceive existing features of an object. We can think of associative processing as performing multiple constraint satisfaction, where the system develops an impression of a stimulus that accommodates both its perceived characteristics and the regularities observed in previous experiences.

3. Associative processing uses general, overall similarity between the cues and stored memory representations to guide retrieval. Past knowledge may be retrieved and used based on superficial or irrelevant similarities to the current cues, rather than only for structurally important or logical reasons (for social psychological demonstrations of this property, see Gilovich, 1981; Lewicki, 1985).

Learning of associations. Learning the representations used in the associative mode takes a long time and requires a large amount of experience. If our long-term knowledge structures were to change quickly, new experiences could overwhelm the information collected in earlier encounters, and our social knowledge would lack stability. By building up knowledge slowly and incrementally, the slow-learning memory system can extract patterns that have been observed consistently over time.

Associations sometimes have been termed "rules." For example, someone may build up through experience the knowledge that green fruits are unripe and taste bitter, or that black and yellow striped insects often sting, and these items of knowledge could be called rules. However, this usage would lead to confusion. For clarity it is important to preserve the distinction between associations (which are built up through repeated experiences over time and are not necessarily interpersonally shared or symbolically encoded) and rules (which can be explicitly learned on a single occurrence and are symbolically represented and often interpersonally shared).

Table 1. *Summary of Theoretical Properties of Two Processing Modes*

Associative Processing	Rule-Based Processing
Draws on associations	Draws on symbolically represented rules
That are structured by similarity and contiguity	That are structured by language and logic
And are learned over many experiences.	And can be learned in just one or a few experiences.
Occurs automatically	Occurs optionally when capacity and motivation are present
And preconsciously, with awareness of the result of processing	And often with conscious awareness of steps of processing

Rule-Based Processing Mode

Features of the rule-based processing mode. The defining feature of rule-based processing is that it uses symbolically represented and intentionally accessed knowledge as rules to guide processing. For example, an individual may effortfully examine a persuasive argument to determine its validity by searching memory for other relevant facts. Or the individual may form an impression of a new acquaintance by considering not only her gender but also available individuating

information. It is crucial to recognize that this processing may use information stored in either the fast-learning or the slow-learning memory system. The individuating information might include the woman's assertive behaviors, which are linked through well-learned knowledge (stored in the slow-learning system) to the trait of assertiveness. The woman also might be wearing a lapel pin that the perceiver learned just minutes ago signifies membership in a conservative political organization. The inference of conservatism and related characteristics would then be mediated by that newly acquired knowledge (or rule). This knowledge would be stored in the fast-learning system, because it was encountered only once and has not had time to be consolidated into the slow-learning system.

Several other characteristics follow from the fundamental nature of this processing mode as the intentional application of rules:

1. First, unlike a database of associative knowledge that must be built up over a long period of time, symbolic knowledge can be learned from a single experience. Symbolic knowledge can then be used as rules to guide inferences and judgments—as the "program" for rule-based processing, in effect.
2. The nature of rule-based processing is interpretive in the sense used by computer scientists (Smolensky, 1988); that is, explicit representations of the symbolic knowledge are retrieved from memory and used to guide processing. The processing uses or follows rules, rather than merely conforms to them.
3. This interpretive process is necessarily sequential and relatively slow (in contrast to the fast, parallel constraint–satisfaction process that can be used with associative knowledge representations). The reason is that only one rule can be explicitly used to guide processing at a time. Rule-based processing is thus more effortful and time-consuming than associative processing.
4. Rule-based processing also 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.

Learning of rules. Symbolic rules may be socially learned by comprehending language input from other individuals, the media, or other cultural sources. Humans do not have the ability to directly transmit what we think or experience to each other, so we must choose commonly accepted symbols (words) to express ourselves. Each time that we talk to another person we have to fit what we want to say into words. Most knowledge shared between individuals therefore exists in symbolic form. Symbolic rules also may be constructed by explicit, conscious thought by an individual rather than by being socially learned. In either case, we can learn symbolic information on a single occasion. The process of learning, however, requires conscious attention and can be directed and controlled strategically—in contrast to learning in the schematic memory system, which is more automatic and less dependent on attention.

Because the rule-based processing mode rests on socially learned and culturally shared rules, the results of this form of processing have greater perceived validity (Smolensky, 1988). We are more likely to trust a statement made by someone when it is based on logical reasoning than when it is based on intuition. It is the wide sharing of the rules of logical inference that generates this feeling of validity (Levine, Resnick, & Higgins, 1993). Ultimately, validity stems from consensus. When many people agree on a rule or on a conclusion generated by applying shared rules, we tend to attribute the agreement to objective reality rather than to possible errors or misinterpretations made by the individuals concerned (Mackie & Skelly, 1994).

Alternative, Sequential, or Simultaneous Processing?

We assume that the two processing modes generally operate simultaneously rather than as alternatives or in sequence. However, because rule-based processing is slower than associative processing, it might be argued that both processing modes would operate initially but then the fast associative processing would finish, leaving only rule-based processing operating. Such a partial-overlap model likely would be difficult to distinguish empirically from a pure sequential model, in which first associative and then rule-based processing takes place. In terms of our model, both partial overlap and sequential processing seem unlikely. True, rule-based processing is relatively slow, but as rule applications generate new concepts and representations, those will elicit associative retrieval from the slow-learning memory system. In other words, the relative automaticity of associative processing means that it will continue to operate rather than ceasing before rule-based processing begins (in the sequential model) or completes (in the partial-overlap model). The ongoing impact of associative processing has been empirically demonstrated in studies by Chaiken and her colleagues (see Chen & Chaiken, 1999).

We now describe the implications and applications of this new dual-processing model in several specific areas of social psychology. First, we focus on each processing mode individually, outlining some of the em-

pirical phenomena that can be traced back to the mode's specific properties. Then we describe important forms of interaction between the processing modes. Finally, we review the implications of the model for several specific theories in social and cognitive psychology, focusing on the modifications and new insights provided by this model.

Associative Processing: Implications for Social Psychological Phenomena

Categorization and stereotyping. The term *association* may suggest a learned connection between two items or concepts, as when people study word pairs like "table–blue" in a paired associates learning task and then try to recall one when given the other as a cue. However, associative processing is better regarded as performing a *pattern completion* function. A slow-learning memory can learn to associate an entire set of characteristics that frequently co-occur, such as the visual appearance of an object, its name, the actions one performs with it, one's emotional reactions to it, and so on. This entire configuration then can be retrieved or reconstructed when a subset of the characteristics (e.g., just the name) is again encountered; the complete pattern is brought forth from a sufficiently distinctive part. Pattern completion processing, therefore, can be regarded as performing categorization, instantiation of a complete "schema" or knowledge structure based on the perception of a diagnostic set of features. In social psychology, categorization is the fundamental process underlying such important phenomena as stereotyping (in which people are categorized into social groups that have specific stereotypes associated with them) and person perception (in which specific behaviors are categorized into traits and other more abstract person characterizations).

Retrieval of well-learned affect and evaluations. Pattern-completion processing in an associative memory system can retrieve not only properties of the object but also affective responses or evaluations that are associated with the object—that is, attitudes. Work by Fazio (1986) showed that when objects had become strongly associated with attitudes (through a large amount of experience over time), evaluations could be retrieved automatically without any conscious effort or intention when the objects were encountered. Bargh, Chaiken, Govender, and Pratto (1992) found evidence that this process can occur even for weakly associated attitudes and, in fact, for essentially all objects. Greenwald, Draine, and Abrams (1996) extended this work by having research participants view words presented subliminally in brief flashes on a computer screen. These researchers used statistical arguments to show that even in the absence of participants' ability to detect the words at a conscious level, the words' evaluations affected patterns of response times. Thus, the associative memory system is able to access people's evaluations of words or other objects, automatically and without subjective intention or effort.

Attributional judgment. The representations constructed by the slow-learning memory system can be used to make causal attributions, in two separate ways. First, of course, these representations record information about the covariation of events. If a particular event has frequently co-occurred with a potential cause in the past, people likely will attribute the event to that cause (Kelley, 1972). Similarly, in classical conditioning, an initially neutral stimulus becomes associated with a more meaningful stimulus through repeated pairings. For example, an animal that always hears a bell before being fed comes to associate the sound of the bell with food. Once the association is formed, the neutral stimulus can evoke responses normally associated only with the meaningful stimulus. Our animal, therefore, may begin to salivate on hearing the bell.

