Psychological Bulletin
2004, Vol. 130, No. 4, 553–573


0033-2909/04/$12.00 DOI: 10.1037/0033-2909.130.4.553

# Individual Differences in Working Memory Capacity and Dual-Process Theories of the Mind

Lisa Feldman Barrett and Michele M. Tugade
Boston College

Randall W. Engle
Georgia Institute of Technology

Dual-process theories of the mind are ubiquitous in psychology. A central principle of these theories is that behavior is determined by the interplay of automatic and controlled processing. In this article, the authors examine individual differences in the capacity to control attention as a major contributor to differences in working memory capacity (WMC). The authors discuss the enormous implications of this individual difference for a host of dual-process theories in social, personality, cognitive, and clinical psychology. In addition, the authors propose several new areas of investigation that derive directly from applying the concept of WMC to dual-process theories of the mind.

Dual-process theories of the mind are ubiquitous in psychology. There are dual-process theories of attribution (e.g., Trope, 1986; Uleman, Newman, & Moskowitz, 1996), person perception (e.g., Brewer, 1988; Fiske & Neuberg, 1988; Gilbert, 1989; Zárate, Sanders, & Garza, 2000), stereotyping and prejudice (e.g., Devine, 1989), persuasion (e.g., Chaiken, 1980; Petty & Cacioppo, 1986), mental control (e.g., Wegner, 1994; Wenzlaff & Wegner, 2000), self-regulation (Baumeister & Heatherton, 1996; Metcalfe & Mischel, 1999), emotion (Teasdale, 1999; van Reekum & Scherer, 1997), and personality (Epstein, 1998). A central principle of these theories is that behavior is determined by the interplay of automatic and controlled processing. In this article, we introduce the idea that there may be individual differences in the ability to control attention that help to negotiate this interplay. As we illustrate, individual differences in the ability to control attention are a major contributor to individual differences in working memory capacity (WMC). As a consequence, what is controllable for one person may be less so for another. Recently, Baddeley (2001) referred to such individual differences as "the most prominent feature in research on the topic (of working memory) in North America" (p. 857). We examine the concept of WMC as it has been defined in the literature over the past two decades and discuss the implications of this individual difference for a host of processes relevant to social, personality, cognitive, and clinical psychology.

Lisa Feldman Barrett and Michele M. Tugade, Department of Psychology, Boston College; Randall W. Engle, School of Psychology, Georgia Institute of Technology.

Preparation of this article was supported by National Science Foundation Grants SBR-9727896 and BCS 0074688 and National Institute of Mental Health (NIMH) Grant K02 MH001981 awarded to Lisa Feldman Barrett, and NIMH Grant F32-MH64267 awarded to Michele M. Tugade. We thank Eliot Smith, Stephanie Goodwin, Laurie Rudman, Paula Pietromonaco, and Nelson Cowan for their comments and suggestions on an earlier draft of this article.

Correspondence concerning this article should be addressed to Lisa Feldman Barrett, Department of Psychology, Boston College, Chestnut Hill, MA 02467-3807. E-mail: barretli@bc.edu

The operational definition of WMC is fairly straightforward: It is the number of items that can be recalled during a complex working memory task. Complex working memory tasks have simultaneous storage (maintaining information in an active state for later recall) and processing (manipulating information for a current computation) components (Daneman & Carpenter, 1980). The conceptual definition of WMC is more complex. In fact, there is no universally agreed upon definition of WMC. There are several aspects or components to working memory, and individual differences in working memory function could presumably result from each of them or from their interaction. Indeed, researchers have investigated a variety of properties that contribute to individual differences in working memory (e.g., resource allocation, Just & Carpenter, 1992; buffer size, Cowan, 2001; processing capacity, Halford, Wilson, & Phillips, 1998). In the literature, however, there is a large and consistent body of research to indicate that the capability to control attention (especially in contexts in which there are competing demands) is a major determiner of an individual's performance on complex working memory tasks (Engle, 2002; Kane, Bleckley, Conway, & Engle, 2001). This is consistent with computational modeling views of working memory (e.g., Anderson, 1983), as well as neurobiological theories (Miller & Cohen, 2001). To the extent that it reflects individual differences in the control of attention, WMC may have a more pivotal role to play in dual-process functions of the mind than has been previously considered.

We begin by describing the prototypic dual-process theory, and the constituent role that WMC may play. Our goal is not to provide a general review of the working memory concept. Many such reviews already exist (e.g., Baddeley, 2000, 2001; Baddeley & Hitch, 1994; Miyake & Shah, 1999; E. E. Smith & Jonides, 1997a, 1997b). And more important, working memory broadly defined is not the topic of this article. When we refer to individual differences in WMC, we are not referring to the working memory concept as a whole, but rather to differences in functioning of what Baddeley and Hitch (1974) called the *central executive*, what Norman and Shallice (1986) called the *supervisory attention system* (SAS), and what Posner and DiGirolamo (2000) called *executive control*. As a result, we present a more focused treatment of one component of the central executive (which itself is only one aspect of working memory)—the ability to control attention—because managing attention is central to controlled processing. Complex measures of WMC exist in the cognitive literature and reflect a variety of influences, but they all measure the ability to control attention, that is, the ability to keep attention focused on one thing and not let it be captured by other events, be they in the external environment or internally generated thoughts and feelings.

We then suggest that the ability to engage in controlled processing in attention-demanding circumstances, especially those that require the suppression or inhibition of automatic processing, is related to individual differences in WMC. We propose ways in which individual differences in WMC may influence research that is guided by dual-process theories. There are many excellent reviews of how dual-processes operate in social life (e.g., Chaiken & Trope, 1999; Wegner & Bargh, 1998), and it is not our purpose to suggest how individual differences in the ability to control attention may moderate the effects of each and every theory. Rather, we offer some examples of how individual differences in WMC may influence our thinking about automatic and controlled processing effects more generally. Finally, we discuss an agenda for new research by suggesting several new areas of investigation that derive directly from applying the concept of WMC to dual-process theories of the mind.

## Dual-Process Theories

Dual-process theories vary in their specifics and emphasis. Of late, social psychologists have focused a great deal on the strength and pervasive influence of automatic processing (e.g., Bargh, 1997, 1999; Bargh & Ferguson, 2000; Chartrand & Bargh, 1999; Greenwald & Banaji, 1995). Cognitive psychologists, however, have been more concerned with the science of cognitive control (e.g., Cohen, Dunbar, & McClelland, 1990; Miller & Cohen, 2001; Monsell & Driver, 2000) and afford it more importance in information processing (e.g., Pashler, Johnston, & Ruthruff, 2001). Both agree, however, that behavior is determined by the interplay of automatic and controlled processing, in the following way: Sensory properties of objects in the environment "capture" attention. This is termed *stimulus-driven*, *bottom-up*, *reflexive*, or *exogenous* attention (Egeth & Yantis, 1997; LaBerge, 2000). The "cocktail party effect" is a good example of attentional capture (e.g., Conway, Cowan, & Bunting, 2001). Knowledge structures (sometimes called *schemas*, *scripts*, or *concepts*, more recently thought of as states; E. R. Smith, 1998) or internal goal states (Bargh, 1990, 1997; Chartrand & Bargh, 1996) are activated by passively "applying attention to those representations," which, in turn, initiate or mediate (depending on your metaphor) a sequence of actions, feelings, or thoughts. This is referred to as *automatic* (sometimes called *nonconscious*, *implicit*, or *heuristic*) *processing*. It is assumed to be ubiquitous and the normal and default mode of processing.

Any environment contains an array of stimuli that activate many representations simultaneously. These compete for behavioral expression, and the strongest at a given time will control behavior, thoughts, and feelings. Norman and Shallice (1986) called this process *contention scheduling*. A variety of representations are independently activated in a given context, but stronger representations will laterally inhibit weaker ones, and the strongest will be expressed in behavior. Contention scheduling explains the automatic selection of routine thought and behavior. The selected thought, feeling, or behavior can be incorrect or inappropriate for the current situation or task, however. In those cases, when conflict in the system reaches a threshold, something else is needed to modulate contention scheduling by providing additional activation or inhibition to already activated representations: the control of attention.

Controlled attention is also referred to as *goal-directed*, *top-down*, or *endogenous* attention (Egeth & Yantis, 1997). According to the traditional dual-process viewpoint, controlled attention determines, to a large extent, the degree to which automatic processing influences thoughts, feelings, and behaviors. For example, when attention is captured by a stimulus and activates a representation that is inconsistent with processing goals, or when two goals are in conflict with one another, attention must be brought under control to resolve the conflict. In such circumstances, attention will be applied to maintain or enhance the activation of an already activated goal-relevant representation (one that was passively activated and would otherwise decay over time), deliberately activate a goal-relevant representation (i.e., to initiate the activation of a needed representation if it is not already activated), and to suppress the activation of goal-irrelevant representations. The manipulation of representations by the control of attention is typically referred to as *controlled* (sometimes called *conscious*, *explicit*, or *systematic*) *processing* in dual-process theories.

Despite their differences, dual-process theories share the common idea that thoughts, behaviors, and feelings result from the interaction between exogenous and endogenous forms of attention. Both types of attention can be applied to representations to increase or decrease their level of activation. As the activation level of a representation increases, so does its accessibility, which in turn increases the probability that it will influence behavior. In times of conflict, accessibility can be managed (i.e., maintained or inhibited) during the stream of processing by the control of attention. In a sense, the "source" of attention (LaBerge, 2000), that is, whatever mechanism that applies the activation to the representation, can be thought of as the gateway of accessibility that is the essence of controlled processing.

## Executive Attention and Control

What is this *gateway*? Norman and Shallice (1986) defined it as the SAS, which is a limited capacity attentional system that controls the activation of representations in situations that are difficult, novel, or have competing demands. Recently, the idea of SAS has been incorporated into models of working memory. Structural theories of working memory, such as Baddeley's (1986, 2001; Baddeley & Hitch, 1974) very popular theory, describe a central executive that is a limited resource attentional system responsible for allocating attention to domain-specific storage buffers (akin to short-term memory [STM] components that serve as a repository for mental representations that are being kept actively in mind), as well as managing the allocation, focus, and management of attention more broadly (Cowan, 2001). Computational (or connectionist) views of working memory treat storage and attention elements as properties of one system (e.g., Anderson, 1983, 1993; Anderson, Reder, & Lebiere, 1996; MacDonald & Christiansen, 2002;

Schneider & Detweiller, 1987) and view the central executive as managing the activation within long-term memory (LTM); STM consists of any information that is currently active above a critical threshold in a network of representations in LTM.

Despite the importance of executive control in understanding human behavior, the literature is marked by several points of debate, including how we know when control of attention is occurring (for a review of issues, see Posner & DiGirolamo, 2000). One guiding assumption has been that the subjective experience of having control over our thoughts and actions is the best way of indicating that controlled processing is underway. This idea began with James (1890), and it was elaborated on by Helmholtz (1910/1925), and later by Bargh (1994), who clearly described the elements of this subjective experience in detail: Controlled processing is defined by the subjective experience of awareness (you are able to self-reflect on your processing attempts), agency (you experience yourself as the agent of your own behavior), effort (you experience processing as effortful), and control (you are aware that automatic processes may be occurring and you are motivated and able to counteract them). Varieties of automatic process, in contrast, were defined by the absence of any feeling of awareness, intention, effort, or control. The interrelationship between attention, conscious experience, and control continues to dominate the distinction between automatic and controlled processing (e.g., Bargh & Ferguson, 2000) such that consciousness and control have been conflated.

The available evidence from the cognitive literature, however, suggests that although attention control can sometimes occur with a feeling of conscious deliberation and choice, it need not. Controlled attention can operate at early perceptual stages, influencing how sensory information is selected, taken in, and processed (for reviews, see Luck & Hillyard, 2000; Posner & DiGirolamo, 2000; Shiffrin, 1988) well before subjective experience is generated. For example, recent evidence gives goal-directed forms of attention a role in phenomena that we typically experience as automatic (for a review, see Pashler et al., 2001). Goal-directed processes can "tune" stimulus-driven forms of attention; the ability of a stimulus to capture attention (i.e., the reflexive allocation of attention) occurs more easily when the individual has a goal to attend to the features of that stimulus in the first place (e.g., Folk, Remington, & Johnston, 1992; Folk, Remington, & Wright, 1994). These findings, and others reviewed in Pashler et al. (2001), indicate that bottom-up, automatic forms of attention are often contingent on more controlled forms of attention. An excellent example of this is laboratory priming procedures. Both subliminal and supraliminal priming procedures activate knowledge representations without a participant's awareness, but the effectiveness of the prime is contingent on goal-directed forms of attention. For the prime to have its effect and automatic processing to take hold, the participant must have the goal to look at the computer screen (in the case of subliminal priming) or engage in a problem-solving task (e.g., sentence completion or lexical decision task).

These findings have two implications. First, automatic processing is often intrinsically influenced by top-down, endogenous forms of attention, making it somewhat artificial to separate the two in practice (a point we return to later in the present article). Second, and more important to our immediate concern, a conscious feeling of control and control of attention can be thought of as orthogonal, and therefore one cannot be used to indicate when the other is occurring.[1] (Attention may be required for subjective experience to emerge; Baddeley & Andrade, 2000, but that is another story.)

One solution to the problem of how to determine when control of attention is at play is to rely on a functional approach—define the presence of attention control according to what is required by the processing context or situation. Luck and Hillyard (2000) argued that the control of attention occurs at any stage of processing in which interfering information is present. Interference can occur as the result of competing sensory stimuli (where endogenous attention can help to direct stimulus-driven, reflexive expressions of attention), or because of competing goals. Social psychologists have argued recently that stimulus-driven attention can initiate goal-related processing (in addition to activating object-related representations). Priming studies have shown that properties of the external world can activate properties of the internal world (e.g., goals and motivations), which, in turn, proceed to influence processing and guide behavior in a reflexive way. External goal activation has been achieved through semantic priming (Bargh, 1990; Bargh & Chartrand, 1999; Bargh & Gollwitzer, 1994; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Bargh, Raymond, Pryor, & Strack, 1995; Chartrand & Bargh, 1996; Depret & Fiske, 1993; but see Kawakami, Young, & Dovidio, 2002). In addition, situations themselves automatically activate goal-related processing to influence behavior (e.g., Moskowitz, Gollwitzer, Wasel, & Schaal, 1999). For example, a situational event (threat to self-esteem) causes people to engage in automatic stereotyping (e.g., Spencer, Fein, Wolfe, Fong, & Dunn, 1998) or self-protective behavior (Feldman Barrett, Williams, & Fong, 2002) of which they are not aware. These goals often conflict with others, such as the goal to be egalitarian or the goal to receive accurate, diagnostic information about the self. Although many representations can activate in parallel, a person can only think or do one thing at one point in time. Controlled attention is required to negotiate the resulting interference or competition, although a person need not be aware of any internal cognitive activity that is initiated.

Controlled processing arises from the central executive aspect of working memory (or similar constructs such as the SAS) and occurs when attention is applied in a goal-directed, top-down, or endogenous fashion. Complex mental processes and social behavior may operate without conscious awareness (cf. Bargh & Fergu-

[1] We believe that part of the confusion between the control of attention and the subjective experience of control comes from the different ways in which psychologists and philosophers use the term *intentional*. From a psychological standpoint, the term *intentional* has come to mean how much people experience themselves as the agents of their own behavior. To the extent that psychological processes are activated by the environment, they are said to initiate without intention; to the extent that they are experienced as being triggered or stopped by an act of will, they are said to be intentional (e.g., Bargh, 1994). From a philosophical standpoint, however, *intentional* simply means that an event is "about" something (Dennett, 1987). Thus, both controlled and automatic processes are intentional because they are caused by something. Recent theorizing suggests that both are very likely triggered by environmental stimuli (Bargh & Ferguson, 2000). On this view, causation of complex mental processes that are the hallmark of controlled processing may begin in the environment, but they are maintained by the central executive component of working memory.

son, 2000), but they rarely occur without the control of attention, at least if there is some level of interference. Goal- and motivation-relevant representations may be reflexively activated by the environment and operate autonomously to influence thoughts, feelings, and behaviors. It is also possible that the suppression of unwanted or goal-irrelevant representations can occur automatically with reflexive attention (e.g., Moskowitz et al., 1999; Wilson, Lindsey, & Schooler, 2000). But when these effects lead to thoughts or behaviors contradictory to those appropriate for the current goal, a condition of interference exists and controlled attention is required.

It is well-known that people need both motivation and opportunity to engage in controlled processing (E. R. Smith & DeCoster, 2000). Yet, we argue that, even with the appropriate motivation and opportunity, people differ in their ability to control attention and therefore in their ability to engage in controlled processing. Without sufficient resources, controlled processing breaks down, and less appropriate or undesired responses emerge.[2] We now turn to the idea that there are individual differences in the ability to control attention, reflected in part by the concept of WMC. We first describe this individual difference, followed by some suggestions for how it may affect theories and research that are guided by dual-process assumptions.

## WMC: Individual Differences in the Ability to Control Attention

### *What Is WMC?*

Individual differences in WMC should influence how well the accessibility of representations is managed and behavioral expressions are controlled in situations in which there is distraction or interference, or in situations that are novel or that involve some time pressure. The concept of WMC is closely tied to the tasks that are used to measure it. These tasks, called *complex span tasks*, engage the executive functions of working memory because participants are required to keep some information active and quickly retrievable while periodically shifting their attention to some other processing task (Baddeley & Hitch, 1974). In the typical complex span paradigm, a memory span test is embedded within a secondary processing task. Participants are presented with some type of information for later recall (e.g., words, digits, spatial orientations), and between the presentation of each item, they are required to perform some attention-demanding computation (e.g., reading sentences, doing simple arithmetic problems, counting, mental rotation, and so forth) that can serve as interference for the memory task. Although capacity is measured as the maximum number of target items (e.g., words, digits, spatial orientations) that can be recalled without error, our assumption is that the underlying construct is not a buffer, limited to some discrete number of bins or slots; instead, the construct is more continuous, ranging from those individuals who have more attentional resources (or who can regulate their attentional focus well) to those who have fewer resources (or who regulate less well). A wide variety of complex span measures now exist, covering verbal, spatial, arithmetic, and emotional domains (e.g., Case, Kurland, & Goldberg, 1982; Daneman & Carpenter, 1980; modified by Bliss-Moreau, Hristic, Feldman Barrett, & Tugade, 2003; Kane & Engle, 2003; Kyllonen & Christal, 1990; Salthouse & Babcock, 1991; Shah & Miyake, 1996; Turner & Engle, 1989).

Older accounts viewed WMC from a resource-sharing framework—as a limited cognitive resource that could be flexibly allocated, depending on the processing needs of a person for a particular task in a particular context (e.g., Daneman & Carpenter, 1980, 1983; Just & Carpenter, 1992). According to this view, a person could be an expert at the computational task (say, answering arithmetic questions), leaving more attention available for the storage component of the task, thereby allowing them to remember more words and achieve a higher working memory span score. This same person could have more difficulty with a different computation (say, comprehending sentences), leaving them with less attention available for the storage component involved in a reading span task, causing them to remember fewer words and achieve a lower span score. A related perspective, the domain-specific view of WMC, proposes that there are separate working memory systems for different modalities or types of representations (e.g., spatial vs. verbal; Jurden, 1995; Shah & Miyake, 1996). Although the resource-sharing and domain-specificity views of WMC have traditionally been discussed separately, they seem similar in that they predict the same relation between the computational and memory span aspects of complex span tasks, with the result that people should not perform consistently across span tasks that involve different computational components. For instance, an individual who has processing expertise in the verbal domain, but not in the spatial domain, should have fewer attentional resources available for the storage components involved in a spatial task, but greater resources for a verbal task, with the result that their WMC scores will be higher when the memory span (storage) test is embedded within a secondary verbal processing task than when it is embedded within a spatial task.

Resource-sharing or domain-specific definitions of WMC have been criticized on a number of grounds, however (e.g., Duff & Logie, 2001; Towse, Hitch, & Hutton, 2000). The most compelling evidence against these views stems from two types of psychometric observations. First, mounting evidence suggests that, although span tasks involve the use of domain-specific STM buffers, they strongly covary with one another across various domains of performance. Confirmatory factor analytic evidence (that controls for measurement error) suggests that people perform consistently across a host of different span tasks that require different types of computations to be made (Daneman & Merike, 1996; Engle, Kane, & Tuholski, 1999; Bliss-Moreau et al., 2003; for a review, see Engle, 2002; Kane et al., 2004; Miyake, 2001). Second, processing speed and accuracy for the computational components are not related to span scores or their correlates (Conway & Engle, 1996; Engle, Cantor, & Carullo, 1992; Bliss-Moreau et al., 2003; Towse et al., 2000; but see Shilling, Chetwynd, & Rabbitt, 2002).

Taken together, the available evidence suggests that, although performance on complex span tasks may be influenced by domain-specific processing competencies, they have a commonality in their measurement of a domain-free ability to control attention. A computational model to predict and explain individual differences

[2] Of course, there are many reasons why the necessary attentional resources may not be available. Individual differences is only one. Alcohol, fatigue, frontal lobe damage, schizophrenia, or depression would lead to reduced attentional resources and a reduced capacity for controlled processing.

in WMC is consistent with a general resource view of controlled processing (Daily, Lovett, & Reder, 2001). Furthermore, a connectionist approach involving temporary maintenance of specific and novel task goals through the circuitry of the prefrontal cortex (PFC) and associated structures (O'Reilly, Braver, & Cohen, 1999) is also consistent with this view.

### *What Neural Systems Subserve WMC?*

The ability to control attention can be thought of as a property of the anatomy and circuitry of the PFC and associated structures (for an extensive review, see Kane & Engle, 2002). The PFC is a collection of interconnected neural areas that play a role in controlling and coordinating processing throughout the brain, and they are particularly important to the relationship between controlled and automatic processing (Miller & Cohen, 2001). The PFC and associated circuitry (LaBerge, 2000; Posner & Peterson, 1990) enacts the executive functions of working memory to accomplish controlled processing by modulating activation levels (i.e., changing neural activity) at the "site of attention" (i.e., in the neural circuits where computations are performed). Miller and Cohen (2001) likened the PFC to a switch operator in a railway system. If several trains (different systems of representations or pathways) use the same bit of track to get where they are going (i.e., use the same output pathways when competing for expression in behavior), then a coordinator is needed to guide them safely to their destinations. Some trains must be stopped at the station; others may be stopped mid-route. Some will be allowed to go, and still others asked to speed up. The fastest train will use the track first (the system with the strongest activation pattern is expressed). The resource limitations of controlled attention are thought to reflect the properties of PFC function (Miller & Cohen, 2001) such that the fundamental computational properties of the PFC are likely related to the ability to control the trains.

Of course, it is important to ask what is controlling the PFC. This is the homunculus question, and it is akin to asking, "who is the controller" in controlled processing (cf. Bargh & Ferguson, 2000; Wegner, 2002; Wegner & Bargh, 1998)? It seems reasonable that other neural structures influencing PFC activation may also contribute to WMC. Because the thalamus is connected to virtually all areas of the cortex, as well as many areas of the subcortex, it is possible that controlled attention is enacted through thalamic gating mechanisms (LaBerge, 2000). The modulatory effect of the thalamus can be driven directly either by bottom-up sources of sensory control or by top-down sources of control from the PFC (LaBerge, 2000). There has been some suggestion that the amygdalar complex (particularly, the central nucleus of the amygdala; Gallagher, 2000; Holland & Gallagher, 1999) and basal ganglia (LaBerge, 1998) may control the focus and intensity of attention via their influence on the thalamus. There is also evidence that the locus coeruleus (receiving inputs from the amygdala and the anterior cingulate cortex) projects to PFC, thereby allowing learning and past experience to influence top-down sources of attention (Gallagher, 2000). Finally, there is evidence that the parietal lobes may be involved with WMC, inasmuch as they are involved in the focus of attention (for a review, see Cowan, 1995). It is possible that WMC may be related to the computational properties of these interacting systems as well, although this remains to be investigated.

### *What Does WMC Relate To?*

Control of attention is necessary for deliberate activation of a representation, maintenance, or enhancement of an already activated representation, and suppression of unwanted representations. If WMC reflects individual differences in the capacity to control attention, and therefore the ability to engage in effortful, attentive processing, particularly in circumstances in which there is interference or distraction, then it should be related to a host of activation, maintenance, and suppression effects in a range of complex cognitive tasks. The available evidence suggests that it is. In addition, WMC is related to a wide range of other important processing outcomes beyond those involving "cold" cognition (for a summary, see Table 1).

*Activation effects.* If a needed representation, such as a goal condition for the current task, is not sufficiently activated by sensory input or automatic spreading activation, then its activation must be enhanced to have the desired effect on behavior. WMC is related to the use of attention to activate needed information (i.e., representations of stimuli, goal states, or action plans) stored in LTM, at least in situations involving proactive interference or attention-capturing distraction (Conway & Engle, 1994; Tuholski, Engle, & Baylis, 2001). This directed search for information is traditionally considered one element of controlled processing in dual-process models. For example, those high in WMC can retrieve goal-relevant information more quickly and accurately than can those who are lower in WMC. In a category fluency task, those high in WMC retrieved a greater number of category exemplars faster than those lower in WMC (Rosen & Engle, 1997). This finding has also been confirmed by computational models of WMC, in which the amount of general "source activation" in the network was related to increased speed and probability of successfully retrieving goal-relevant information relative to nongoal-related information (Daily et al., 2001).

*Interference effects.* Representations can be activated above a threshold so that they become conscious, but they undergo constant decay and quickly become insufficiently activated to affect behavior or thought. To influence ongoing thought, feeling, and behavior, individuals must keep information in a highly active, easily accessible state, and this maintenance typically occurs when other things are calling for our attention. The ability to maintain already activated representations requires the resources to resist distraction. WMC is related to this ability to resist interference while keeping goal-congruent information actively in mind, suggesting that WMC is related to another aspect of controlled processing in dual-process models. For example, individuals with low WMC are more vulnerable to various forms of interference on a range of memory tasks when compared with those who are high in WMC (e.g., "fan" interference, Conway & Engle, 1994; negative priming, Conway, Tuholski, Shisler, & Engle, 1999; proactive interference, Kane & Engle, 2000; Rosen & Engle, 1998; retroactive interference, Rosen & Engle, 1997). Individuals lower in WMC were considerably slower to complete a counting task when presented with distracting information that shared physical features with the target stimuli (Tuholski et al., 2001).