Second, the strength of the connection between two features in an associative network is not simply a direct measure of the extent to which the two features are correlated in the environment or how frequently they have co-occurred in the past. In fact, associative learning rules perform more powerful and complex computations that estimate the causal impact of one event controlling for the impact of other events (Gluck & Bower, 1988). In an experiment on "blocking," for example, a participant first learns an association between one neutral stimulus and a meaningful stimulus. The participant then receives further training with the addition of a second neutral stimulus. For example, after learning to associate a bell with food, an animal goes through a number of learning trials in which it both hears a bell and sees a flashing light each time it is fed. In this case, the animal will not learn to associate the light with food. To explain this and related conditioning phenomena, Rescorla and Wagner (1972) proposed that an association only will be formed between two stimuli to the extent that one provides unique, diagnostic information about the occurrence of the other. Social psychologists are familiar with the phenomenon of blocking under another name: Kelley's (1972) discounting principle. Both humans making causal attributions and animals learning cues that predict an important reward (such as food) rely similarly on the unique predictive power of each cue controlling for other currently available cues, not simply on the correlation of cues. In this way, the associations between events built up over time in an associative memory system are actually more akin to partial regression coefficients than to simple correlations.

Facilitation of repeated judgments. When people make a judgment about a particular stimulus (e.g., judge whether a behavior implies a specific trait), a repe-

tition of the same judgment is facilitated for a long time afterward (Smith, Stewart, & Buttram, 1992). Like many forms of implicit memory, this facilitation (often termed *repetition priming*) does not require explicit memory of the initial experience (Schacter, 1987; Smith et al., 1992). In contrast to semantic priming, in which the processing of a stimulus creates a temporary processing benefit for semantically related concepts, the benefits of repetitive processing are long lasting, even enduring for months (Sloman, Hayman, Ohta, Law, & Tulving, 1988).

Wiles and Humphreys (1993, pp. 157–163) proposed that this effect is mediated by an associative memory system. They concluded that changes in connection weights in networks that translate information from one representation to another (e.g., from letters to word meanings) were responsible. These models learn by incrementally changing weights after processing each pattern. A repeated pattern will have an advantage over a novel pattern because the network changed its weights the first time to more accurately and more efficiently process the pattern. Similar suggestions have been made by Humphreys, Bain, and Pike (1989), Rueckl (1990), Schacter (1994), and Moscovitch (1994).

Summary. It is tempting to identify intelligent thought with the rational processing performed by the rule-based system and to think of the associative processing system, which we share with nonhuman animals, as extremely limited—in fact, downright stupid. In contrast, we suggest that it is capable of highly adaptive, apparently "thoughtful" processing. The previous sections have argued, for instance, that the associative system can perform categorization, generate affective responses to stimuli based on similar past experiences, and carry out attributional reasoning using covariation and discounting principles. These are all processes that social psychological theories often have assumed are performed thoughtfully and effortfully, but we now must realize that the apparent complexity of these processes does not necessarily require the use of a conscious, rule-using processor. Associative processing can generate remarkably sophisticated results.

Rule-Based Processing: Implications for Social Psychological Phenomena

One-shot learning and rule use. Perhaps the most significant ability of the rule-based system is to learn a new fact or rule, whether from personal observation or social (linguistic) input, and make immediate use of it in processing. For example, someone may be told "Those black and yellow striped insects sting" or "It's a good idea to castle your king as early as possible" and apply those facts in situations in which they are relevant, without needing to accumulate experience slowly (and perhaps painfully)—experience that would produce the equivalent knowledge in the associative system. The benefits that this ability brings to individuals—of being able to build on the experiences and learning of other individuals and also the experiences embodied in cultural knowledge and formal education—are obvious (see Smolensky, 1988).

Shared rules and validity. Symbolically encoded and socially learned rules may be pragmatically useful, but they often have another quality as well: socially accepted validity. 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 for any given individual (Sloman, 1996; Smolensky, 1988). The results of such reasoning, such as a mathematical proof or a logical argument, will not only be socially accepted as valid because of the special properties attributed to the rule system but will be subjectively experienced as particularly compelling and valid by the individual reasoner as well. This is one way in which social sharing of knowledge leads to perceived validity (see Levine et al., 1993).

Explicit, reusable memory traces. As we described previously, rule-based processing depends on an ability to dynamically construct and change knowledge representations that encode, for example, the meaning of a sentence that is being comprehended. The fast-learning memory system's ability to bind together multiple elements rapidly into new combinatorial structures underlies this ability. Such new structures, given sufficient attention and other cognitive resources, may be retained in memory and be explicitly retrievable at a later time (McClelland et al., 1995). Thus, if the rule-based processing system creates a new symbolic representation encoding a perception, inference, or linguistic input, it may leave an enduring memory trace that can have an effect later when retrieved by another process. Such a representation even may be consciously accessible and verbally reportable. In contrast, processing in the associative system does not strongly affect explicit memory; recall that the basic nature of the memory system that stores associative information involves only slow, incremental weight changes (McClelland et al., 1995).

It is true that processing a specific stimulus may produce traces in the slow-learning memory system that can cause repetition priming. However, this type of trace is use-specific, facilitating only the same type of processing of the same or a closely similar stimulus (Wiles & Humphreys, 1993). The new memory structures constructed in the course of symbolic processing are much more flexible, being retrievable even for processing in other types of tasks and in other contexts.

Neuropsychological evidence as well as computational models (Eichenbaum, 1997; Gluck, 1996) suggest that a key role of the hippocampus (the core of the fast-learning system) is to promote flexible retrieval of information outside of the specific contexts in which it was originally learned. Clark (1993) and others have described the distinction between use-specific knowledge and explicit, flexibly accessible knowledge as a key marker of the difference between associative and rule-based processing.

Flexible recombination and construction of counterfactuals. Associative systems construct representations based on repeated experiences. Thus, they may find it difficult to represent events that they have never encountered. For example, an associative system might be able to represent "dog bites man" but not "man bites dog." In contrast, symbolic language permits the recombination of symbols in new ways, so that unlikely or even completely impossible events ("space alien abducts man") can be expressed and represented. The ability to reason counterfactually, essential for such important tasks as planning future actions, seems to be a key function of the rule-based system (Clark, 1997, p. 167). In social psychology, counterfactual thoughts are known to influence affect, judgments about the self and others, and overt behavior (Miller & McFarland, 1986; Roese, 1994).

Analytic focus on key dimensions. Symbolically represented rules often focus on specific key dimensions of stimuli. For example, a novel object may be categorized on the basis of its overall similarity to known category members; this is a pattern-completion type of process that the associative system is well suited to perform. In contrast, the object may be categorized on the basis of a single key feature that is known, on the basis of some abstract theory, to analytically define a given category. Keil (1989) documented the way in which young children's categorization judgments concerning cleverly constructed examples (e.g., a raccoon that is given a skunk's appearance through surgery) shift with age from similarity-based to theory-based.

The distinction between decisions relying on one or two key features versus more global similarity-based associations has implications aside from categorization judgments. Clark (1997) discussed the way people can use symbolic rules to monitor their own decisions and behavioral intentions generated by the associative system. In some cases, these symbolic rules may be social norms or in other ways have special moral force. Clark (1997) gave this example:

> Suppose we explicitly commit ourselves to an ideal of acting compassionately in all circumstances. We then see ourselves reacting with anger and frustration at the apparent ingratitude of a sick friend. By spotting the local divergence between our ideal and our current practice, we may be able to bias our own way of taking the person's behavior—in effect, canceling out our representation of those aspects of the behavior rooted in their feelings of pain and impotence .... We may be led to focus attention on such aspects of input vectors as might help us bring our outputs back into line. (pp. 119–120)

In most cases, our intuitive judgments and behavioral decisions serve us well, but when they conflict with symbolically represented ideals or norms, the rule-based system may help us change our associatively driven responses. We can do this, as Clark (1997) noted, by focusing attention on the most "correct" or appropriate aspect of the input. Intentionally thinking hard about the sick friend's pain may induce feelings of sympathy to replace the undesired feelings of annoyance. The process is not very different from the child's replacing a similarity-based categorization (it's a skunk because it looks like a skunk) with a theory-based override by focusing on the single key attribute (even if it looks like a skunk, it must be a raccoon, because its parents were raccoons and that's all that matters).

Providing explanations or justifications. The associative system works by pattern completion, and its operations are quick and subjectively inaccessible. An answer provided by the associative system just "pops" into the head so the perceiver may be unable to provide any justification for it other than intuition. In contrast, the rule-based system maintains and uses explicit representations of rules to derive its conclusions. The individual may be aware of discrete, sequential steps in this process and may be able to report verbally on the rules that were used (Sloman, 1996). This ability to backtrack provides a basis for explaining or justifying a conclusion. The social importance of this ability is clear: Other people are likely to be more readily convinced of a conclusion if one can offer a step-by-step logical account of how it was derived than if the conclusion is simply based on "gut feelings" or intuitions.

Interactions Between the Systems

From symbolic rules to associations. Suppose someone repeatedly uses a step-by-step rule-based process to make an inference or solve a problem—perhaps just counting on one's fingers to get the answer to 2 + 3. Repeated trials create the conditions for associative learning, so eventually the same answer can be re-

trieved by pattern-completion from the associative system, rendering the step-by-step procedure superfluous (Logan, 1988; Sloman, 1996). With enough practice, therefore, the answer to such a problem just pops into consciousness.

This is a fundamentally important point with implications that go far beyond increased efficiency and decreased conscious awareness of task performances. Consider that by definition, the workings of the rule-based system are socially structured—as Smolensky (1988) said, cultural knowledge is the program that runs on this processor. As this socially shared knowledge shapes and tunes the associative system as well, we can see how all aspects of the human mind become socially structured. Vygotsky is perhaps the most famous proponent of this position:

> Any higher mental function necessarily goes through an external stage in its development because it is initially a social function. ... When we speak of a process, "external" means "social." Any higher mental function was external because it was social at some point before becoming an internal, truly mental function. (as cited in Hutchins, 1995, p. 283)

Clark (1997) put the point into more modern terms:

> What emerges ... is a vision of the brain as a kind of *associative engine,* and of its environmental interactions as an iterated series of simple pattern-completing computations. At first blush, such a vision may seem profoundly inadequate. How can it account for the sheer scale and depth of human cognitive success? Part (but only part) of the answer is that our behavior is often sculpted and sequenced by a special class of complex external structures: the linguistic and cultural artifacts that structure modern life, including maps, texts, and written plans. Understanding the complex interplay between our on-board and online neural resources and these external props and pivots is a major task confronting the sciences of embodied thought. (p. 53)

Many other recent authors have agreed with this fundamental point (Hutchins, 1995; Millikan, 1996; Nelson, 1996; Sloman, 1996; Smolensky, 1988). The idea is reminiscent of George Herbert Mead (1934) as well, with his emphasis on linguistic–symbolic influences on mental processes, conscious awareness, and the self. The external social world, acting indirectly through the rule-based processing system, ends up shaping the workings of the more personal, private, intuitive associative system, importing social influence into every aspect of our mind's operation.

From associations to symbolic rules. As we have described, information can be passed from the rule-based processing system to the associative system through repeated use of a rule. Information also can move in the other direction. People can reflect on their own past experiences and summarize them, perhaps in the form of a symbolically represented rule. For example, after going fishing with your buddy Hank on many occasions, you may observe that Hank always knows where the fish will be biting. Turning this knowledge from a mere association built up from repeated experiences into a symbolic representation has several benefits—the knowledge can be used flexibly, applied in other contexts, or it can be communicated to other people. Investigations of learning models have found that adding a rule-induction component on top of a standard connectionist associative learner can improve performance (Sun, Peterson, & Merrill, 1996). Thus, we cannot accept the strong form of the Vygotskian claim that all associative or intuitive knowledge was symbolic (i.e., socially learned) knowledge first. In some domains, when people lack relevant rules, they may at first use whatever associations they have available to perform adaptively; symbolic knowledge may arise later as people reflect on their behavior and its successes or failures.

Use associations or symbolic rules? Roles of motivation and capacity. In many cases, associative and rule-based processing will arrive at the same answer. This can occur, for instance, when people originally used a symbolic rule but over time learned to produce the same response associatively (e.g., Logan, 1988). However, there also will be times when the two modes produce different responses. In fact, Sloman (1996) treated this type of "simultaneous contradictory belief" as a key criterion for demonstrating two independent processing systems. Conflicting answers arising from the two systems have been intensively investigated in the domain of persuasion, in which a message may be constructed containing strong or weak arguments, together with cues that lead people to agree or disagree with it through well-learned associations (Petty, Cacioppo, & Goldman, 1981). A message containing weak arguments, for example, may be presented by an attractive or an expert source. When the two modes tend to give different responses, what factors affect the way people weight them and arrive at an overall response? We hold that motivation and capacity are the key factors.

As we outlined earlier in this article, using the rule-based system is subjectively effortful, requiring attentional resources. Thus, if people are not motivated to use rules, the response generally will be controlled by the relatively effortless associative system. Several distinct motives may spur rule-based processing. Perhaps most obvious is a desire for accuracy. The socially shared and subjectively valid nature of rule-based processing means that people believe it provides more ac-

curate answers than does low-effort associative processing (Chaiken, Liberman, & Eagly, 1989). However, other motives also can encourage rule-based processing. Chen and Chaiken (1999) discussed the processing effects of motivation to defend important existing beliefs or attitudes or to meet social goals, such as creating a positive impression on others. Note that rule-based processing driven by these motives may not be evenhanded and unbiased and may, in fact, decrease (rather than increase) the accuracy of overall conclusions compared to the results of associative processing.

Cognitive capacity, as well as motivation, is required for rule-based processing. Capacity refers to available processing time as well as attentional resources. Rule-based processing generally takes longer than associative processing (Logan, 1988), and, because it requires attention, it is more subject to disruption by distraction, interference, and so forth. Thus, responses that are made quickly or when the perceiver is busy or distracted likely will be controlled by the associative system. However, given adequate time and freedom from distraction, rule-based responses (because of their greater subjective validity) may override associative responses (Chaiken et al., 1989).

Use associations or symbolic rules? Other potential moderators. Motivation and capacity have been well studied as potential influences on people's reliance on the two processing modes. Several factors besides motivation and capacity also have received tentative support.

1. *Type of judgment:* Different types of judgments may elicit responses that are more heavily weighted by the associative or rule-based processors. In particular, judgments that are more "intuitive" or affective, involving how one subjectively feels about an object or event, appear to be more associatively driven, compared to more analytic, rational judgments such as those about causation. For example, Epstein, Lipson, Holstein, and Huh (1992) gave students brief stories describing fictitious characters experiencing negative events and asked both affective questions (such as "How foolish would you feel if you had reacted that way?") and more rational attributional questions ("How foolishly did the person actually behave?"). Responses to the affective questions were more strongly influenced by such logically irrelevant factors as whether the individual in the story had acted in a typical or atypical way. Probably more of us than care to admit feel at an intuitive level that if we take an umbrella on a cloudy day it is less likely to rain than if we leave the umbrella at home, despite our rational knowledge that our behavior cannot affect the weather.

2. *Generality or specificity of stimuli or judgment targets:* Many instances of dissociations between people's judgments of specific stimuli and logically equivalent general classes have been identified. For example, although the American public holds Congress in abysmally low esteem, the same citizens typically approve of their own congressional representatives—who en masse constitute Congress—and tend to vote them back into office year after year (see Sears, 1983). Similarly, Fazio, Jackson, Dunton, and Williams (1995) demonstrated dissociations between people's positive or negative evaluative responses to pictures of Black stimulus persons and their favorable or unfavorable attitudes about Blacks as a group. Although there are several factors that may contribute to such dissociations, one possibility is that specific and general judgments call differentially on the two processing modes (Sherman, Beike, & Ryalls, 1999). It seems likely that more richly detailed, specific stimuli are better cues for responses from the associative system, whereas more general and abstract stimuli—often verbally represented—better afford processing by symbolic rules (Epstein, 1991; Kahneman & Miller, 1986).

3. *Mood:* Finally, findings in several topic areas suggest a generalization about the effects of mood on the use of the two processing systems (see Bless, in press). Positive mood seems to elicit more reliance on the associative system, which tends to increase performance on some types of tasks (such as those requiring creativity) and decrease performance on other tasks (such as the thoughtful evaluation of persuasive arguments). Conversely, negative mood appears to promote reliance on rule-based processing. Some mood effects on processing may be mediated by motivation or capacity (e.g., positive mood may elicit distracting thoughts), but Bless (in press) suggests that at least part of the effect is direct and not due to motivation or capacity.

Explanations for Various Dissociations

Our theory also may explain many empirical findings of dissociations between seemingly closely related measures or variables. In general, the explanation involves the assumption that one measure taps the associative processing system (and therefore the contents of the slow-learning memory system), whereas the other measure is generated by rule-based processing.

One well-known dissociation in social psychology is that commonly observed between judgment and explicit memory (usually recall) of the information on which the judgment was based. For example, a perceiver may encounter a mix of positive and negative information about a target person and then both report an overall evaluation of the person and attempt to recall the provided information. In many cases, the correlation between the judgment and the recalled information (weighted by its evaluative implications) is near zero (Hastie & Park, 1986). From the perspective of our

model, the reported judgment is based on the net association of the target person with positivity or negativity, an association that is gradually and automatically built up "online" as positive or negative information about the person is encountered trial after trial. Evidence reviewed earlier showed that amnesiac patients could extract the general features common to a set of presented items despite being unable to recall the individual items (Knowlton et al., 1992). Similarly, forming an overall impression that a person is likable (based on a majority of behaviors being positive) is a function that can be performed by the slow-learning memory system.[2] In contrast, explicit recall draws on episodic traces in the fast-learning memory system. The typical dissociation is explained as a function of the considerable degree of independence between the two memory systems.

This dissociation is not always empirically observed. For example, if people are exposed to information about a person and then asked a question they could not have anticipated (such as the person's suitability for a particular occupation), recall and judgment are typically correlated (Hastie & Park, 1986). In such cases, whatever associations people build up "online" cannot be used to make the required judgment, so they must engage in rule-based processing, presumably relying on search, retrieval, and integration of specific items of information from memory. This process results in a positive judgment–memory correlation.