*Suppression effects.* If a representation passively becomes accessible as a result of activation by sensory input or automatic spreading activation, but it is not needed (because it is irrelevant) or unwanted (because it is goal-incongruent), then its activation

Table 1
*Processing Outcomes Associated With Working Memory Capacity (WMC)*

| Processing outcome | Representative citation |
|---|---|
| Activation effects | |
| Latency and frequency of generating exemplars from a category | Rosen & Engle (1997) |
| Speed and probability of successfully retrieving goal-relevant information | Daily, Lovett, & Reder (2001) |
| Resisting interference effects | |
| "Fan" interference | Conway & Engle (1994) |
| Negative priming | Conway, Tuholski, Shisler, & Engle (1999) |
| Proactive interference | Kane & Engle (2000); Rosen & Engle (1998) |
| Retroactive interference | Rosen & Engle (1997) |
| Distracting information with physical similarities to target information | Tuholski, Engle, & Baylis (2001) |
| Suppression effects | |
| Monitoring prior responses and suppressing repetitive exemplars in category fluency task | Rosen & Engle (1997) |
| Resisting the lure of a powerful orienting cue (e.g., dichotic listening task) | Conway, Cowan, & Bunting (2001) |
| Resisting attention-capturing peripheral visual cue (e.g., antisaccade task) | Kane, Bleckley, Conway, & Engle (2001) |
| Inhibiting prepotent automatic or habitual responses (e.g., Stroop task) | Kane & Engle (2003) |
| Age-related declines in ability to suppress "automatic" processing in dual-process models | Chiappe, Hasher, & Siegel (2000); Hasher & Zacks (1988) |
| Thought suppression | Brewin & Beaton (2002) |
| Suppression of counterfactual thoughts | Goldinger, Kleider, Azuma, & Beike (2003) |
| Age-related declines in ability to inhibit stereotype use | von Hippel, Silver, & Lynch (2000) |
| Processing strategies (low vs. high WMC) | |
| Automatic spreading activation vs. controlled attention in category fluency task (e.g., category fluency task) | Rosen & Engle (1997) |
| Quick to respond, relying on automatic parsing vs. slow to respond, maintaining multiple interpretations (e.g., syntactically ambiguous sentences) | MacDonald, Just, & Carpenter (1992) |
| Drawing inferences earlier vs. later in the process (e.g., when reading difficult, ambiguous prose) | Whitney, Ritchie, & Clark (1991) |
| Cognitive miser vs. motivated tactician | cf. Fiske & Taylor (1991); Taylor (1981) |
| Learning and memory | |
| Construction of mental representations that support new learning | Cantor & Engle (1993) |
| Rule-based learning (in comparison with associative learning) | E. R. Smith & DeCoster (2000) |
| Encoding of new information | Rosen & Engle (1997) |
| Establishing coherence between various parts of a text during the comprehension process | Budd, Whitney, & Turley (1995) |
| Real-world cognitive tasks | |
| Reading comprehension | Daneman & Carpenter (1980, 1983); Daneman & Merikle (1996) |
| Language comprehension | Just & Carpenter (1992); King & Just (1991); MacDonald et al. (1992) |
| Listening comprehension and problem solving | Adams & Hitch (1997); Carpenter, Just, & Shell (1990) |
| Reasoning | Kyllonen & Christal (1990) |
| Adapting strategies to changing success rates | Schunn & Reder (2001) |
| Vocabulary learning | Daneman & Green (1986) |
| Spelling | Ormrod & Cochran (1998) |
| Following directions | Engle, Carullo, & Collins (1991) |
| Logic learning | Kyllonen & Stephens (1990) |
| Taking lecture notes | Kiewra & Benton (1988) |
| Writing | Benton, Kraft, Glover, & Plake (1984) |
| Storytelling | Pratt, Boyes, Robins, & Manchester (1989) |
| Emotional processing | Bliss-Moreau et al. (2003) |
| Ability to reason, solve novel problems, and adapt to new situations | Conway, Cowan, Bunting, Therriault, & Minkoff (2002); Engle, Tuholski, Laughlin, & Conway (1999); Kyllonen & Christal (1990) |

level must be reduced to prevent its expression in behavior. The executive functions of working memory are related to suppression effects (e.g., Macrae & Bodenhausen, 2000; Macrae, Bodenhausen, Schloerscheidt, & Milne, 1999; von Hippel, Silver, & Lynch, 2000), as are individual differences in WMC (Brewin & Beaton, 2002; Rosen & Engle, 1998), suggesting that WMC is related to the ability to use attention to keep some information actively out of mind. For example, in a category fluency task, individuals low in WMC were less able to monitor prior responses and suppress repetitive exemplars, such that they produced a greater number of repetitions during the fluency task than did those higher in WMC (Rosen & Engle, 1997). Compared with those higher in WMC, those lower in WMC are less able to resist the lure of a powerful orienting cue (e.g., they were less able to resist orienting to their name being spoken in an unattended ear during a dichotic listening task, Conway et al., 2001; to the presentation of an attention-capturing peripheral visual cue in an anti-saccade task, Kane et al., 2001). Those lower in WMC are also less able to inhibit prepotent automatic or habitual responses. In a Stroop paradigm, individuals higher in WMC made fewer word-naming errors on incongruent trials (e.g., the word *BLUE* printed in the color green) than did those lower in WMC (Kane & Engle, 2003) when incongruent trials were relatively rare. In addition, those lower in WMC who are under concurrent memory load are especially susceptible to bias associated with counterfactual thoughts that are automatically generated during a judgment task (Goldinger, Kleider, Azuma, & Beike, 2003). It seems, then, that WMC modulates the active suppression or inhibition of "automatic" processing in dual-process models. Indeed, age-related declines in WMC (Chiappe, Hasher, & Siegel, 2000; Hasher & Zacks, 1988) may be one reason why elderly participants, although motivated to inhibit stereotype use, were less able to do so when compared with younger participants (von Hippel et al., 2000).

*Processing strategies.* There is some indication that individuals characterized by different levels of WMC differ in their use of automatic and controlled processing strategies during demanding tasks. For example, in Rosen and Engle (1997), described above, individuals lower in WMC relied on automatic spreading activation for the retrieval of category exemplars in a fluency task, whereas those higher in WMC used controlled attention to guide their search after a certain point in time. When a secondary load task was added to another task to make resisting interference more difficult, performance was impaired for those higher in WMC, whereas it was unaffected for those lower in WMC (Conway et al., 1999; Kane & Engle, 2000; Rosen & Engle, 1997).

These strategy differences have an impact on performance in several ways. Individuals lower in WMC may respond more quickly to complex tasks. For example, individuals high in WMC are slower to respond to questions about syntactically ambiguous sentences because they are able to maintain two possible interpretations of the sentences and use semantic information to disambiguate their meaning. Those lower in WMC rely on their first, more automatic parsing of the sentences, allowing them to respond more quickly (MacDonald, Just, & Carpenter, 1992). Individuals low in WMC also draw inferences earlier in the process of reading difficult, ambiguous prose than do those with larger working memory capacities (Whitney, Ritchie, & Clarke, 1991), and, as a result, they may be more susceptible to source monitoring errors (see Johnson, Hashtroudi, & Lindsay, 1993, on source monitoring errors) because they are poor at recalling information about the encoding context (Lee-Sammons & Whitney, 1991).

These processing differences lead to very different metaphors to describe information processing in those who have relatively high versus low WMC. Those higher in WMC may be described by the motivated tactician metaphor (Fiske & Taylor, 1991). Motivated tacticians have multiple information-processing strategies available and can select among them on the basis of goals, motives, and the constraints of the environment. A motivated tactician, like a person with a large WMC, should have the resources to bring controlled attention to bear on goal-relevant information processing and all that it implies about managing activation levels of relevant and irrelevant knowledge structures. In contrast, those lower in WMC may be best described by the cognitive miser metaphor (Taylor, 1981). Cognitive misers, like those lower in WMC, have severely limited attentional resources and, as a result, adopt strategies that simplify the need for controlled attention. Although they may have an array of goals or motives, they do not have the attentional resources to maintain goal-relevant processing in the face of complex situations, such that they end up emphasizing efficiency over any other processing goal.

*Learning and memory.* In addition to influencing the degree of controlled processing in a dual-process sense, WMC also seems related to a host of other cognitive processes related to learning and memory. WMC influences the construction of mental representations that support new learning (Cantor & Engle, 1993), particularly rule-based learning (in comparison with associative learning; E. R. Smith & DeCoster, 2000). When explicitly attempting to learn complicated mental models, low-capacity individuals are less able to maintain all of the necessary information in working memory to construct a complex, integrated representation. Some evidence suggests that capacity limitations may also have their impact at the encoding of new information (cf. Rosen & Engle, 1997; although see Radvansky & Copeland, 2001). This hypothesis is supported by findings that WMC plays a role in establishing coherence between various parts of a text during the comprehension process (Budd, Whitney, & Turley, 1995), both in a local sense (when processing individual propositions within a passage) and in a thematic sense (when linking sentences within a text to create a representation of a passage in its entirety).

WMC is not only related to new learning, but it may also enhance people's ability to use what they already know to improve their performance. Individuals high in WMC benefit from preexisting domain knowledge to a greater extent than do those lower in WMC, such that high WMC amplifies the effect of domain knowledge on memory performance (Daily et al., 2001; Hambrick & Engle, 2002; but for evidence of additive effects, see Rukavina & Daneman, 1996). The argument used here is similar to that used to describe how WMC supports new learning. Memory for new information requires that it be integrated into domain-specific representations that exist in LTM. This integration depends not only on the complexity of the knowledge structure but also on the ability to maintain the new information in an activated state for some period of time while encoding and elaboration occur.

*Real-world cognitive tasks.* In addition to correlating with cognitive and perceptual laboratory tasks, individual differences in WMC contribute to proficiency in a wide range of real-world cognitive activities. Span scores are related to reading comprehension (Daneman & Carpenter, 1980, 1983; Daneman & Merikle, 1996), language comprehension (Just & Carpenter, 1992; King & Just, 1991; MacDonald et al., 1992; but see MacDonald & Christiansen, 2002; Waters & Caplan, 1996), listening comprehension and problem solving (Adams & Hitch, 1997; Carpenter, Just, & Shell, 1990), reasoning (Kyllonen & Christal, 1990), adapting strategies to changing success rates (Schunn & Reder, 2001), vocabulary learning (Daneman & Green, 1986), spelling (Ormrod & Cochran, 1998), following directions (Engle, Carullo, & Collins, 1991), logic learning (Kyllonen & Stephens, 1990), taking lecture notes (Kiewra & Benton, 1988), writing (Benton, Kraft, Glover, & Plake, 1984), storytelling (Pratt, Boyes, Robins, & Manchester, 1989), and emotional processing (Bliss-Moreau et al., 2003). WMC is also strongly related to measures of *fluid intelligence*, defined by Cattell (1943) as the ability to reason, solve novel problems, and adapt to new situations (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002; Engle, Tuholski, Laughlin, & Conway, 1999; Kyllonen & Christal, 1990). Some consider WMC to be the main processing component that supports fluid intelligence (Kyllonen, 1996).

### Summary

WMC reflects individual differences in the ability to control attention associated with the central executive aspect of working memory. It can be thought of as an individual difference in the "source of goal-directed attention" that serves to activate, maintain, or suppress memory representations. It is associated with the anatomy and circuitry of the PFC and related structures. WMC can be measured by a host of complex span tasks (a memory span task embedded within a secondary processing task) that have excellent reliability and validity. Individual differences in WMC are related to a variety of processing outcomes, including the capability to simultaneously keep goal- or task-related representations actively in mind (regardless of whether they were initially activated exogenously or endogenously); engage in a controlled, planful search of memory and effortful retrieval of additional goal- or task-related representations as needed; monitor for potential conflicts when there are competing response options; and resolve this conflict by inhibiting actions and suppressing the activation of unwanted information in conditions that are complex, full of distractions, or that pull for response competition. From the perspective of dual-process models of the mind, individual differences in WMC likely influence the capability to engage in controlled processing, thereby determining our ability to control our thoughts, feelings, and actions in the course of everyday life.

## Implications of Individual Differences in Controlled Attention Ability for Dual-Process Models

It is fairly well accepted that controlled processing will occur only when there are sufficient attentional resources (Bargh, 1989) or motivation (E. R. Smith, 1998; E. R. Smith & DeCoster, 2000). Competing sensory information, conflicting goals, and the like are the norm. Individual differences in WMC will determine whether a person has sufficient attentional resources to engage in controlled processing in these circumstances. As a result, many of the controlled, corrective mental processing effects that have been documented in the research literature are very likely moderated by WMC. Rather than provide a laundry list of specific effects that might be moderated by capacity considerations, we examine the extent to which WMC may influence the success of representative processing tasks. To do so, we directly build on a recent article by E. R. Smith and DeCoster (2000), who discussed the processing modes associated with controlled and automatic effects as they occur in dual-process theories. Examples of specific psychological effects are offered briefly for illustrative purposes. When discussing these examples, we are not implying that they deal with the moderating influences of WMC. Rather, we suggest that these articles detail effects that we think may be moderated by WMC. We offer our observations in the context of discovery (Popper, 1968; Reichenbach, 1947; see also Whewell, 1860/1971) to illustrate the fact that there are important areas of social, personality, cognitive, and clinical psychology that can be further informed by the idea of individual differences in WMC.

### Processing Modes

In a recent review of the literature, E. R. Smith and DeCoster (2000) linked automatic and controlled processing to distinct processing modes. The associative mode draws on pattern-completion or similarity-based retrieval, and functions on the basis of preexisting representations. Information is processed automatically, outside of focal attention. As a result, WMC differences would not affect the range of automatic categorization effects or retrieval of well-learned affective or evaluative responses, all of which are instances of associative processing. To the extent that all individuals use associative processing, they will experience the phenomena described so nicely by E. R. Smith and DeCoster (2000). Knowledge representations and evaluative or affective responses will be automatically and preconsciously activated by cues that are present in the stimulus environment. Resulting thoughts and feelings are experienced as part of the stimulus information rather than being seen as the perceiver's own reaction. That is, affect or interpretations attributed to an object will be experienced as part of the stimulus properties of that object.

The rule-based mode involves symbolic representations and cultural knowledge for guiding behavior. Compared with the associative system, the rule-based system is subjectively effortful, strategically coordinated to the individual's processing goals, be they specified by the task (as in a Stroop paradigm) or motivational in nature (as when trying to control stereotyping behavior), and requires attentional resources. As a result, rule-based processing may be more subject to the effects of constraints on attentional capacity, including individual differences in WMC.

### Incorporate Additional Information Into Existing Representations

Dynamically modifying knowledge representations online is achieved by rule-based processing (E. R. Smith & DeCoster, 2000). As such, WMC is likely related to the ability to incorporate new or inconsistent information into a preexisting representation of an object, potentially moderating a host of different effects. For example, during the process of perceiving another person, we typically begin by using categorical (group-related) information to draw inferences about that target person, later incorporating individuating information (that is specific to the target) into our inference; individuals low in WMC may not have sufficient resources to detect, process, or remember information that is unexpected or inconsistent with their categorical representations (e.g., Hastie & Kumar, 1979; Sherman, Lee, Bessenoff, & Frost, 1998; Srull & Wyer, 1989). This would be especially true if, as suggested by Conway and Kane (2001), individuals lower in WMC form impressions early in the information-processing trajectory. As a result, individuals low in WMC, like those with explicitly prejudicial beliefs, may possess more stereotypic group-based information in their representations of other people, whereas those higher in WMC, like those with egalitarian beliefs, may hold proportionally less of that information in memory (e.g., Hilton & von Hippel, 1996; Wittenbrink, Judd, & Park, 1997).