Another type of dissociation is that not all knowledge can be verbalized. Cognitive and motor skills or perceptual abilities, such as the ability to judge whether a smile is genuine or false, often defy verbal explanation. We attribute this dissociation to the distinction between two memory and processing systems. The associative processor (drawing on slow-learning memory) is responsible for skilled performance, whereas verbal reports are generated by the rule-based system. Not all knowledge is represented verbally in the first place, so verbal reports necessarily will be limited and inaccurate in some respects (see Hutchins, 1995, pp. 310–312).

Another typical dissociation is that between explicit memory and repetition priming. Having processed a particular stimulus in a particular way facilitates a repetition of that same processing for a long period of time (Smith et al., 1992; Tulving, Schacter, & Stark, 1982). This facilitation generally is found to be independent of explicit memory measures, such as the ability to recognize that the stimulus has been previously processed. Like several other theorists, we explain this dissociation by attributing repetition priming to small changes in connection weights in slow-learning memory; explicit recall, or recognition, draws on the fast-learning memory system (see Schacter & Tulving, 1994; Wiles & Humphreys, 1993).

In the area of categorization, dissociations have been observed between similarity judgments (e.g., the similarity of a new exemplar to category prototypes or known exemplars) and category membership judgments. One likely explanation is that similarity judgments are relatively global, drawing on associative processes, whereas category membership judgments in many cases depend on symbolic rules (Sloman, 1996). Of course, in cases where category membership is judged purely on the basis of similarity (because the perceiver does not possess a theory concerning the category) we would not expect this dissociation to emerge.

Finally, Sloman (1996) pointed to a general category of dissociations, which he termed *simultaneous contradictory beliefs.* In some circumstances, different responses come from different processing modes, and each has its own subjective "pull." One response (provided by associative processing) is subjectively or experientially compelling, and the other (provided by rule-based processing) seems more valid and more likely to be agreed on in a social context (Epstein, 1991; Sloman, 1996). Of course, such dissociations only emerge with specific types of problems, such as the well-known "Linda problem." In this problem, people read background information about Linda, who is described in ways that suggest she is liberal and socially concerned. They are then asked whether it is more likely that Linda is (a) a bank teller or (b) a bank teller who is also a feminist. Many people pick option (b), although logic dictates that (a) must be correct.[3] In this and similar problems, associative processing, relying on associations between Linda's characteristics and being a feminist, points toward answer (b) in a subjectively compelling way. However, the logical rules demanding answer (a) are also available to the same individuals. The socially shared validity of rule-based responses makes them subjectively compelling as well. Yet even someone who knows the laws of probability that make one answer objectively "correct" can see the attraction of the other answer—just as in looking at an optical illusion one can "know" that the two lines are the same length even while recognizing that they look different.

[2]We are not claiming that online processing is always simply associative. When people are actively scrutinizing an argument, for instance, they may process online in a temporal sense (i.e., while the argument is being presented) but do so using systematic or rule-based processing. Our claim is that in person perception situations (on which the review by Hastie & Park, 1986, is largely based), online processing is generally simple and associative, effectively equivalent to forming and updating an implicit evaluation of the person.

[3]This slightly oversimplifies the matter. There are several potential explanations for the conjunction fallacy, including the idea that pragmatic assumptions about language lead people to assume that alternative (a) really means bank teller but not feminist. Such issues are not essential for the point being made here, that logical and intuitive processes may generate conflicting responses.

Thus, by incorporating the idea of two separate memory systems with distinct functional properties, our model can account for several types of dissociation among memory and judgment, as well as for the characteristics of dual-processing modes. We earlier described various processes that tend to create similar or parallel representations in the two memory systems (e.g., consolidation or the transfer of information over time from the fast to the slow-learning system). However, these dissociations illustrate the point that the two systems may at times contain different and even conflicting information. Predictable conditions lead to such dissociations: for example, when one type of information is frequently encountered over a lengthy period of time (e.g., a person learns socially shared group stereotypes from other people or the media) and then different information is encountered a few times (e.g., the person has positive personal encounters with members of the stereotyped group or decides that stereotyping is morally wrong). Wilson (1999) recently developed an account of "multiple attitudes" that is consistent with this view, although in our framework the point applies to any type of representation, rather than only to attitudes.

Implications for Existing Dual-Process Models

Dual-process models have been advanced in numerous specific areas of social psychology and cognitive psychology (see Abelson, 1994; Epstein & Pacini, 1999, for lists). Some models using the *dual-process* label rest on different processing distinctions from the one on which we focus and will not be reviewed here. We do not claim that all dual-process models have important common features, but a significant subset of them do, and these are the focus of this article. This review necessarily simplifies the models; most of them have been the topic of numerous empirical studies and in some cases lengthy theoretical discussions as well. However, the basic assumptions of the models, as well as the domains in which they have been applied and tested, can be described concisely. Following the description of each model, we discuss relevant new insights and implications of our integrative model.

Persuasion

Within social psychology, dual-process models have been most influential in the field of persuasion and attitude change. Petty and Cacioppo (1981) and Chaiken (1980) proposed broadly similar models. As described by Chen and Chaiken (1999), the Chaiken model assumes that a person may have any of several goals activated in a given situation: to form valid attitudes that will accurately guide thought and action, defend currently held attitudes that are congruent with one's interests or important self-definitions, or hold attitudes and beliefs that will serve current social goals (such as creating a positive impression on others). Whatever the goal, two types of processing are possible. *Heuristic* processing is said to involve the use of simple, well-learned, and readily accessible decision rules like "experts are always right," "the majority is correct," or "statistics don't lie." Heuristic processing is the default processing mode; people will process heuristically unless special circumstances intervene.

People go beyond heuristic processing when circumstances (a) make them feel an unusually great need to be accurate, defend an attitude, or create a positive impression; and (b) offer enough time and cognitive capacity to permit more effortful processing. When both of these conditions hold, people will perform *systematic* processing. This involves the active, effortful scrutiny of all relevant information and therefore demands considerable cognitive capacity. For example, people may evaluate arguments by considering their logical coherence or by comparing them to existing knowledge. Systematic processing leads to attitude change that is more enduring and more resistant to further persuasion attempts. Systematic processing is assumed to take place in addition to, and simultaneously with, heuristic processing rather than replace it. The two types of processing may have additive or offsetting effects on judgment, depending on the circumstances. Many studies support the general assumptions of the heuristic–systematic processing framework in the domain of attitude change and social influence (for a review, see chapter 7 in Eagly & Chaiken, 1993). Additional work has taken the basic framework as a general model of social judgment, applicable to other topic areas including person perception, decision making, and the like (see Chaiken et al., 1989; Chen & Chaiken, 1999).

Petty and Cacioppo's (1986) Elaboration Likelihood Model (ELM) is similar in most respects. The ELM focuses on the influence of what are termed "central" and "peripheral" processing on elaboration likelihood. *Elaboration likelihood* is the extent to which the impact of a persuasive message is caused by the arguments contained in the message (high elaboration) versus peripheral aspects of the message, its source, or the persuasion situation (low elaboration). As in the heuristic–systematic processing model, it is assumed that when people are low in capacity or motivation they will not engage in much elaboration. Therefore, judgments will be based mostly on highly salient peripheral cues. When people possess both capacity and motivation, they perform a detailed analysis of the message. They consider argument strength as well as have an opportunity to correct for effects of any potentially biasing peripheral cues. During elaborated processing,

people are still affected by peripheral cues, although their influence is mediated by conscious consideration of their relevance (Petty & Wegener, 1999). Because of the strong similarities between the ELM and Chaiken's (1980) model, we focus our discussion on the latter, which is closer to our own perspective.

Implications of our model for persuasion processes. Chaiken's model (1980) is closely aligned with our perspective in most ways. For example, it assumes the two modes operate simultaneously and takes a broad view of the potential motives that can encourage systematic processing. One terminological difference is Chaiken's use of the term *simple decision rules* or *heuristics* to describe the representations that guide processing in the heuristic or associative mode. The term *rule* probably should be avoided in this context, for a key assumption of the current model is that associations and rules are quite different (see Table 1). If the representations used in heuristic processing were described as well-learned associations rather than as rules, the distinction would be clearer.

In Chaiken's model (Chen & Chaiken, 1999), defense of existing attitudes or social goals other than the desire for accuracy can motivate systematic processing. In this case, the processing may be biased rather than even-handed. A full account of biased selection or use of rules in rule-based processing is beyond the scope of this article. However, it is easy to incorporate one type of biased processing in our model: The extent to which rule-based processing is used may depend on the specific answer given by initial associative processing; that is, if a quick glance leads to a tentative answer supporting one's existing beliefs, self-interests, or self-presentational goals, little further processing is likely to occur. In contrast, if the tentative answer appears uncongenial on the basis of current social motives, the perceiver may engage in rule-based processing (which may or may not be biased) that might offer some chance of yielding a different answer. This is a familiar principle; for example, we generally give more careful scrutiny to arguments for positions with which we disagree than to arguments whose conclusions we like (e.g., Ditto & Lopez, 1992).

Attitude Access

When people need to evaluate a particular object, such as a politician or consumer product, when and how do they come up with an attitude? The question is important, for it is generally assumed that an attitude (in fact, any mental representation) will not affect thoughts or behavior unless it is made active in some way (Higgins, 1996). Fazio (1986) proposed a dual-process model of attitude access and use. If an individual's attitude is strongly associated with the cognitive representation of an attitude object, simply encountering the object may cause the attitude to be spontaneously activated. Based on several experiments, Fazio and his colleagues (Fazio, Sonbonmatsu, Powell, & Kardes, 1986) argued that access to such strong attitudes does not depend on the perceiver's having a particular goal beyond attending to the object. For example, access occurs even when the individual thinks the attitude object is merely a distractor in an experiment. Attitude access may become spontaneous through repeated expression of the attitude or through extensive direct behavioral experience with the object. Bargh et al. (1992) offered an alternative view, holding that essentially all attitudes, even weak ones, are capable of automatic activation.

On the other hand, if an attitude is not automatically activated or if a current goal makes people wish to process further, they can construct an attitude. This process, however, will be somewhat effortful, involving a search for evaluatively relevant information about the object and its integration into a single overall judgment (Fazio, 1986). In either case, whether the attitude is quickly and spontaneously activated or is effortfully constructed, it can then bias further processing of information about the object and direct the individual's actions with regard to the object.

Implications of our model for attitude access. The two postulated modes of attitude access (using a well-learned association vs. effortfully retrieving relevant information and constructing an attitude) probably operate simultaneously instead of as alternatives. Thus, a previously formed attitude may be associatively retrieved and bias a simultaneously occurring search for further information. Also, Fazio (1986) has emphasized the capacity requirements of the effortful attitude construction process, but we should note that motivation is also required.

Person Perception

We often process information about other people in an extremely superficial manner, simply categorizing them by age, gender, race, or role. For example, a few minutes after interacting with a server in a restaurant we might be unable to describe the person's appearance. The categorization as a server is adequate to guide our behaviors toward the individual. On the other hand, we may extensively process information about other people when they are motivationally relevant to us—for example, when we will be dependent on them. Brewer (1988) and Fiske and her colleagues (Fiske & Neuberg, 1988) developed dual-process models of person perception that make similar distinctions between categorical processing and more effortful, individuated processing triggered by motiva-

tional relevance. In support of their model, Neuberg and Fiske (1987) demonstrated that perceivers who receive fairly rich information about a target person may simply categorize him or her (e.g., as a former mental patient) and use the category as a basis for judging the person and forming an impression. But if the perceiver expects to interact with the target while performing a task, the perceiver will pay more attention to individuating information about the target and will use that to go beyond the simple initial categorization.

Brewer's model (1988; Brewer & Feinstein, 1999) treats categorization and individuation in much the same way as does Fiske's model and adds a third process termed personalization. In this mode, category-relevant (even category-inconsistent) features of the person do not receive any special treatment; a category is not a reference point in processing at all, as it is for both categorization and individuation. Instead, features that are relevant to the perceiver's interaction goals or relationship with the target person receive the most attention.

Implications of our model for person perception. The existing models (Brewer, 1988; Fiske & Neuberg, 1988) maintain that the two types of processing occur sequentially, with relatively effortless categorization preceding individuation. From the perspective of our model, the two forms of processing occur simultaneously.

Our model emphasizes that the categorical–individuating information content distinction crosscuts the associative–rule-based processing mode distinction, as Fiske, Lin, and Neuberg (1999) and Brewer and Feinstein (1999) agreed. Associative processing can be based on either social category membership or salient individual attributes such as extreme height or red hair. In fact, a connectionist associative memory system can draw on both types of attributes simultaneously, performing parallel constraint satisfaction, as Kunda and Thagard (1996) also argued. Similarly, either categorical information or individual attributes such as behaviors can be processed through the flexible but effortful application of symbolic rules. In many circumstances in real life (as well as in many research paradigms), categorical information is indeed the most readily available to be processed without much effort, whereas individuating information takes attention and effort to extract and use. However, this confounding of information type with processing mode is not necessary in principle.

Correspondent Inference

Gilbert and his associates (Gilbert, Pelham, & Krull, 1988) have advanced a dual-process model in the domain of person perception and attributional inference. Consider a perceiver observing a woman who is visibly nervous. Consistent with the well-known correspondence bias (Jones & Harris, 1967), the perceiver is likely to see the woman as a dispositionally anxious person. However, what if the perceiver knows that the target is in a situation that would make just about anyone anxious—for example, being interviewed about her sexual fantasies? Presumably the perceiver should realize that the anxiety might stem from this external source and appropriately discount the dispositional inference. Gilbert et al. (1988) set up this situation and found that participants in a control condition did exactly this: They rated the target as less dispositionally anxious when they thought the discussion topics were sensitive and anxiety-provoking than when they thought the topics were mundane. However, participants given an extra task that drained their cognitive capacity did not engage in discounting and rated the target as equally dispositionally anxious, regardless of the topics. The failure to discount could not stem from a lack of awareness of the topics, for the participants' extra task was to memorize the topics themselves.

Gilbert's account for the results in this and related studies (see Gilbert, 1989, for a review) follows the general lines of the other dual-process models that we have discussed, although it assumes two sequential stages instead of either simultaneously occurring or mutually exclusive processes. Minimal effort and processing resources are required to make a correspondent dispositional inference, attributing a trait to the person based directly on observed behavior. Thus, participants can do this even if their capacity is limited or if they have little reason to think deeply about the target person. On the other hand, a second stage, considering a range of possible situational causes of the behavior and appropriately discounting the initial correspondent inference, requires more processing effort. This second stage will not be carried out by perceivers who have little cognitive capacity—or, presumably, by those who have little reason to devote any effort to the task (though Gilbert's, 1989, research has dealt mainly with capacity).

Implications of our model for correspondent inference. Gilbert's model (1989) holds that attributional reasoning may follow, and possibly correct, an initial correspondent inference. From our perspective, however, the two processes occur simultaneously rather than in sequence. Associative processing continually activates trait concepts that are linked to the observed behavior, even while the perceiver considers the possibility of alternative, situational causes. Gilbert's research emphasizes that the correction process requires more resources than does correspondent inference, although he has acknowledged that motivation is also required.

Social Judgment and Correction

The dual-process principle has been formulated in a relatively general way by several theorists including Martin and his colleagues (Martin, Seta, & Crelia, 1990). Their experiments focus on trait judgments about other people, but their ideas are intended to apply to many types of social judgment. Consider the effect of a "priming" manipulation that raises the accessibility of a trait construct that is potentially applicable to a target person. As we know, the effect of such priming is usually assimilative: The impression of the target will move closer to the primed trait (Higgins, 1996). In Martin's studies, both the perceiver's motivation to correct for the effect of the prime and his or her ability to do so are manipulated. A perceiver is assumed to be motivated to correct when he or she is aware of the priming and realizes that it might contaminate the judgment. Ability to correct can be influenced by an external cognitive load or by time pressure. The results indicate that people may correct their judgments (often ending up overcorrecting, leading to a contrast effect) when they have both motivation and ability but otherwise fail to correct and end up being affected by the primed construct. Wegener and Petty (1995; see also Martin & Stapel, 1998) have proposed a conceptually similar model that emphasizes how perceivers use naive theories about the influence of salient situational or contextual factors (such as a priming manipulation or a transitory mood state) to direct the correction process.

Implications of our model for social judgment and correction. Martin's model (Martin et al., 1990) recognizes the requirements of both motivation and capacity to correct for automatically occurring judgmental effects. However, like Gilbert's (1989) two-stage model of person perception, it holds that the processes occur sequentially, whereas from our perspective simultaneous operation seems more likely.

Stereotyping and Suppression

Devine (1989) proposed a model of stereotyping that also follows the general dual-process framework. She held that virtually everyone learns common stereotypes of gender, ethnic, and other groups from other people or the media. These well-learned associations are automatically activated merely by encountering or thinking about a group member, in a way that is relatively constant across perceivers with different levels of prejudice toward the group. However, an additional process may occur as a second sequential stage in individuals who are low in prejudice. These people may effortfully override the automatic activation of stereotypes by using their relatively more favorable "personal beliefs" about the group's characteristics. The motivation underlying this extra processing is the desire to avoid guilty feelings by appearing (to oneself as well as to others) relatively unprejudiced.

Implications of our model for stereotyping and suppression. In Devine's (1989) model, both motivation (stemming from guilty feelings about using stereotypes) and capacity are stressed, but automatic stereotype access and conscious suppression processes probably should be considered to occur simultaneously rather than sequentially.