Even if they recognize inconsistent information, those lower in WMC may not have the attentional resources to elaboratively process this information, therefore making it more difficult to resolve any inconsistency between the individuating information and information about the group to which the target belongs (e.g., Macrae et al., 1999). The hypothesis that WMC is related to the ability to resolve inconsistency in information about a person is not much different from the idea that WMC is related to success in establishing coherence between disparate parts of a textual passage (Whitney et al., 1991).

Of course, the idea that the central executive is implicated in person perception is not new (see Macrae & Bodenhausen, 2000; Macrae et al., 1999). More novel is the idea that people differ in the capacity of their executive functions, and therefore may vary in their ability to organize their impressions, judgments, or memories of a target person around information that is specific to the target person, rather than to the target's group.

More generally, WMC may moderate how we perceive others at various stages in the person perception process. In general, the act of perceiving another person can be summarized in three stages (Gilbert, 1998). First, there is behavioral identification—how an observer perceives what a target person is doing. People are constantly moving and engaging in actions, and we partition this continuous movement into discrete meaningful acts. We isolate and organize behavioral actions (like facial muscle movements) into a recognizable behavioral act (like a smile). Second, there is attributional inference. Once we have identified a behavioral act, we want to know why it happened. Here, we infer the cause of the acts that we have identified. Typically, we believe the cause rests with some property of the person (a trait, an internal state, etc). Finally, we have the correction stage. Once we have identified an act and attributed its cause, we form an impression about the target person. Aspects other than some property of the target person (like the situational context) might have caused the behavior, but we factor these in after the fact. It is typically assumed that the first two stages proceed automatically, but that the correction stage requires controlled processing. As a result, considering alternative, possibly situational causes for a person's behavior may be moderated by WMC. For example, an individual lower in WMC may be less able to correct for initial inferences when forming impressions of others (e.g., Gilbert, Pelham, & Krull, 1988; Trope & Gaunt, 2000), either because they habitually rely on automatic processing about persons or because they do not have adequate control of their attentional resources to factor in evidence for alternative influences on behavior. As a result, an individual lower in WMC may be more likely to commit the fundamental attribution error when making attributions about others.

WMC may influence the extent to which individuals use either "online" or "memory-based" processing strategies when forming a judgment about a person (e.g., Hastie & Park, 1986; McConnell, Sherman, & Hamilton, 1994). An online strategy is similar to rule-based processing: Individuals encode information as they are exposed to it. This recently formed impression is then stored in memory and retrieved when needed, thereby allowing individuals to use a preprocessed impression when asked to make a judgment about another person (or themselves; Feldman Barrett, 1997). A memory-based strategy is more similar to associative processing: Individuals will construct an impression on the basis of whatever information is available at the time of judgment. There is no necessity that memory-based processing must be associative in nature, but in attention-demanding situations when a strategic memory search cannot be sustained, judgments may be based on whatever information is effortlessly accessible. As a result, individuals higher in WMC may use an online processing strategy, whereas those lower in WMC may use a memory-based processing strategy. When online judgments are required, individuals higher in WMC may update their representations of a person as they go along, incorporating both early and late information, whereas those lower in WMC may form an impression early on, relying on early information. This idea is consistent with findings that individuals with higher span scores make inferences about textual information much later than do those with lower span scores, who make inferences early on in the comprehension process (Singer, Andrusiak, Reisdorf, & Black, 1992; Singer & Ritchot, 1996).

### *Use Symbolically Represented Rules to Regulate Behavior*

E. R. Smith and DeCoster (2000) suggested that the rule-based processing system is responsible for quickly learning a new fact or rule, symbolically representing it, and using it in subsequent processing to guide behavior. Individuals high in WMC should be better able to use symbolically represented rules to monitor decisions and behaviors (e.g., using social norms or explicitly held beliefs to regulate behavior). They may even be more aware that a stimulus can prime or automatically influence subsequent judgments or behaviors (e.g., Wilson & Brekke, 1994), thereby allowing them to more successfully counter its effects. For example, it is possible that participants primed with violent rap music in a study by Rudman and Lee (2002) would have avoided using negative stereotypes when they judged an African American target (in a supposedly unrelated experiment) had they known that the music could cause that effect. This is consistent with the findings that those higher in WMC showed enhanced ability to perform on Stroop (Kane & Engle, 2003) or anti-saccade tasks (Kane et al., 2001), in which the experimental situation provides a symbolic rule to guide behavior.

Of course, it would be incorrect to assume that those lower in WMC fail to use their rule-based knowledge in some pervasive way. In the absence of interference or distraction, individuals who are low in WMC may be able to use rule-based knowledge to guide their behavior effectively. Furthermore, E. R. Smith and DeCoster (2000) pointed out that with repeated use, rule-based knowledge will be applied associatively, so rule-based knowledge, like goals or other symbolic representations related to behaviors, may be passively activated by the environment. Yet, at some point, goal-directed attention would be required to manage the activation level of rule-related representations. Without sufficient attentional resources, it would be unlikely that the rule would have a sustained impact on information processing and subsequent behavioral outcomes. And, of course, when we suggest that goal-directed attentional influences are at work, we are not necessarily assuming that a person is subjectively aware of attending to the rule or that it is the focus of their attention.

### *Explaining and Introspecting*

E. R. Smith and DeCoster (2000) argued that rule-based processing produces an explicit step-by-step logical account of how a processing outcome is derived (unlike associative processing, which only produces a "gut" feeling). If individuals higher in WMC are better at rule-based processing, then they may have an easier time reflecting on and summarizing their own past experiences during the act of remembering. On this basis, we can form a number of hypotheses. Individuals high in WMC may show less distortion or retrospective memory bias when recalling past events. They may also be more accurate when responding to standard self-report measures of personality and motivation because such questionnaires require respondents to retrieve previous instances of thoughts, feelings, or behaviors and then summarize them into a coherent answer (for a discussion, see Feldman Barrett, 1997; Robinson & Clore, 2002). We could also argue, however, that those higher in WMC may show more bias because retrospections are constructed on the basis of concurrent goals or theories, and people with more attentional resources would have more ability to enact those goals or theories during the act of remembering (for reviews, see, e.g., Ross, 1989; Schacter, 1996). We can reconcile these ideas by suggesting that the accuracy or bias contained in global self-reports or retrospections made by those higher in WMC will depend on the processing goals at the time of report; they may show more bias when a consistency or enhancement goal is present, but more accuracy with an accuracy goal. Those lower in WMC may not be as sensitive to such goals, such that their reports or recollections may be more consistent across response contexts.

WMC may affect not only the content of representations but also the functional properties of the representations. Individuals high in WMC may have a greater wealth of exemplar-based information available to them (*exemplars* are the theoretical entities that are assumed to record the specific history of use of a general concept; E. R. Smith, 1998). The rule-based processing system encodes information as exemplars, creating a symbolic representation of how or when an episodic event occurred, thereby leaving an enduring source memory trace that can be retrieved at a later time. Previous research has shown that WMC is associated with the extent to which people can recall information about the encoding context (Lee-Sammons & Whitney, 1991). Together, these findings suggest that those high in WMC encode more episodic information than do those lower in WMC.

As a result, individuals high in WMC may have categories that are constructed on a subset of exemplar representations that are activated from LTM, rather than categories that are retrieved as a unified whole, during information processing (e.g., E. R. Smith & Zárate, 1992). In contrast, those lower in WMC may be less able to represent episodic information associated with the encoding context, making their representations more schemalike and semantic. Because exemplar-based categories are more flexible than semantic categories, WMC may influence the flexibility of concepts or categories. Moreover, when remembering information about the self, individuals with lower capacity may rely more on semantic information, whereas those with higher capacity may rely more on episodically infused information (e.g., Robinson & Clore, 2002).

### *Implementing Motivation*

Recent evidence suggests that goals can be automatically activated and affect a host of social psychological outcomes (Bargh, 1990, 1997; Chartrand & Bargh, 1996). Yet for goals and other task-related motivations to have a prolonged impact on behavioral outcomes, they must have a sustained impact on information processing. To be successful, goal- or task-related processing must maintain or enhance the activation of relevant representations and suppress the activation of goal- or task-irrelevant representations. Thus, it is important to know whether a person has the attentional capability to maintain and manipulate information in the service of a processing goal, in addition to knowing which goals are being pursued. One interesting implication of a WMC perspective is that not everyone can enact a processing goal in attention-depleting, complex social circumstances, even if they possess the goal.

E. R. Smith and DeCoster (2000) suggested that motivation and capacity constraints have independent effects on rule-based processing, but from a WMC standpoint, the two may not be so independent. First, work by Engle and his colleagues (e.g., Rosen & Engle, 1997) indicates that WMC is associated with the extent to which individuals even attempt to enact controlled processing in attention-demanding circumstances. For those lower in WMC, a failure to attempt controlled processing may not reflect a lack of motivation to correct; rather, it may reflect previous learning that such attempts of control are unsuccessful.

Second, even if motivations to correct are present, controlled attention is required to implement the associated processing goal. Those with larger working memory capacities will be more effective in achieving goal-directed attention to guide processing and behavior. Without sufficient controlled attention resources, those low in WMC will be unable to correct or control their associative processing, even if they have the explicit motivation or intention to do so. As a result, even those theories that put relatively more emphasis on motivation for countering the negative effects of automaticity (e.g., Brewer, 1988; Devine, 1989; Fiske, 1989; Petty & Cacioppo, 1986) are not immune from considering the implications of WMC differences.

This sort of differential ability to enact goal-related processing would have an impact on a host of social psychological effects. In the stereotyping literature, researchers have argued that everyone engages in the same associative process when they encounter a stigmatized group member, but that individuals with more egalitarian goals inhibit their stereotyped thoughts and replace them with nonprejudice beliefs (e.g., Devine, 1989; Devine & Monteith, 1999; Plant & Devine, 2001). Incorporating WMC into this classic model may help to explain why there is inconsistency in the empirical findings on whether people who are motivated to control prejudice are able to do so. WMC would influence the ability to engage in controlled inhibition of stereotyped thoughts such that some motivated individuals have the cognitive resources to do so, whereas others do not. Incorporating WMC into the analysis may also help to explain why practice overcomes the automatic activation of stereotyped information (e.g., Kawakami & Dovidio, 2001). Practice may level the cognitive playing field by making the process more automatic, allowing both low- and high-WMC individuals to achieve inhibition.

Some researchers have argued that stereotype activation is automatic for all people, and that stereotype application is influenced by goals (Devine, 1989). Recent evidence suggests that goal states can influence category activation, however (e.g., Moscowitz et al. 1999; for a summary, see Macrae & Bodenhausen, 2000). Such goal-related categorization effects may be differentially effective, depending on a person's WMC. For example, egalitarian individuals higher in WMC may not experience stereotype activation automatically (e.g., Devine, 1989; Wittenbrink et al., 1997), whereas egalitarian individuals lower in WMC may experience automatic activation of their stereotyped categories because they do not have the attentional resources to sustain goal-related processing.

The elaboration likelihood model of persuasion (Petty & Cacioppo, 1986) suggests that a persuasive message has its impact via two routes: the automatic processing of noncontent-related information (e.g., the source of the message) that allows a person to make a quick judgment about a message, and the controlled elaboration of the content for which a person carefully thinks about the issue-relevant arguments. Because elaboration requires controlled processing, those lower in WMC may be less able to achieve elaboration in complex or attention-demanding circumstances. In complex situations, only those high in WMC may elaborate on the contents of the message or resist the importance of noncontent-related information (by deliberately considering it and suppressing its subsequent influence on processing). In addition, WMC may mediate several of the known moderators of elaborative processing. For example, WMC may be positively related to need for cognition (e.g., Cacioppo, Petty, Feinstein, & Jarvis, 1996) or negatively related to the degree of confidence that people have in their own thoughts, both of which are known to influence elaborative processing (e.g., Haugtvedt & Petty, 1992; Petty, Brinol, & Tormala, 2002). (See the *Perspective Taking* section below for a discussion of why low WMC may be associated with enhanced confidence in judgments and decisions.)

### *Suppression*

Suppression effects have been well documented in person perception and stereotyping processes (for summaries of such effects, see Bodenhausen & Macrae, 1998; Devine & Monteith, 1999; Wilson & Brekke, 1994). In recent years, there has been an explosion of research and theorizing about self-regulatory processes that either explicitly or implicitly implicate the importance of suppression. Researchers refer to "willpower" (Metcalfe & Mischel, 1999), "self-control" (Muraven & Baumeister, 2000), and "effortful control" as aspects of temperament (Rothbart & Bates, 1998) to explain individual differences in the ability to suppress unwanted or undesired thoughts, feelings, and behaviors during self-regulation. Individual differences in WMC may underlie or mediate these effects because it plays some role in regulating thought and action via inhibiting the activation of goal- or task-irrelevant representations. Those high in WMC may be better able to inhibit unwanted, but prepotent behavioral or cognitive responses when they desire to do so than those lower in WMC, with important consequences for well-being. For example, recent evidence suggests that people who are vulnerable to depression engage in a high level of thought suppression to avoid elaborative processing of the negative thoughts that result from feelings of low self-worth (Wenzlaff, Rude, & West, 2002). This suppression requires substantial mental effort, and when under cognitive load, depressive cognitions surface and the vulnerability is unmasked, potentially leading to a depressive episode (Wenzlaff et al., 2002). Individual differences in WMC may moderate the link between self-worth and depression such that those with low self-worth and who are lower in WMC are more susceptible to depression than those who are higher in WMC (who can more effectively suppress negative thoughts about the self in a tonic fashion).

Existing evidence suggests that suppressing an unwanted behavior involves a series of processing steps, including monitoring for potential conflicts and decreasing the behavioral expression of unwanted representations (that were passively primed by the situation) by restraining habitual responses, or inhibiting the processing of attention-capturing stimuli. It would be important and interesting to take a more molecular look at where individual differences in controlled attention have their effect.