Our proposal also solves a puzzle that is implicit in Devine's (1989) theory. Her model (among others) assumes that people possess "implicit" beliefs such as group stereotypes that contradict their "explicit" verbalizable, consciously held beliefs. How an assumed single memory system can represent both of these contradictory beliefs is not made clear. Under our model, stereotypes are represented by associations built up in a connectionist distributed memory, and explicit beliefs are symbolically represented, solving the representational puzzle. The term *association* is probably clearer in cases like this than clumsy terms like *implicit beliefs* because of the qualitative difference between associations and explicit symbolically represented beliefs. For this reason, we welcome the adoption of the label "Implicit Association Test" by Greenwald, McGhee, and Schwartz (1998) for their measure of automatically elicited reactions to social groups.

Rational Versus Intuitive Reactions

Epstein and his associates (e.g., Epstein, 1991; Kirkpatrick & Epstein, 1992) have proposed cognitive experiential self-theory (CEST) as a general theory of personality and have applied it to several domains including problem solving. The theory assumes that people have two processing modes, labeled *experiential* and *rational.* The former is preconscious, automatic, and intuitive and operates heuristically. It is chiefly responsible for emotional and affective responses to situations or events. In contrast, the rational system is conscious and primarily verbal in nature. The two processing modes are assumed to function simultaneously.

Donovan and Epstein (1997) applied this model to reasoning involving the conjunction fallacy, such as occurs in the Linda problem. As noted previously, in this problem, experiential processing—relying on associations between Linda's characteristics and being a feminist—makes the "feminist and bank teller" answer seem correct, although the logical rules that validate the other answer also may be known.

Implications of our model for CEST. Epstein's (1991) model generally fits well with the outlines of the

model advanced here, except that he gives more attention to capacity than to the motivational determinants of rational processing. Epstein also emphasized that the results of processing in the experiential mode (which we term *associative*) are particularly subjectively compelling. We agree that in some cases, such as food preferences, experientially based reactions override rational responses. However, in general, validity arises from social sharing and therefore is higher for the rational system (Levine et al., 1993). Moreover, reactions that were initially generated by the rule-based–rational system come over time to be embodied in associations. This process means that socially shared reactions often will acquire the phenomenologically given quality that the preconscious associative (or experiential) system affords. The idea that spinach is good for you, originally derived from symbolic, socially shared knowledge, eventually becomes just as compelling and subjectively valid as the idea that spinach tastes awful.

Problem Solving and Reasoning

Sloman (1996) outlined a two-process model of reasoning and problem solving. His two processes are labeled *associative* and *rule-based.* Associative processing is quick, intuitive, and relatively effortless. Associations are structured by similarity and patterns of temporal co-occurrence rather than by logic. Thus, in the associative mode, people use concepts that are related through well-learned associations to cues found in a problem (as being a feminist bank teller is associated with Linda's liberalism). In the area of categorization, this process gives rise to similarity-based categorization, whether based on previously learned category exemplars or on abstract prototypes.

In contrast, rule-based processing involves the use of symbolically represented rules to manipulate problems and derive solutions. The laws of logic and causal inference, rather than simple association, are brought to bear. These rules are abstract, incorporating variables that can be bound to specific contents. Importantly, this mode is assumed to make use of explicit symbolic representations of rules in the course of processing; it uses or follows rules rather than simply conforms to them (Sloman, 1996) in the sense that a thrown ball conforms to the law of gravity. In this processing mode, people would conclude that it has to be more likely that Linda is a bank teller, because that possibility includes her being a bank teller and feminist. Rule-based processing also underlies theory-based categorization, including the occasions when a theory overrides similarity-based categorization.

Sloman (1996) held that, in general, both modes work together, not that people use one or the other as alternatives. Sometimes they provide different answers, as in the Linda problem. In other cases, they work more cooperatively; for example, in proving a mathematical theorem, one "sees" intuitively what step is needed next and then uses symbolic rules to check that the proposed step actually works.

Logan's (1988) model of problem solving is similar in many respects to that of Sloman. Logan studied an "alphabet arithmetic" task, in which people see problems like "*H* + 3" and have to give the answer "*K*." When initially introduced to this task, people mentally count ("*I, J, K*") to give answers, as evidenced by response times that are proportional to the number added. However, after a specific problem has been seen enough times, responses become much faster and times are no longer related to the content of the problem. Logan (1988) accounted for this pattern of performance with a model similar to the others reviewed in this article, involving initial performance of the task by explicit rule use. Numerous repetitions of an individual problem allow the problem and its solution to become associated in the slow-learning memory system, permitting rapid associative access to the solution. Logan explicitly postulated that both types of process go on simultaneously, with a "race" model in which the first process to run to completion controls the overt response.

Implications of our model for reasoning. Sloman's (1996) and Logan's (1988) models fit well with the one we advance here, except that (like Epstein) both emphasize cognitive capacity, failing to discuss the necessity for motivation for rule-based processing. Our model differs from Sloman's in particular by (a) incorporating conceptual links to underlying memory systems and (b) linking the processing modes to a much wider range of models in social psychology.

Summary of Models' Common Features

Table 2 summarizes the key features of the different models that have been presented here. Because the models use different labels for the two processing modes, some common terms have to be chosen. We have labeled the heuristic–automatic–effortless processing mode "associative" and the systematic–controlled–effortful mode "rule-based." These terms (from Clark, 1993; Sloman, 1996) seem the most descriptive of the basic operations of the systems. Summarizing the previous descriptions, we now present the common features of the various models as well as some of their more notable differences.

Associative Mode

In general, the previous theories agree with our model on the fundamental properties of the associative mode. Processing in this mode amounts to the auto-

Table 2. *Summary of Key Points of Existing Dual-Process Models*

Model and Domain of Application	Terminology and Properties of Low-Effort Processing Mode	Terminology and Properties of High-Effort Processing Mode	Assumptions About Relations Between Processing Modes
Chaiken (1980); Petty & Cacioppo (1981) Persuasion	Heuristic: Use learned associations of salient cues like source attractiveness or message length with positive/negative evaluations	Systematic: Effortfully search for relevant information and logically evaluate arguments	Systematic processing when specially high need for subjective confidence and processing resources are available; both modes occur simultaneously
Fazio (1986) Attitude Access	Associative access: Use evaluation associated with attitude object through repeated pairings	Construct attitude: Search for and summarize attitudinally relevant information	Associative processing when strongly associated attitude exists; modes are alternatives
Brewer (1988); Fiske & Neuberg (1988) Person Perception	Categorization: Use information and evaluations associated with person's salient category membership (gender, race, etc.)	Individuation: Process and summarize multiple individual characteristics	Individuation requires specific motivation (e.g., due to interdependence) or perceived lack of fit to category; modes are alternatives
Gilbert (1989) Person Perception, Attributional Inference	Correspondent inference: Use trait associated (through semantic similarity) with person's observed behaviors	Attributional thinking: Process range of attributionally relevant information such as situational causes of behavior	Attributional thinking requires cognitive capacity; modes are sequential stages; attribution follows correspondent inference
Martin, Seta, & Crelia (1990) Social Judgment and Correction	Automatic contextual influences: Prime or other contextual factor (e.g., mood) affects judgment	Correction: Engage in attributional thinking to detect the contextual influence and shift judgment to correct for it	Correction occurs only when both motivation and capacity are present; modes are sequential stages; correction follows contextual influence
Devine (1989) Stereotype Use and Suppression	Automatic stereotyping: Apply stereotype information associated with group through past learning	Suppression: Effortfully access personal beliefs about group, use to override stereotype	Low-prejudice people are motivated to engage in suppression; modes are sequential stages; suppression follows automatic stereotyping
Epstein (1991) Experiential Versus Rational Thinking	Experiential: Thoughts and feelings learned in association with stimulus through past experiences are reactivated	Rational: Use conscious, largely verbal thought to make judgments	Modes are activated by features of stimulus situation and the nature of the judgment being made; modes operate simultaneously
Sloman (1996) Reasoning	Associative: Use concepts that are related to cues in stimulus through well-learned associations	Rule-based: Use symbolically represented rules in sequential fashion to reason or make judgments	Rule-based reasoning requires more capacity; modes operate simultaneously

matic access, based on a cue that is salient in the current stimulus or context, of knowledge or affective reactions that have become associated with that cue. The buildup or learning of such an association is assumed to take repeated trials over a long time, a point on which Devine (1989), Fazio (1986), and Sloman (1996) were particularly clear. Activation of the knowledge is automatic and preconscious, so that it becomes subjectively part of the stimulus information (rather than being seen as part of the perceiver's own evaluation or interpretation of it). The associated knowledge, therefore, has the potential to affect judgments and behavior. This emphasis is perhaps clearest in Fazio's (1986) and Epstein's (1991) models.