## Extending the Context of Discovery

By this point, we hope that it is obvious that individual differences in WMC are important to consider in any theory in which automatic and controlled processes come into play, particularly in complex social situations in which there is the potential for interference from automatically retrieved representations that are contradictory to the current goal state. In these sorts of situations, something that is controllable for one person is not necessarily so for another. We have offered examples of how individual differences in WMC may moderate a host of effects from existing dual-process theories, and because they were offered in the context of discovery, these hypotheses await empirical test. The concept of WMC may have an even more important role to play in the context of psychological discovery, however, in that it suggests several novel hypotheses for investigation across a broad range of psychological topics. We offer four examples.

### *On the Preconscious Nature of Control*

Early in this article, we argued that controlled processing should be defined in terms of whether attention is controlled, rather than in terms of the subjective experience of control or will. Our conscious experience of what we do, and how it feels when we do what we do, is not the best way to build a theory about controlled processing. This idea is consistent with the long-held view in social psychology that we are rather limited in our abilities to explain the causes of our behavior, and we cannot take subjective experience as solid evidence for the presence of causal processes (Nisbett & Wilson, 1977). As a result, conscious experience is not diagnostic for distinguishing the presence of automatic and controlled processes. Bargh and Ferguson (2000) made this point nicely when they stated that "the feeling of volition . . . cannot be taken as evidence for the existence of volitional control" (p. 940). People experience themselves as controlling their behavior even when they are not in control. This observation has been discussed in depth by Wegner (2002). We argue that the opposite is also true—people can engage in controlled processing even when they do not experience themselves as doing so.

We distinguished controlled (from automatic) processing on the basis of whether goal-directed attention (in the form of PFC mediation) is involved. Earlier in this article, we also suggested that perhaps no such definition is even needed because the distinction between automatic and controlled processing breaks down all together at a certain level of analysis. This may make sense in light of the fact that all processing is initiated by the environment in one way or another (Bargh & Ferguson, 2000), and most acts of attention involve both stimulus-driven and goal-directed influences (Monsell & Driver, 2000). Pure instances of attentional capture do occur, but they are more infrequent than situations in which goal-directed attention sets the preconditions for such automatic processing to take place (Pashler et al., 2001). Perhaps it makes more sense to argue that controlled processing occurs when previous learning and past experience influence the distribution of attention (i.e., where attention is applied) in a goal-directed or top-down fashion. With few exceptions, then, both the properties of the object (say, characteristics of a person) and the goals of the observer (based on previous experience and learning and instantiated by connections between representations) determine how attention is deployed.

Moreover, if we accept the idea that controlled processing is not synonymous with conscious experience, then we are free to consider the idea that goal-directed attention may function like a preconscious filter that selects the focus of attention (and potentially what is available to consciousness). This idea is consistent with the emerging view that attention is captured automatically by stimulus features primarily when there is some goal-directed attentional preparation to allow this. As a result, controlled processing may not be merely reversing the effects of automatic processing, but it may also prevent (or allow) the expression of attention on representations that were activated in a stimulus-driven way. As long as one has a processing goal (like an egalitarian goal to prevent stereotyping, for example), as well as the WMC to deploy goal-directed attentional effects, that processing goal can be enacted. As a result, some of the effects that we think of as automatic (e.g., Moskowitz et al., 1999) may well involve the control of attention so early on that there is no associated experience of will or agency. For example, it may be that a property of the person (e.g., skin pigmentation) automatically activates both a stereotype and a goal to be egalitarian, and with sufficient WMC resources, the activation level of the stereotype can be suppressed before it influences subsequent processing, thereby allowing egalitarian outcomes with perceived ease.

Finally, goal structures are activated in some way by the environment, but we might question the idea that goal-related representations are, themselves, automatically activated by stimulus-driven attention. When an object (say, a brown-skinned individual) is already the focus of attention (because the individual is being interviewed for a job or is in a conversation with the observer), it is not possible to clearly separate bottom-up and top-down sources of attention. A property of the object (the pigmentation of the person's skin) may activate categories and goals, but only when we are attending to that object in the first place. We noted earlier that most of our experimental paradigms test the implicit nature of stereotyping and prejudice in a way that requires goal-directed attention as a precondition. For example, participants are instructed to form an impression of the target person, or are asked to process information about that person, such that the target person is the focus of attention. It may be that we see evidence for automatic processing precisely because the experimental setup produces the goal-directed precondition to allow automatic processing to proceed. Thus, some of the effects that we assume to be a function of automatic processing may in fact be influenced by the goal-directed control of attention in ways that we have yet to consider.

### *Perspective Taking*

E. R. Smith and DeCoster (2000) noted that the output of associative processing "pops" into awareness so that the perceiver is unable to provide any justification for it other than intuition. Intuition often serves to justify the truth value of a belief—when we have an intuition about an object, we treat our belief about the object as true and absolute, rather than as contextual or relative (Bargh, 1994). As a result, individual differences in WMC may influence the extent to which people can treat their own beliefs as hypotheses to be supported or disconfirmed. Individuals low in WMC may be more confident about the validity of their ideas and treat their beliefs as fact or knowledge. Because they form impressions early on and do not represent the ambiguity that might be inherent in a stimulus (e.g., a textual passage; MacDonald et al., 1992), the mere act of forming an interpretation or judgment would lead them to believe it to be true (Descartes, 1641/1931; Gilbert, 1991). And even if they detected the ambiguity, leading to a motivation to correct their interpretation or judgment, they may not have the attentional resources to consider the stimulus in a more deliberate fashion. In contrast, those higher in WMC may have the capacity to see their ideas in more relative terms and treat their beliefs as just that—beliefs. Of course, just because one has the capacity to do something does not mean that one will do it. Other factors, like motivation or context, would obviously play an important role (Gilbert, 1995).

Any knowledge that is activated via associative processing is treated as an inherent property of the stimulus, rather than as a part of the perceiver's own evaluation or interpretation of the stimulus object, precisely because the perceiver does not experience themselves acting to evaluate or interpret (E. R. Smith & DeCoster, 2000). Yet, for the most part (there is some debate on the matter), scientists accept the idea that we have no direct access to objects in the natural world, and we come to know them through the filter of our senses. When we hold a bowl, we do not directly experience "a bowl," we experience haptic and visual, and potentially olfactory cues (from the substance contained in the vessel) that activate knowledge representations that lead us to perceive a bowl. Similarly, we do not directly see a "happy person," we experience sensory cues that tell us a person is moving his or her face and gesturing in a particular way. These actions, or perhaps other salient cues about the person or the context, serve to automatically activate emotion concepts and person-related categories, leading us to interpret the actions as a behavioral act (i.e., he or she is smiling), thereby allowing us to perceive the person as happy (for an overview of these processes, see Gilbert, 1998). Because individuals who are lower in WMC tend to approach complex tasks using more automatic, associative processing strategies, they may be less able to distinguish between the properties of the stimulus and their own perception of or reaction to the stimulus. That is, they may be more likely to reify objects. In contrast, those higher in WMC tend to approach complex tasks with a more deliberative mindset, such that they would have the capability to separate the properties of a stimulus from their interpretation of that stimulus. But again, capability and actuality are not the same thing.

The ability to treat your beliefs as hypotheses and to distinguish between an object and your interpretation of that object are both prerequisites for understanding that other people may see things differently than you do. For example, individuals may hold authoritarian views in part because they just have not considered the possibility that they may be wrong (Altemeyer, 1996). Individual differences in WMC, then, may be associated with the differential capacity for perspective taking in complex, interference-filled situations. Perspective taking is a basic set of skills that have implications for empathy (e.g., Keefe, 1976), interpersonal communication (e.g., Fussell & Kreuz, 1998; Krauss & Fussell, 1996; Schober, 1998), and self-awareness (e.g., Ferrari & Sternberg, 1998; Hass, 1984). It is possible that individual differences in WMC have some role to play in these behaviors as well.

### Functional Modularity

*A cognitive module* is defined as a fast, domain specific set of processes that have evolved to handle particular types of information. Among other criteria (Fodor, 1983), modules are encapsulated and impenetrable—a module's activities and outputs cannot be influenced by other classes of information such as prior knowledge, expectations, beliefs, or any other cognitive input. Modules are reflexive; they must provide predetermined outputs when predetermined inputs are present. Modules operate outside of awareness (it is impossible to reflect on the operations of a module). The typical assumption is that these properties of modules directly result from the architecture of the brain systems (modules are mediated by dedicated neural systems). Recent evidence suggests that individual differences in WMC can produce a kind of functional "modularity," whereby a system appears modular, but only because of attention (rather than architectural) constraints. This is because capacity constraints create functional boundaries between different processes when attentional resources are insufficient to permit direct interaction between those processes.

Research on language comprehension demonstrates how capacity constraints may produce the appearance of modularity (Just & Carpenter, 1992). Evidence suggests that syntactic parsing is modular. When asked to parse a single sentence in isolation (i.e., without reference to the context provided by other sentences), WMC is not involved. Given our long developmental exposure to language (and some would argue our innate propensity to develop language rules), we parse syntax automatically using a set of overlearned, language-specific operations, and therefore syntactic processing tends to be immune to capacity limitations (Caplan & Waters, 1999). Language comprehension, however, requires some appreciation of context (i.e., the individual must not only parse the syntax of a given sentence but also must track the meaning of a concept across several sentences). To accomplish this, participants must hold information from previous sentences in working memory as they continue to parse those upcoming. In essence, this is a complex span task. And, indeed, language comprehension is related to WMC. Those lower in WMC are unable to use context to disambiguate a syntactically ambiguous sentence, making their language comprehension appear more "modular" and cognitively impenetrable. In contrast, those higher in WMC are able to use context to help them understand a syntactically ambiguous sentence, such that their language comprehension does not have the properties of a modular system (for a discussion, see Just & Carpenter, 1992; MacDonald, Just, & Carpenter, 1992).

The idea of functional modularity has heuristic value for understanding the role of attention control in dual-process theories. Without ample attentional resources controlled, rule-based processing will not interact with the more automatic, associative processes, thereby creating a functional boundary between the two. When this boundary occurs, phenomena appear modular, or reflexlike. As a result, a processing effect that resembles a "module" for one person does not necessarily appear modular in another.

In addition, the idea of functional modularity also has potential conceptual value in any domain in which modules are hypothesized but where attention plays a role. As an illustration, we apply the idea to the concept of "basic" emotions. Many theories define emotions (anger, sadness, fear, etc.) as modular systems—distinct natural kinds, free from symbolic interpretation, and biologically distinct (e.g., Ekman, 1973, 1992; Ekman, Levenson, & Friesen, 1983; Izard, 1992; Johnson-Laird & Oatley, 1989; Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson, Ekman, & Friesen, 1990; Panksepp, 1982, 1986, 2000; Tomkins, 1962; Tooby & Cosmides, 1990). Although specific theories vary from one another in some of their details, the general view holds that each emotion is an entity with an essence (usually a neural system or brain area); that it has causal power (i.e., it causes a set of correlated, measurable manifestations [facial movements, heart rate and blood pressure changes, voluntary actions, etc.]; that it is hard-wired from our animal past; and that, once triggered, it cannot be stopped (although it can be regulated after the fact). Evidence against these various assumptions is mounting, however (see, e.g., Bradley & Lang, 2000; see also Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Russell, 2003; Russell, Bachorowski, & Fernández-Dols, 2003).

A host of dual-process models of emotion exist (e.g., Matthews & Wells, 1999; Oschner & Feldman Barrett, 2001; Teasdale, 1999; van Reekum & Scherer, 1997), each of which relies on the now familiar distinction between automatic and controlled processing. These theories differ from more modern nativist theories in the aspects of emotional responding they consider automatic. Modern nativist views hold that emotion reflexes are merely tendencies, not actualities. These tendencies (packets of coordinated responses) are automatically activated by predetermined stimuli, but then are acted on (controlled, if you will), by learning, display rules, and the like, allowing responses to be more flexible and coordinated to the context. Most dual-process theories of emotion assume that attention comes into play earlier in the formation of an emotional response, and is not merely regulating the expression of a reflex once it has fired.

On the basis of a recent model proposed by Feldman Barrett (in press), we speculate a more provocative role for WMC in the generation of a modular emotional response. We begin with the idea that core affective reactions of pleasure and displeasure are, like other evaluations, automatic and rooted in associative processing (for a review, see Fazio, 2001). As a result, they are modular—reflexive, incapable of being stopped by effortful processing (Quigley & Feldman Barrett, 1999), and therefore immune to capacity limitations. By analogy, core affective responding is more like syntactic processing. The generation of a discrete emotional reaction, like anger, sadness, or fear, may be more similar to language comprehension. If conceptual knowledge about emotion works like other categorical knowledge (and we have no reason to suspect that it does not), then features of the situation or immediate environment will trigger knowledge about an emotion category. Attention control is required for strategic management of this emotion knowledge, however. If this is correct, then low-capacity individuals will not have sufficient control of their attention to attempt deliberate processing at all. As a result, their emotional response will be the direct result of their core affective response plus whatever conceptual knowledge about emotion that remains active, resulting in a functionally modular response. In contrast, those higher in WMC who have the attentional resources to engage controlled processing can prevent a modular response and will generate emotional responses in a more strategic, flexible manner. Of course, under conditions of extreme cognitive load, like very stressful situations, they would display functionally modular responses as well, but this might happen less frequently.

We do not mean to suggest, however, that higher WMC is always associated with the more functionally effective emotional response. Individuals low in WMC may fare better in situations that call for quick actions in negative situations, whereas those higher in WMC may engage in unnecessary deliberation. In addition, attentional resources that allow for the deliberation on negative experiences produce an increased risk for the experience of depression (Mathews & MacLeod, 1994). In fact, sustained processing of negative information is related to the development of depressive disorders. For example, those higher in WMC may have the ability to sustain a focus on negative circumstances and to "resist distraction" from positive information.