Using this mode, people automatically access such things as their well-learned attitudes toward specific attitude objects (Fazio, 1986), stereotypes that are culturally associated with particular social groups (Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1988), concepts that suggest particular solutions to reasoning or categorization problems (Sloman, 1996), traits that are related to observed behaviors performed by oneself or others (Bem, 1967; Gilbert, 1989), or favorable or unfavorable evaluations of persuasive messages based on easily noticed cues such as message length or source attractiveness (Chaiken, 1980; Petty & Cacioppo, 1981). Once accessed, these knowledge structures, often with an affective or emotional tinge, can affect people's thoughts, feelings, or overt behaviors. Our interpretation emphasizes that associative processing (a) relies on well-learned associations that have been built up over time and (b) depends on the properties of the underlying slow-learning memory system.

Rule-Based Mode

The models reviewed here also share most of our key assumptions about the nature of rule-based processing. This mode is consciously controlled and effortful and involves search, retrieval, and use of task-relevant information (see Fiske & Neuberg, 1988; Petty & Cacioppo, 1981; Sloman, 1996). The "rules" that govern processing in this mode range from formal or normative rules like those of logic to loose, informal maxims like "Consider people as unique individuals rather than just stereotyping them." Rule-based processing is assumed to be strategic, and its exact nature will vary depending on the specifics of the task, the individual's goals, or situational constraints. When it occurs, this type of processing generally gives rise to a higher level of perceived validity and to more long-lasting effects (Chaiken et al., 1989). Our proposal emphasizes not only the relatively effortful nature of rule-based processing but also the idea that it draws on symbolically represented rules, which are structured by language and logic. These rules may be maintained in either the fast-learning or slow-learning memory system depending on how often they have been encountered, whether consolidation has had time to occur, and so forth.

Using this mode, people may consider the details of persuasive arguments and evaluate their validity based on logic and general knowledge (Chaiken, 1980; Petty & Cacioppo, 1981), use logical or mathematical reasoning to solve problems (Sloman, 1996), engage in attributional thinking to determine the causes of their own or others' behaviors (Gilbert, 1989), summarize a number of known facts about a person or object into an individuated impression or attitude (Brewer, 1988; Fazio, 1986; Fiske & Neuberg, 1988), or effortfully override automatically generated judgments with alternative responses deemed more appropriate (Devine, 1989; Martin et al., 1990).

Relations Between Modes

The dual-process models outlined previously generally agree, often strikingly well, on the characterizations of the two processing modes themselves. However, three main differences among the models become evident when one considers their accounts of the relations between the processing modes. First, the models differ somewhat in their emphasis on the role of motivation versus ability or cognitive capacity in determining how people process. Several models put the greatest stress on motivation, although they make varying assumptions about the specific nature of the relevant motives (Brewer, 1988; Fazio, 1986; Fiske & Neuberg, 1988). Other models emphasize factors affecting cognitive capacity, whether in the form of time pressure, distraction from external stimuli or simultaneous tasks, or resources such as task-relevant background knowledge (Gilbert, 1989; Sloman, 1996). Still other models give weight to both motivation and ability (Chaiken, 1980; Devine, 1989; Martin et al., 1990; Petty & Cacioppo, 1986). The models that give more emphasis to one of these factors tend to have been developed in domains in which the other factor can be assumed to be available and unproblematic. For example, people generally have access to information needed to formulate an attitude about an object whenever they are motivated to do so (Fazio, 1986), so little theoretical attention need be given to cognitive capacity. Conversely, participants in problem-solving studies in cognitive laboratories are assumed to be motivated by the task instructions to attempt to perform the task adequately (Sloman, 1996), so theories can emphasize capacity and take motivation for granted. All these dual-process theorists would presumably agree that both capacity and motivation are in fact required, as our model assumes.

The theories also differ substantially in their account of the temporal and logical relations between the two processing modes. Some models hold that the two are alternatives: People process either one way or the other, but not both (Brewer, 1988; Fazio, 1986). Other models assume sequential processing, with automatic associative processing occurring first and rule-based processing optionally following (Devine, 1989; Fiske & Neuberg, 1988; Gilbert, 1989; Martin et al., 1990; Wegener & Petty, 1995). Still other theories agree with ours in holding that both processing modes occur simultaneously (Chaiken, 1980; Epstein, 1991; Petty & Cacioppo, 1986; Sloman, 1996). In this case, their effects may be additive (if they lead to the same conclusions), or associative processing may bias ongoing rule-based processing, or the two modes may work in opposition (see Chen & Chaiken, 1999).

Finally and perhaps most interestingly, the models reviewed here differ in the extent to which they imply an evaluative distinction between the two processing modes, identifying associative processing with bias and general badness and rule-based processing with accuracy and general goodness. Models that state or connote such an evaluative distinction include Chaiken (1980), Petty and Cacioppo (1981), Brewer (1988), Fiske and Neuberg (1988), Gilbert (1989), Martin et al. (1990), Wegener and Petty (1995), and Devine (1989). All of these models offer qualifications and caveats, of course. Some acknowledge that the efficiency of associative processing may on occasion outweigh its assumed potential for bias. The heuristic–systematic processing model (Chaiken, 1980) emphasizes people's assumption that systematic processing will lead to more accurate results than heuristic pro-

cessing, rather than the claim that this will generally actually occur. Furthermore, several models describe ways in which each type of processing can produce either accuracy or inaccuracy (e.g., when a "correction" process using the symbolic mode can lead to biased responses; Martin et al., 1990; Wegener & Petty, 1995).

Some other models have little or no connotation of an evaluative distinction between the two processing modes. Such models simply describe alternative ways of processing without stressing potential differences in accuracy (Fazio, 1986), or they emphasize that both types of processing are needed for successful task performance (Epstein, 1991; Sloman, 1996).

Why are the two processing modes often implicitly treated as good versus bad? Abelson's (1994) analysis is insightful.

> This may be partly because of the fairly slow arrival of affect onto the agenda of social psychologists, partly because of a bias toward rational instrumentalism in Western thought, and partly because in the major topic pitting reason against impulse—racial prejudice—is an area in which the self-conscious, rational self is a socially desirable egalitarian, fighting against the habitual negative feelings of a prejudiced inner self. (p. 28)

Various factors suggest a recently increasing appreciation for the roles of less rational (i.e., intuitive and affective) processes, not only by social psychologists. Consider the observations of devastating social incompetence produced by brain damage to emotional centers even though the patients' reasoning abilities are intact (Saver & Damasio, 1991). Western culture has inherited from the ancient Greeks equations of mind = rules = rationality = good, and body = intuition = emotion = bad, which will not be unlearned quickly. Still, perhaps we are moving toward recognizing that either type of processing can have appropriate and adaptive effects, just as either can produce social and personal evil and destructiveness, including (but not only) racial prejudice.

Are there two processing systems or only one? Although (as reviewed previously) dual-processing models have been popular in social psychology, some theorists hold that single-mode theories are still viable. Kruglanski, Thompson, and Spiegel (1999), in particular, advanced a "unimodel" in the area of persuasion and argued that the effects observed in the empirical literature can be explained by a single type of persuasion process. This argument rests on the idea that at an abstract level, both the use of simple heuristic cues and the detailed analysis of message arguments can be conceptualized as the application of "if–then" rules. "If an expert says so, it must be right" and "If the argument makes sense in terms of all my general knowledge, it must be right" would be examples. Kruglanski et al. (1999) acknowledged that ability and motivation influence the amount of processing that people carry out, but they held that the type of processing remains constant, involving the application of such if–then rules.

In company with most other dual-process theorists, we do not find this suggestion compelling. First, if–then rules are highly abstract constructs—too abstract to capture differences in actual psychological processes. For example, a simple physical law may be expressed as "If I let go of my pencil, then it will fall to the floor" and a computation in an income tax program as "If total deductions are less than the standard deduction, then use the standard deduction." The possibility of putting both of these into a common abstract logical form does not erase the distinction between physical and logical–computational types of processes. Second, as we elaborate further subsequently, the associations and symbolic rules that respectively underlie the operation of associative and rule-based processes involve fundamentally different kinds of if–then connections and are applied by fundamentally distinct mental operations. Associations are structured by similarity and repeated contiguity and are retrieved by a fast, automatic pattern-completion mechanism. Symbolic rules are structured by logic and language and are used by a more or less conscious, explicit reasoning process. Although the two can be put into the same logical if–then format, this does not constitute a strong argument against the existence of two distinct processing modes.

Distinctive Contributions of This Integrative Model

The review makes it obvious that dual-process models within social and cognitive psychology have strong common features. Moreover, some of those models have been applied in more than one specific topic area (such as the heuristic–systematic processing model or the various judgmental correction models; Chen & Chaiken, 1999; Epstein & Pacini, 1999; Martin et al., 1990). What differentiates our model from these? Several points that are important to our model have been incorporated in few if any of the current dual-process models.

Link to properties of two underlying memory systems. A key feature of our model is its explicit links to current theories of separate memory systems (e.g., McClelland et al., 1995; Schacter & Tulving, 1994; Sherry & Schacter, 1987). This conceptual link-

age in turn connects our model to a wide range of neuropsychological and behavioral evidence (such as the specific patterns of memory deficits in people with amnesia, or studies of animals with hippocampal lesions) that has not previously been regarded as relevant to dual-process theories. As noted previously, postulating two memory systems also allows us to account for several types of dissociations (e.g., between recall and judgment or between recognition memory and repetition priming) that have not been dealt with by existing dual-process models.