Of course, our ideas are pure speculation at this point, but if evidence from social psychology proves instructive, then they are at least plausible. We have already referred to the wealth of empirical evidence in social psychology that knowledge structures can be activated and deactivated to have a profound influence on subsequent thoughts, feelings, and behaviors (for a review, see Bargh & Chartrand, 2000). When the concept "old" is activated, college-aged participants walk slower (Bargh, Chen, & Burrows, 1996). When the concept "African American" is activated, European American participants act more aggressively (Bargh et al., 1996). Moreover, our ideas about the role of conceptual knowledge about emotion in emotional responding are consistent with the "embodied" view of the conceptual system (Barsalou, 1999) and emotion categories in particular (Niedenthal, Barsalou, Ric, & Krauth-Gruber, in press). If it is possible that emotion knowledge is formative in human emotional responding, then so is the ability to manage it well.

### *Mechanisms of Self-Regulation*

WMC may set the stage for a more nuanced understanding of self-regulation. First, WMC may be related to the tolerance of ambiguity. Tolerance of ambiguity is considered to be a source of ego-strength (Block & Block, 1980; Klohnen, 1996). Although uncertainty has been linked to an enhanced perception of threat (Lazarus & Folkman, 1984; Milburn & Watman, 1981), there are times when ambiguity may be advantageous, such that it permits the maintenance of hope, inspires optimism, or prevents premature closure. When environmental cues signal harm or danger, ambiguity can be used to reduce threat by allowing alternative, perhaps reassuring, interpretations of the meaning of the situation. The ability to tolerate ambiguity is related to a host of positive outcomes, including less depression, effective emotion regulation, and general positive health (e.g., Felton, Revenson, & Hinrichsen, 1984; Frenkel-Brunswik, 1949; Krohne, 1986; Lazarus & Folkman, 1984). It may be that those higher in WMC can better tolerate the ambiguity associated with the uncertainty of future events, whereas those who have lower capacity may engage in premature closure by entertaining only one expected outcome. In support of this hypothesis, research has shown that individuals higher in WMC were more able to tolerate ambiguity (by maintaining multiple interpretations of a sentence) than were those lower in WMC (MacDonald et al., 1992).

Second, WMC may assist in the ability to resist the attentional capture from negative information. When threat is perceived, there is a greater likelihood that individuals will focus their attention on threatening cues (Pratto & John, 1991). The reason for this is a function of the neuroanatomical organization of our attentional system. The act of paying attention to (and processing the sensory information from) one stimulus results in inhibition of other representations, such that other objects are functionally filtered out of focal attention (Kastner & Ungerleider, 2000, 2001). As a result, stimuli with a potential to be dangerous result in attentional narrowing (Easterbrook, 1959) such that other affectively significant stimuli, some of which may be positive, are neglected. Sustained attention to negative information has a host of negative consequences that interfere with the development and maintenance of emotion regulation strategies (Rothbart & Derryberry, 1981). The shifting of attentional focus to nonthreatening cues is fundamental to any regulatory process, such that flexible allocation of attention may be an important element in allowing individuals to be resilient to negative emotional circumstances. Those higher in WMC may be more effective at this type of attentional control than those lower in WMC. As a result, they may be less likely to develop posttraumatic stress disorder and a host of other anxiety-related disorders.

Finally, the possibility that WMC may influence the ability to suppress previously learned affective associations would be important to attitudes and other evaluation-tinged judgments. Classical conditioning, which is a form of associative processing, is still widely seen as the fundamental process through which new cues come to acquire affective significance (e.g., Bouton, Mineka, & Barlow, 2001; LeDoux, 1996, 2000). Whether they are negative or positive, the associative system treats first-learned responses as though they are relatively invariant across contexts and indelible (Nelson & Bouton, 2002). Processes like extinction do not involve a removal of old representations, but rather a controlled inhibition of them associated with newer learning (Bouton, 1994; Nelson & Bouton, 2002). This means that once acquired, affective memories leave virtually unmodified traces in the brain. Even after extinction to a conditioned stimulus, an animal's brain retains changes in neuronal firing patterns (Sanghera, Rolls, & Roper-Hall, 1979) or in neuronal connections between cells (Quirk, Repa, & LeDoux, 1995) that were not present prior to learning. These findings are consistent with the idea that old attitudes never die, but merely exist in parallel with newer ones (Wilson et al., 2000).

Extinction occurs via the controlled inhibition of previously learned affective responses. There are several lines of evidence that suggest WMC may be associated with this learned inhibition. Although the biological substrates of learned inhibition are far from clear, there is some suggestion that previous threat learning is inhibited by the influence of higher cortical structures, such as the medial PFC (Morgan, Romanski, & LeDoux, 1993), or ventromedial PFC (Quirk, Russo, Barron, & Leron, 2000), on subcortical areas integral to threat learning (particularly the amygdaloid complex). As we indicated earlier, PFC circuitry is associated with controlled attentional processes (Kane & Engle, 2002). Any process that requires the control of attention (e.g., increased cognitive load or multitasking that limits working memory resources) could permit a return of the original response (cf. Quigley & Feldman

Barrett, 1999). This may explain why, when under significant stress, people experience a reduction in their controlled attention resources (Klein & Boals, 2001; Mizoguchi et al., 2000), such that people experience a resurgence of the threat response. It also suggests the possibility that individuals who differ in WMC may be differentially able to inhibit the expression of a previously learned threat response.

There is some evidence that regulatory inhibition involves a sensitivity to context (Nelson & Bouton, 2002). Part of regulation involves counterconditioning, or learning that a stimulus has changed its meaning (from negative to positive, or vice versa). When a stimulus has two possible meanings, context determines its current meaning. For example, when a stimulus is paired with a negative outcome (in one context), and is then paired with a positive outcome (in a second context), its affective value at a particular moment in time will be determined by the current context. This is exactly analogous to how the verbal system determines the meaning of ambiguous words (Bouton, 1994). The context effectively disambiguates the meaning of an ambiguous cue by controlling retrieval of the second meaning. Those higher in WMC can use context to disambiguate the meaning of a sentence, and similarly, they may also be able to disambiguate the affective meaning of a stimulus by using context to retrieve the corresponding meaning. Those lower in WMC may not countercondition as easily and continue to respond to a stimulus according to its original meaning.

## Conclusion

The central executive aspect of working memory has had tremendous influence in cognitive psychology over the past several decades, but is only recently being considered in other areas of psychological theory and research. In this article, we have suggested that individual differences in one aspect of the central executive—the ability to control attention—has much to offer dual-process accounts of the mind. Incorporating this individual difference into dual-process theories will provide a stronger, more coherent account of human behavior. The central executive is one aspect of working memory, and individual differences in the ability to control attention is one important contributor to individual differences in WMC. We reviewed the research literature on how to measure and conceptualize WMC and suggested that it may moderate a host of processes that derive from dual-process accounts. Our goal here is not to argue that existing dual-process theories or their experimental findings are necessarily wanting. Nor are we arguing that factors other than WMC, like previous experience, knowledge, and motivation, are unimportant. Rather, we suggest that person-level variance captured in dual-process-inspired experiments (typically treated as error, or within-group variability) may, in part, be meaningfully explained by individual differences in WMC. We have also considered a number of domains, from perspective-taking to self-regulation, in which the concept of WMC may come in handy.

Ironically, our consideration of WMC has led us to depart from the standard dual-process theories in two ways. First, controlled processing allows people to flexibly interface with their environment, and the source of this flexibility is the ability to control attention in a goal-directed manner, whether or not those goals are represented in conscious awareness. Thus, we have defined controlled processing not by the phenomenology of control, but by the extent to which goal-directed attention is at play. Second, our brief discussion about the dynamics of attention makes clear that goal-directed attention is often the precondition that allows more automatic forms of attention deployment to occur. The interplay between these two types of attention allocation, especially when considered at the neuroanatomical level, may obfuscate the need for the distinction between automatic and controlled processing whatsoever, thereby drastically revising the dual-process story as we now know it.

There are several things that we did not discuss in this review. We did not address the source of this individual difference, in part because not much is known and speculation on our part would be premature at this juncture. We have also not addressed the more basic aspects of cognition that constitute the control of attention, especially how such control can be achieved without the need for a homunculus (e.g., Newell, 1980; Wegner & Bargh, 1998), although we did touch on that point when discussing the neural systems that might subserve WMC. We have noted several times in this article that goals can be automatically activated by cues in the environment (for reviews, see Bargh & Chartrand, 1999; Bargh & Ferguson, 2000). In a very real way, then, the environment may influence the activation of goals in goal-directed attention that we argue is the essence of controlled attention. How efficiently and effectively this occurs likely depends on computational properties associated with the PFC and associated attentional networks. Nor did we discuss other individual differences that may contribute to individual differences in the efficiency or functioning of working memory, like the size of the storage buffers (Cowan, 2001) or processing capacity as it relates to the relational complexity of what is being processed (Halford et al., 1998). Both may contribute to how well a person performs on memory span tasks, as well as to a host of cognitive and real-world variables, but the evidentiary basis for these ideas does not yet permit such claims. In addition, we have not discussed developmental differences in WMC. If WMC underlies or moderates the person perception, stereotyping, self-regulation, and mental health effects as we have suggested, then these effects, so well documented in young adults, may differ in children and in older adults.

Finally, the idea that some people may have the capacity to better control their behavior than do others is fraught with moral implications about responsibility: the responsibility of actors for the outcomes of their behavior. Automatic and controlled processing differ in their evaluative connotation. Typically, associative processing is linked to negative outcomes and controlled processing to positive outcomes (E. R. Smith & DeCoster, 2000). Of course, there are always caveats. Automatic processing can lead to better outcomes in nonverbal decoding (Ambady, Bernieri, & Richeson, 2000) or when maximizing the accuracy of preferences (Wilson & Schooler, 1991). Controlled processing can lead to biased responses when judgment correction results in contrast effects (Dijksterhuis et al., 1999) or when thought suppression leads to a rebound effect (e.g., Monteith, Sherman, & Devine, 1998; Wegner, 1994). And in situations when attentional resources are especially taxed, automatic processing may confer both advantages and disadvantages but, depending on the situation, may be the lesser of two evils. All else being equal, however, we typically think of controlled processing as more desirable. Our discussion of WMC follows the same general evaluative distinction. In general, more controlled processing is better, even if only because it leads to more flexibility in psychological outcomes. Yet, caveats exist. Compared with those higher in WMC, perhaps individuals lower in WMC might perform better in those domains that favor automatic processing. And perhaps those higher in WMC will be more impaired as they attempt to engage in controlled processing and persist at it when, given the circumstances, their attentional resources cannot support it (e.g., MacDonald et al., 1992).

There is perhaps a more important reason not to view high WMC with global positivity. As we have briefly mentioned before, having the resources to engage in controlled processing does not necessarily mean that a person will do so. A person pays for controlled processing with attentional resources. Just because some people have more cash in the bank does not mean that they will be generous in how they spend it. In fact, they may choose not to spend much of it at all if they believe something is a bad investment, or if they believe that they can maximize their outcomes without spending a cent. Thus, the concept of WMC does not replace the importance of motivations or goals. It is merely a necessary condition for enacting them. Obviously, more research is warranted to fully understand all the implications of WMC for matters of behavioral control.

## References


Adams, J. W., & Hitch, G. J. (1997). Working memory and children's mental addition. *Journal of Experimental Child Psychology, 67,* 21–38.

Altemeyer, B. (1996). *The authoritarian specter*. Cambridge, MA: Harvard University Press.

Ambady, N., Bernieri, F. J., & Richeson, J. A. (2000). Toward a histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 32, pp. 201–271). San Diego, CA: Academic Press.

Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.

Anderson, J. R. (1993). *Rules of the mind*. Hillsdale, NJ: Erlbaum.

Anderson, J. R., Reder, L. M., & Lebiere, C. (1996). Working memory: Activation limitations on retrieval. *Cognitive Psychology, 30,* 221–256.

Baddeley, A. D. (1986). *Working memory*. Oxford, England: Oxford University Press.

Baddeley, A. D. (2000). Short-term and working memory. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 77–92). New York: Oxford University Press.

Baddeley, A. D. (2001). Is working memory still working? *American Psychologist, 56,* 849–864.

Baddeley, A. D., & Andrade, J. (2000). Working memory and the vividness of imagery. *Journal of Experimental Psychology: General, 129,* 126–145.

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (pp. 47–90). New York: Academic Press.

Baddeley, A. D., & Hitch, G. J. (1994). Developments in the concept of working memory. *Neuropsychology, 8,* 485–493.

Bargh, J. A. (1989). Conditional automaticity: Varieties of automatic influence in social perception and cognition. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 3–51). New York: Guilford Press.

Bargh, J. A. (1990). Auto-motives: Preconscious determinants of social interaction. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition* (Vol. 2, pp. 93–130). New York: Guilford Press.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer (Ed.), *Advances in social cognition* (pp. 1–61). Hillsdale, NJ: Erlbaum.

Bargh, J. A. (1999). The cognitive monster. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 361–382). New York: Guilford Press.

Bargh, J. A., & Chartrand, T. L. (1999). The unbearable automaticity of being. *American Psychologist, 54,* 462–479.

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253–285). New York: Cambridge University Press.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology, 71,* 230–244.

Bargh, J. A., & Ferguson, M. J. (2000). Beyond behaviorism: On the automaticity of higher mental processes. *Psychological Bulletin, 126,* 925–945.

Bargh, J. A., & Gollwitzer, P. M. (1994). Environmental control over goal-directed action: Automatic and strategic contingencies between situations and behavior. In W. D. Spaulding (Ed.), *Nebraska Symposium on Motivation: Vol. 41. Integrative views of motivation, cognition, and emotion* (pp. 71–124). Lincoln: University of Nebraska Press.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trötschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81,* 1014–1027.

Bargh, J. A., Raymond, P., Pryor, J. B., & Strack, F. (1995). Attractiveness of the underling: An automatic power → sex association and its consequences for sexual harassment and aggression. *Journal of Personality and Social Psychology, 68,* 768–781.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22,* 577–660.

Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7,* 1–15.

Benton, S. L., Kraft, R. G., Glover, J. A., & Plake, B. S. (1984). Cognitive capacity differences among writers. *Journal of Educational Psychology, 76,* 820–834.