Qualitatively distinct associative and rule-structured databases. In our model, the two processing modes tap separate databases that represent knowledge in distinct formats. The associative mode draws solely on patterns of features built up over time in the slow learning memory system. Rule-based processing, although it also makes use of the slow learning memory system for the storage of long-term knowledge of word meanings and the like, uses the fast-binding memory holding symbolically encoded propositions and other linguistic materials. Many dual-process models within social psychology, although recognizing that the two processing modes differ in efficiency, automaticity, and conscious awareness, nevertheless have held that both forms of processing are of essentially the same kind. For example, both often have been regarded as "schematic processing" in more and less efficient versions (see Fiske & Taylor, 1991). From our perspective, the two modes differ much more fundamentally than that. In other words, the two processing modes are not accurately characterized as involving just more or less extensive processing; rather, qualitatively different types of processing are involved.

Powerful features of associative processing. In current dual-process theories, low-effort, or heuristic, processing is generally assumed to rely only on links between concepts formed on the basis of their repeated co-occurrence. However, recent work suggests that an associative memory system is considerably more powerful than implied by this description. We listed a number of capabilities of such a memory previously in this article, including the fact that links between concepts in an associative memory are much more akin to partial regression coefficients than to simple correlations. Such a memory can perform a type of causal or attributional analysis, including such complexities as Kelley's (1972) discounting principle (Gluck & Bower, 1988). Moreover, associative processing can draw on multiple representations simultaneously in performing multiple constraint satisfaction, rather than using a single memory representation. Traditional theories in social psychology assume that a single schema or other representation, presumably the most accessible and best fitting one, is retrieved from memory and used to interpret an input stimulus. In contrast, connectionist associative memories operate by means of a multiple constraint satisfaction process (Rumelhart et al., 1986; Shultz & Lepper, 1996). As Smith and DeCoster (1998) and Kunda and Thagard (1996) demonstrated, this multiple constraint satisfaction process can yield novel or creative emergent features, as well as flexible, context-specific versions of general constructs.

Breadth and integrative quality. Each of the existing models reviewed in this article involves a number of specific details, and each has been fine-tuned with additional assumptions to account for empirical findings in its own topic domain. In comparison to those, our own model offers fewer topic-specific details. The details are certainly important for understanding how people process persuasive messages, form attitudes, suppress stereotypes, and so on. However, we believe that an integrative treatment of these diverse models provides new insights and ultimately will benefit theorists in each area by providing multiple sources of strong constraints. The type of integration that we offer here goes beyond the idea of simply applying one of the theories (e.g., a model of persuasion) to the ways people process information in other domains (e.g., person perception). Such new applications can offer new insights, such as the idea that a given cue like a person's gender can be processed in more than one way (e.g., it may be a basis for associative–categorical processing or may afford elaborative processing using various rules). However, bringing all these models under a single common framework can do more than simply take one of those models and apply it in different domains. In our broad conception, the basic nature of the two processing modes is constant across all these empirical domains. This means that theorists working in a particular area can directly make use of findings from any of the other areas rather than just take insights originally developed in a single area and apply them in others. Theories of attitude change or cognitive dissonance or problem solving will be able to draw on a strong, well-supported common framework, supported not only by research in all those areas but also by more basic work in memory (e.g., McClelland et al., 1995) and cognitive science (e.g., Smolensky, 1988). In this way, theoretical integration promises to strengthen researchers' ability to elucidate the special and unique processes that operate in each particular area (within the general framework of two general processing modes), not to blur over all such distinctions.

Our dual-process model thus offers several advantages that are not part of any of the existing models. We believe that it illustrates some of the power offered by linking social psychological models of dual-processing modes to related models in cognitive psychology and to underlying properties of two distinct memory systems. Particularly important are some of the new insights and new predictions generated by the model, such as the following examples:

1. Social psychological theories typically have regarded attributional reasoning or online combination of multiple knowledge representations as highly complex processes and assumed that they are mediated by extensive symbolic thought. However, as described previously, associative memory systems can perform attributional reasoning (going beyond mere covariation analysis to perform discounting) and can combine multiple knowledge structures (though multiple parallel constraint satisfaction processes; Holyoak & Thagard, 1989; Kunda & Thagard, 1996). Thus, our model predicts that these sophisticated types of processing should be found even when people do not engage in rule-based processing because of lack of capacity or motivation.

2. As noted previously, some existing theories have postulated that people simultaneously maintain representations with conflicting implications, such as a general negative stereotype of a social group combined with "personal beliefs" that deny the stereotype (e.g., Devine, 1989). How such conflicting knowledge could be actually represented in memory was generally left unclear. Our model offers the insight that the two types of knowledge may exist in two distinct memory systems. Thus, stereotypes may be held in the slow-learning system even by people who sincerely deny those beliefs, precisely because the stereotypes take the form of associations between social group membership and various negative characteristics, built up over many years through exposure to biased and stereotypic media content, comments from other people, and so forth.

3. A clear implication of our model is that a newly learned rule should be unable to affect associative processing. Even if the rule is represented in the fast-learning memory system, it should not be automatically activated (the signature of the associative processing mode) until enough time has passed for consolidation to occur or until the rule has been encountered or thought about many times. Although not framed in these theoretical terms, there is evidence for this hypothesis from cognitive studies demonstrating that a large amount of practice is necessary before a newly learned association can mediate automatic activation (Dagenbach, Horst, & Carr, 1990). The point is also supported by work on "dual attitudes" showing that well-learned evaluative associations are not immediately overturned by newly learned information (Wilson, 1999).

4. People with amnesia have deficits specific to the fast-learning memory system. Because our model holds that this memory system plays little role in associative processing, a number of testable hypotheses follow. For instance, compared to normals, people with amnesia should be more influenced by heuristic cues than by argument strength in persuasion settings (Petty et al., 1981), should be less able to suppress their stereotypes (Devine, 1989), and should be more likely to attribute behaviors to personal dispositions even in the presence of plausible situational causes (Gilbert, 1989). Hypotheses like these concerning social judgment and social behavior only rarely have been tested with such patient populations (but see Klein et al., 1996). Not only people with amnesia but also normal elderly people may show similar effects such as increased reliance on stereotypes and persuasion heuristics. This prediction is based on evidence that normal aging is associated with reduced efficiency of the fast-learning memory system and increased reliance on stable, general memory structures (Radvansky, 1999). Testing these hypotheses will involve careful consideration of potential confounds (e.g., different stereotype content learned over a lifetime by elderly vs. young participants), but the tests are important for assessing the generality of research conclusions based on college student participants.

Summary and Conclusions

In this article, we proposed a model involving two processing modes that we label *associative* and *rule-based* (Sloman, 1996; Smolensky, 1988), which draw in different ways on two underlying memory systems. The existence and properties of the memory systems are independently supported by much evidence (McClelland et al., 1995; Sherry & Schacter, 1987). We have reviewed a number of dual-process models that have been developed in diverse areas of social and cognitive psychology, emphasizing their strong common points and the implications of our new model for these specific areas of application.

In our view, this type of integration represents an increasingly important trend in psychology. Traditionally, theories in social psychology were formulated for specific topic areas (e.g., attribution, attitude change) and used topic-specific theoretical constructs. As a result, such theories tended to be incommensurable and could not easily be placed within more comprehensive conceptual frameworks (see Smith, 1998). The social cognition movement of the 1970s and 1980s brought a strong trend toward increased integration within social psychology, as theories in various topic areas drew on a common conceptual vocabulary (of

schemas, exemplars, prototypes, automatic and controlled processing, etc.; Devine, Hamilton, & Ostrom, 1994). This vocabulary was largely shared with cognitive psychology as well, so the integration went beyond the boundaries of social psychology.

We believe that the continuation of this cross-disciplinary unifying trend is important and that participation of social psychologists in this endeavor is essential. The reason is that the integrative model advanced here strongly suggests the importance of language and social influences on individual cognition. As Smolensky (1988) emphasized, the symbolic system is intrinsically social, running a "program" that is (at least) encoded in linguistic form and (most of the time) directly communicated from other people and the cultural environment. Over time, processes that are repeatedly carried out following socially shared programs also affect the associative system as well, importing social influence into all our processing modes. Hutchins (1995) argued that this insight demands a reformulation of the entire nature of cognitive science. The traditional information-processing, or artificial intelligence, approach focused on the individual, assuming that "cognition" was what went on in individual brains. However, we now must recognize that computation or cognition occurs in a social system, not within an individual brain (Clark, 1997; Hutchins, 1995). This reconceptualization places social psychology at the very core of the cognitive sciences. The relations of language and memory (e.g., Semin & Smith, 1999) and other aspects of socially structured cognition are a new and inviting field, to which social psychologists can make fundamental contributions.

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