Bliss-Moreau, E., Hristic, A., Feldman Barrett, L., & Tugade, M. M. (2003, February). *Working memory capacity: A test of content-specificity and implications for dual process models.* Poster session presented at the annual meeting of the Society for Personality and Social Psychology, Los Angeles.

Block, J. H., & Block, J. (1980). The role of ego-control and ego-resiliency in the origination of behavior. In W. A. Collings (Ed.), *The Minnesota Symposia on Child Psychology* (Vol. 13, pp. 39–101). Hillsdale, NJ: Erlbaum.

Bodenhausen, G. V., & Macrae, C. N. (1998). Stereotype activation and inhibition. In R. S. Wyer Jr. (Ed.), *Advances in social cognition: Vol. 11. Stereotype activation and inhibition* (pp. 1–52). Mahwah, NJ: Erlbaum.

Bouton, M. E. (1994). Conditioning, remembering, and forgetting. *Journal of Experimental Psychology: Animal Behavior Processes, 20,* 219–231.

Bouton, M. E., Mineka, S., & Barlow, D. H. (2001). A modern learning theory perspective on the etiology of panic disorder. *Psychological Review, 108,* 4–32.

Bradley, M. M., & Lang, P. J. (2000). Measuring emotion: Behavior, feeling, and physiology. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 242–276). New York: Oxford University Press.

Brewer, M. B. (1988). A dual-process model of impression formation. In T. K. Srull & R. S. Wyer (Eds.), *Advances in social cognition* (Vol. 1, pp. 1–36). Hillsdale, NJ: Erlbaum.

Brewin, C. R., & Beaton, A. (2002). Thought suppression, intelligence, and working memory capacity. *Behaviour Research and Therapy, 40,* 923–930.

Budd, D., Whitney, P., & Turley, K. J. (1995). Individual differences in working memory strategies for reading expository text. *Memory & Cognition, 23,* 735–748.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. In R. Lewis & J. M. Haviland-Jones (Eds.), *The handbook of emotion* (2nd ed., pp. 173–191). New York: Guilford Press.

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin, 119,* 197–253.

Cantor, J., & Engle, R. W. (1993). Working-memory capacity as long-term memory activation: An individual-differences approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 1101–1114.

Caplan, D., & Waters, G. S. (1999). Verbal working memory and sentence comprehension. *Behavioral and Brain Sciences, 22,* 77–126.

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review, 97,* 404–431.

Case, R., Kurland, D. M., & Goldberg, J. (1982). Operational efficiency and the growth of short-term memory span. *Journal of Experimental Child Psychology, 33,* 386–404.

Cattell, R. B. (1943). The measurement of adult intelligence. *Psychological Bulletin, 40,* 153–193.

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology, 39,* 752–766.

Chaiken, S., & Trope, Y. (1999). *Dual-process theories in social psychology*. New York: Guilford Press.

Chartrand, T. L., & Bargh, J. A. (1996). Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology, 71,* 464–478.

Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: The perception–behavior link and social interaction. *Journal of Personality and Social Psychology, 76,* 893–910.

Chiappe, P., Hasher, L., & Siegel, L. S. (2000). Working memory, inhibitory control, and reading disability. *Memory & Cognition, 28,* 8–17.

Cohen, J. D., Dunbar, K., & McClelland, J. L. (1990). On the control of automatic processes: A parallel distributed processing model of the Stroop effect. *Psychological Review, 97,* 332–361.

Conway, A. R. A., Cowan, N., & Bunting, M. F. (2001). The cocktail party phenomenon revisited: The importance of working memory capacity. *Psychonomic Bulletin & Review, 8,* 331–335.

Conway, A. R. A., Cowan, N., Bunting, M. F., Therriault, D. J., & Minkoff, S. R. B. (2002). A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence. *Intelligence, 30,* 163–184.

Conway, A. R. A., & Engle, R. W. (1994). Working memory and retrieval: A resource-dependent inhibition model. *Journal of Experimental Psychology: General, 123,* 354–373.

Conway, A. R. A., & Engle, R. W. (1996). Individual differences in working memory capacity: More evidence for a general capacity theory. *Memory, 4,* 577–590.

Conway, A. R. A., & Kane, M. J. (2001). Capacity, control and conflict: An individual differences perspective on attentional capture. In C. L. Folk, B. S. Gibson, & S. Bradley (Eds.), *Attraction, distraction and action: Multiple perspectives on attentional capture. Advances in psychology* (pp. 349–372). New York: Elsevier.

Conway, A. R. A., Tuholski, S. W., Shisler, R. J., & Engle, R. W. (1999). The effect of memory load on negative priming: An individual differences investigation. *Memory & Cognition, 27,* 1042–1050.

Cowan, N. (1995). *Attention and memory: An integrated framework*. New York: Oxford University Press.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences, 24,* 87–185.

Daily, L. Z., Lovett, M. C., & Reder, L. M. (2001). Modeling individual differences in working memory performance: A source activation account. *Cognitive Sciences, 25,* 315–353.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19,* 450–466.

Daneman, M., & Carpenter, P. A. (1983). Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 561–584.

Daneman, M., & Green, I. (1986). Individual differences in comprehending and producing words in context. *Journal of Memory and Language, 25,* 1–18.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin & Review, 3,* 422–433.

Dennett, D. C. (1987). *The intentional stance*. Cambridge, MA: MIT Press.

Depret, E., & Fiske, S. (1993). Social cognition and power: Some cognitive consequences of social structure as a source of control deprivation. In G. Weary, F. Gleicher, & K. L. Marsh (Eds.), *Control, motivation and social cognition* (pp. 176–202). New York: Springer-Verlag.

Descartes, R. (1931). *Meditations on first philosophy*: *The Philosophical works of Rene Descartes* (E. S. Haldane & G. R. T. Ross, Trans.). New York: Cambridge University Press. (Original work published 1641)

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56,* 5–18.

Devine, P. G., & Monteith, M. J. (1999). Automaticity and control in stereotyping. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 339–360). New York: Guilford Press.

Dijksterhuis, A., Spears, R., Postmes, T., Stapel, D., Koomen, W., Knippenberg, A., & Scheepers, D. (1999). Seeing one thing and doing another: Contrast effects in automatic behavior. *Journal of Personality and Social Psychology, 75,* 862–871.

Duff, S. C., & Logie, R. H. (2001). Processing and storage in working memory span. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 54,* 31–48.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66,* 183–201.

Egeth, H. E., & Yantis, S. (1997). Visual attention: Control, representation, and time course. *Annual Review of Psychology, 48,* 269–297.

Ekman, P. (1973). *Darwin and facial expression: A century of research in review*. Oxford, England: Academic Press.

Ekman, P. (1992). Are there basic emotions? *Psychological Review, 99,* 550–553.

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983, September 16). Autonomic nervous system activity distinguishes among emotions. *Science, 221,* 1208–1210.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11,* 19–23.

Engle, R. W., Cantor, J., & Carullo, J. J. (1992). Individual differences in working memory and comprehension: A test of four hypotheses. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 972–992.

Engle, R. W., Carullo, J. J., & Collins, K. W. (1991). Individual differences in working memory for comprehension and following directions. *Journal of Educational Research, 84,* 253–262.

Engle, R. W., Kane, M. J., & Tuholski, S. W. (1999). Individual differences in working memory capacity and what they tell us about controlled attention, general fluid intelligence, and functions of the prefrontal cortex. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 102–134). New York: Cambridge University Press.

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory, short-term memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology: General, 128,* 309–331.

Epstein, S. (1998). Cognitive-experiential self-theory: A dual-process personality theory with implications for diagnosis and psychotherapy. In R. F. Bornstein & J. M. Masling (Eds.), *Empirical perspectives on the psychoanalytic unconscious: Vol. 7. Empirical studies of psychoanalytic theories* (pp. 99–140). Washington, DC: American Psychological Association.

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition & Emotion, 15,* 115–141.

Feldman Barrett, L. (1997). The relationships among momentary emotion experiences, personality descriptions, and retrospective ratings of emotion. *Personality and Social Psychology Bulletin, 23,* 1100–1110.

Feldman Barrett, L. (in press). The experience of emotion. In L. Feldman Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotions: Conscious and unconscious*. New York: Guilford Press.

Feldman Barrett, L., Williams, N. L., & Fong, G. T. (2002). Defensive verbal behavior assessment. *Personality and Social Psychology Bulletin, 28,* 776–788.

Felton, B. J., Revenson, T. A., & Hinrichsen, G. A. (1984). Stress and coping in the explanation of adjustment among chronically ill adults. *Social Science in Medicine, 18,* 889–898.

Ferrari, M. D., & Sternberg, R. J. (1998). *Self-awareness: Its nature and development*. New York: Guilford Press.

Fiske, S. T. (1989). Examining the role of intent: Toward understanding its role in stereotyping and prejudice. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 253–283). New York: Guilford Press.

Fiske, S. T., & Neuberg, S. L. (1988). A continuum model of impression formation: From category-based to individuating processes as a function of information, motivation, and attention. *Advances in Experimental Social Psychology, 23,* 1–74.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition*. New York: McGraw-Hill.

Fodor, J. A. (1983). *The modularity of the mind*. Cambridge, MA: Bradford.

Folk, C. L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human Perception and Performance, 18,* 1030–1044.

Folk, C. L., Remington, R. W., & Wright, J. H. (1994). The structure of attentional control: Contingent attentional capture by apparent motion, abrupt onset, and color. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 317–329.

Frenkel-Brunswik, E. (1949). Intolerance of ambiguity as an emotional and perceptual personality variable. *Journal of Personality, 18,* 108–143.

Fussell, S. R., & Kreuz, R. J. (1998). *Social and cognitive approaches to interpersonal communication*. Mahwah, NJ: Erlbaum.

Gallagher, M. (2000). The amygdala and associative learning. In J. P. Aggleton (Ed.), *The amygdala: A functional analysis* (2nd ed., pp. 311–330). Oxford, England: Oxford University Press.

Gilbert, D. T. (1989). Thinking lightly about others: Automatic components of the social inference process. In J. S. Uleman, S. James, & J. A. Bargh (Eds.), *Unintended thought* (pp. 189–211). New York: Guilford Press.

Gilbert, D. T. (1991). How mental systems believe. *American Psychologist, 46,* 107–119.

Gilbert, D. T. (1995). Attribution and interpersonal perception. In A. Tesser (Ed.), *Advanced social psychology* (pp. 126–141). New York: McGraw-Hill.

Gilbert, D. T. (1998). Ordinary personology. In D. T. Gilbert & S. T. Fiske (Eds.), *The handbook of social psychology* (4th ed., Vol. 2, pp. 89–150). New York: McGraw-Hill.

Gilbert, D. T., Pelham, B. W., & Krull, D. S. (1988). On cognitive busyness: When person perceivers meet persons perceived. *Journal of Personality and Social Psychology, 54,* 733–740.

Goldinger, S. D., Kleider, H. M., Azuma, T., & Beike, D. R. (2003). Blaming the victim under memory load. *Psychological Science, 14,* 81–85.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review, 102,* 4–27.

Halford, G. S., Wilson, W. H., & Phillips, S. (1998). Processing capacity defined by relational complexity: Implications for comparative, developmental, and cognitive psychology. *Behavioral and Brain Sciences, 21,* 803–865.

Hambrick, D. Z., & Engle, R. W. (2002). Effects of domain knowledge, working memory capacity, and age on cognitive performance: An investigation of the knowledge-is-power hypothesis. *Cognitive Psychology, 44,* 339–387.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (pp. 193–225). San Diego, CA: Academic Press.

Hass, R. G. (1984). Perspective taking and self-awareness: Drawing an E on your forehead. *Journal of Personality and Social Psychology, 46,* 788–798.

Hastie, R., & Kumar, P. A. (1979). Person memory: Personality traits as organizing principles in memory for behaviors. *Journal of Personality and Social Psychology, 37,* 25–38.

Hastie, R., & Park, B. (1986). The relationship between memory and judgment depends on whether the judgment task is memory-based or on-line. *Psychological Review, 93,* 258–268.

Haugtvedt, C. P., & Petty, R. E. (1992). Personality and persuasion: Need for cognition moderates the persistence and resistance of attitude changes. *Journal of Personality and Social Psychology, 63,* 308–319.

Helmholtz, H. von. (1925). *Treatise on psychological optics* (J. P. C. Southall, Trans.). (3rd ed., Vol. 3). Menasha, WI: Banta. (Original work published 1910)

Hilton, J. L., & von Hippel, W. (1996). Stereotypes. *Annual Review of Psychology, 47,* 237–271.

Holland, P. C., & Gallagher, M. (1999). Amygdala circuitry in attentional and representational processes. *Trends in Cognitive Sciences, 3,* 65–73.

Izard, C. E. (1992). Basic emotions, relations among emotions, and emotion–cognition relations. *Psychological Review, 99,* 561–565.

James, W. (1890). *The principles of psychology*. Oxford, England: Holt.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3–28.

Johnson-Laird, P. N., & Oatley, K. (1989). The language of emotions: An analysis of a semantic field. *Cognition & Emotion, 3,* 81–123.

Jurden, F. H. (1995). Individual differences in working memory and complex cognition. *Journal of Educational Psychology, 87,* 93–102.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99,* 122–149.

Kane, M. J., Bleckley, M. K., Conway, A. R. A., & Engle, R. W. (2001). A controlled-attention view of working-memory capacity. *Journal of Experimental Psychology: General, 130,* 169–183.

Kane, M. J., & Engle, R. W. (2000). Working-memory capacity, proactive interference, and divided attention: Limits on long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 336–358.

Kane, M. J., & Engle, R. W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. *Psychonomic Bulletin & Review, 9,* 637–671.

Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 132,* 47–70.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R.W. (2004). The generality of working-memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General, 133,* 189–217.

Kastner, S., & Ungerleider, L. G. (2000). Mechanisms of visual attention in the human cortex. *Annual Review of Neuroscience, 23,* 315–341.

Kastner, S., & Ungerleider, L. G. (2001). The neural basis of biased competition in human visual cortex. *Neuropsychologia, 39,* 1263–1276.

Kawakami, K., & Dovidio, J. F. (2001). The reliability of implicit stereotyping. *Personality and Social Psychology Bulletin, 27,* 212–225.

Kawakami, K., Young, H., & Dovidio, J. F. (2002). Automatic stereotyping: Category, trait, and behavioral activations. *Personality and Social Psychology Bulletin, 28,* 3–15.

Keefe, T. (1976). Empathy: The critical skill. *Social Work, 21,* 10–14.

Kiewra, K. A., & Benton, S. L. (1988). The relationship between information-processing ability and notetaking. *Contemporary Educational Psychology, 13,* 33–44.

King, J., & Just, M. A. (1991). Individual differences in syntactic processing: The role of working memory. *Journal of Memory and Language, 30,* 580–602.

Klein, K., & Boals, A. (2001). The relationship of life event stress and working memory capacity. *Applied Cognitive Psychology, 15,* 565–579.

Klohnen, E. C. (1996). Conceptual analysis and measurement of the construct of ego-resiliency. *Journal of Personality and Social Psychology, 70,* 1067–1079.

Krauss, R. M., & Fussell, S. R. (1996). Social psychological models of interpersonal communication. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 655–701). New York: Guilford Press.

Krohne, H. W. (1986). Coping with stress: Dispositions, strategies, and the problem of measurement. In M. H. Appley & R. Trumbull (Eds.), *Dynamics of stress: Physiological, psychological, and social perspectives* (pp. 207–232). New York: Plenum Press.

Kyllonen, P. C. (1996). Is working memory capacity Spearman's *g*? In I. Dennis & P. Tapsfield (Eds.), *Human abilities: Their nature and measurement* (pp. 49–75). Hillsdale, NJ: Erlbaum.

Kyllonen, P. C., & Christal, R. E. (1990). Reasoning ability is (little more than) working-memory capacity? *Intelligence, 14,* 389–433.

Kyllonen, P. C., & Stephens, D. L. (1990). Cognitive abilities as determinants of success in acquiring logic skill. *Learning and Individual Differences, 2,* 129–160.

LaBerge, D. (1998). Attention as the intensification of cortical activity. *Revue de Neuropsychologie, 8,* 53–81.

LaBerge, D. (2000). Networks of attention. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (2nd ed., pp. 711–724). Cambridge, MA: MIT Press.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer Publishing.

LeDoux, J. E. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon & Schuster.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23,* 155–184.

Lee-Sammons, W. H., & Whitney, P. (1991). Reading perspectives and memory for text: An individual differences analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 1074–1081.

Levenson, R. W., Carstensen, L. L., Friesen, W. V., & Ekman, P. (1991). Emotion, physiology, and expression in old age. *Psychology and Aging, 28*–35.

Levenson, R. W., Ekman, P., & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27,* 363–384.

Luck, S. J., & Hillyard, S. A. (2000). The operation of selective attention at multiple stages of processing: Evidence from human and monkey electrophysiology. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (2nd ed., pp. 687–710). Cambridge, MA: MIT Press.

MacDonald, M. C., & Christiansen, M. H. (2002). Reassessing working memory: Comment on Just and Carpenter (1992) and Waters and Caplan (1996). *Psychological Review, 109,* 35–54.

MacDonald, M. C., Just, M. A., & Carpenter, P. A. (1992). Working memory constraints on the processing of syntactic ambiguity. *Cognitive Psychology, 24,* 56–98.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology, 51,* 93–120.

Macrae, C. N., Bodenhausen, G. V., Schloerscheidt, A. M., & Milne, A. B. (1999). Tales of the unexpected: Executive function and person perception. *Journal of Personality and Social Psychology, 76,* 200–213.

Mathews, A., & MacLeod, C. (1994). Cognitive approaches to emotion and emotional disorders. *Annual Review of Psychology, 45,* 25–50.

Matthews, G., & Wells, A. (1999). The cognitive science of attention and emotion. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 171–192). New York: Wiley.

McConnell, A. R., Sherman, S. J., & Hamilton, D. L. (1994). On-line and memory-based aspects of individual and group target judgments. *Journal of Personality and Social Psychology, 67,* 173–185.

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106,* 3–19.

Milburn, T. W., & Watman, K. H. (1981). *On the nature of threat: A social psychological analysis*. New York: Praeger.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24,* 167–202.

Miyake, A. (2001). Individual differences in working memory: Introduction to the special section. *Journal of Experimental Psychology: General, 130,* 163–168.

Miyake, A., & Shah, P. (1999). *Models of working memory*: *Mechanisms of active maintenance and executive control*. New York: Cambridge University Press.

Mizoguchi, K., Yuzurihara, M., Ishige, A., Sasaki, H., Chui, D., & Tabira, T. (2000). Chronic stress induces impairment of spatial working memory because of prefrontal dopaminergic dysfunction. *Journal of Neuroscience, 20,* 1568–1574.

Monsell, S., & Driver, J. (2000). *Control of cognitive processes: Attention and performance*. Cambridge, MA: MIT Press.

Monteith, M. J., Sherman, J. W., & Devine, P. G. (1998). Suppression as a stereotype control strategy. *Personality and Social Psychology Review, 2,* 63–82.

Morgan, M. A., Romanski, L. M., & LeDoux, J. E. (1993). Extinction of emotional learning: Contribution of medial prefrontal cortex. *Neuroscience Letters, 163,* 109–113.

Moskowitz, G. B., Gollwitzer, P. M., Wasel, W., & Schaal, B. (1999). Preconscious control of stereotype activation through chronic egalitarian goals. *Journal of Personality and Social Psychology, 77,* 167–184.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126,* 247–259.

Nelson, J. B., & Bouton, M. E. (2002). Extinction, inhibition, and emotional intelligence. In L. Feldman Barrett & P. Salovey (Eds.), *The wisdom of feeling*. New York: Guilford Press.

Newell, A. (1980). Reasoning, problem solving and decision process: The problem space as a fundamental category. In R. Nickerson (Ed.), *Inter-*

*national Symposium on Attention and Performance 8* (pp. 693–719). Princeton, NJ: Erlbaum.

Niedenthal, P. M., Barsalou, L. W., Ric, R., & Krauth-Gruber, S. (in press). Embodiment in the acquisition and use of emotion knowledge. In L. Feldman Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotions: Conscious and unconscious*. New York: Guilford Press.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84,* 231–259.

Norman, D., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. Davidson, R. G. Schwartz, & D. Shapiro (Eds.), *Consciousness and self-regulation: Advances in research and theory* (pp. 1–18). New York: Plenum Press.

O'Reilly, R. C., Braver, T. S., & Cohen, J. D. (1999). A biologically-based computational model of working memory. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 102–134). Cambridge, England: Cambridge University Press.

Ormrod, J. E., & Cochran, K. F. (1998). Relationship of verbal ability and working memory to spelling achievement and learning to spell. *Reading Research & Instruction, 28,* 33–43.

Oschner, K. N., & Feldman Barrett, L. (2001). A multiprocess perspective on the neuroscience of emotion. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Current issues and future directions. Emotions and social behavior* (pp. 38–81). New York: Guilford Press.

Panksepp, J. (1982). Toward a general psychobiological theory of emotions. *Behavioral and Brain Sciences, 5,* 407–467.

Panksepp, J. (1986). The neurochemistry of behavior. *Annual Review of Psychology, 37,* 77–107.

Panksepp, J. (2000). Emotion as natural kinds within the mammalian brain. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 137–156). New York: Guilford Press.

Pashler, H., Johnston, J., & Ruthruff, E. (2001). Attention and performance. *Annual Review of Psychology, 52,* 629–651.

Petty, R. E., Brinol, P., & Tormala, Z. L. (2002). Thought confidence as a determinant of persuasion: The self-validation hypothesis. *Journal of Personality and Social Psychology, 82,* 722–741.

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration-likelihood model of persuasion. *Advances in Experimental Social Psychology, 19,* 123–205.

Plant, E. A., & Devine, P. G. (2001). Responses to other-imposed pro-Black pressure: Acceptance or backlash? *Journal of Experimental Social Psychology, 37,* 486–501.

Popper, K. R. (1968). *The logic of scientific discovery*. New York: Harper & Row.

Posner, M. I., & DiGirolamo, G. J. (2000). Cognitive neuroscience: Origins and promise. *Psychological Bulletin, 126,* 873–889.

Posner, M. I., & Peterson, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13,* 25–42.

Pratt, M. W., Boyes, C., Robins, S., & Manchester, J. (1989). Telling tales: Aging, working memory, and the narrative cohesion of story retellings. *Developmental Psychology, 25,* 628–635.

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61,* 380–391.

Quigley, K. S., & Feldman Barrett, L. (1999). Emotional learning and mechanisms of intentional psychological change. In J. Brandtstadter & R. M. Lerner (Eds.), *Action and development: Origins and functions of intentional self-development* (pp. 435–464). Thousand Oaks, CA: Sage.

Quirk, G. J., Repa, J. C., & LeDoux, J. E. (1995). Fear conditioning enhances short-latency auditory responses of lateral amygdala neurons: Parallel recordings in the freely behaving rat. *Neuron, 15,* 1029–1039.

Quirk, G. J., Russo, G. K., Barron, J. L., & Leron, K. (2000). The role of ventromedial prefrontal cortex in the recovery of extinguished fear. *Journal of Neuroscience, 20,* 6225–6231.

Radvansky, G. A., & Copeland, D. E. (2001). Working memory and situational model updating. *Memory & Cognition, 29,* 1073–1080.

Reichenbach, H. (1947). *Elements of symbolic logic*. New York: Macmillan.

Robinson, M. D., & Clore, G. L. (2002). Episodic and semantic knowledge in emotional self-report: Evidence for two judgment processes. *Journal of Personality and Social Psychology, 83,* 198–215.

Rosen, V. M., & Engle, R. W. (1997). The role of working memory capacity in retrieval. *Journal of Experimental Psychology: General, 126,* 211–227.

Rosen, V. M., & Engle, R. W. (1998). Working memory capacity and suppression. *Journal of Memory and Language, 39,* 418–436.

Ross, M. (1989). The relation of implicit theories to the construction of personal histories. *Psychological Review, 96,* 341–357.

Rothbart, M. K., & Bates, J. E. (1998). Temperament. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology* (Vol. 3, pp. 105–176). New York: Wiley.

Rothbart, M., & Derryberry, D. (1981). Development of individual differences in infant temperament. In M. Lamb & A. Brown (Eds.), *Advances in developmental psychology* (Vol. 1, pp. 37–87). Hillsdale, NJ: Erlbaum.

Rudman, L. A., & Lee, M. R. (2002). Implicit and explicit consequences of exposure to violent and misogynous rap music. *Group Processes & Intergroup Relations, 5,* 133–150.

Rukavina, I., & Daneman, M. (1996). Integration and its effect on acquiring knowledge about competing scientific theories for text. *Journal of Educational Psychology, 88,* 272–287.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110,* 145–172.

Russell, J. A., Bachorowski, J., & Fernández-Dols, J. (2003). Facial and vocal expressions of emotion. *Annual Review of Psychology, 54,* 329–349.

Salthouse, T. A., & Babcock, R. L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology, 27,* 763–776.

Sanghera, M. K., Rolls, E. T., & Roper-Hall, A. (1979). Visual responses of neurons in the dorsolateral amygdala of the alert monkey. *Experimental Neurology, 63,* 610–626.

Schacter, D. L. (1996). *Searching for memory: The brain, the mind, and the past*. New York: Basic Books.

Schneider, W., & Detweiller, M. (1987). A connectionist/control architecture for working memory. In G. Bower (Ed.), *The psychology of learning and motivation: Vol. 21. Advances in research and theory* (pp. 54–119). New York: Academic Press.

Schober, M. F. (1998). Different kinds of conversational perspective-taking. In S. R. Fussell & R. J. Kreuz (Eds.), *Social and cognitive approaches to interpersonal communication* (pp. 145–174). Mahwah, NJ: Erlbaum.

Schunn, C. D., & Reder, L. M. (2001). Another source of individual differences: Strategy adaptivity to changing rates of success. *Journal of Experimental Psychology: General, 130,* 59–76.

Shah, P., & Miyake, A. (1996). The separability of working memory resources for spatial thinking and language processing: An individual differences approach. *Journal of Experimental Psychology: General, 125,* 4–27.

Sherman, J. W., Lee, A.Y., Bessenoff, G. R., & Frost, L. A. (1998). Stereotype efficiency reconsidered: Encoding flexibility under cognitive load. *Journal of Personality and Social Psychology, 75,* 589–606.

Shiffrin, R. M. (1988). Attention. In R. C. Atkinson, R. J. Herrnstein, G. Lindzey, & D. Luce (Eds.), *Stevens' handbook of experimental psychology: Vol. 2. Learning and cognition* (pp. 739–811). Oxford, England: Wiley.

Shilling, V. M., Chetwynd, A., & Rabbitt, P. M. A. (2002). Individual inconsistency across measures of inhibition: An investigation of the construct validity of inhibition in older adults. *Neuropsychologia, 40,* 605–619.

Singer, M., Andrusiak, P., Reisdorf, P., & Black, N. L. (1992). Individual differences in bridging inference processes. *Memory & Cognition, 20,* 539–548.

Singer, M., & Ritchot, K. F. M. (1996). The role of working memory capacity and knowledge access in text inference processing. *Memory & Cognition, 24,* 733–743.

Smith, E. E., & Jonides, J. (1997a, February 19). Storage and executive processes in frontal lobes. *Science, 283,* 1657–1661.

Smith, E. E., & Jonides, J. (1997b). Working memory: A view from neuroimaging. *Cognitive Psychology, 33,* 5–42.

Smith, E. R. (1998). Mental representation and memory. In D. T. Gilbert & S. E. Taylor (Eds.), *The handbook of social psychology* (4th ed., Vol. 2, pp. 391–445). New York: McGraw-Hill.

Smith, E. R., & DeCoster, J. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Personality and Social Psychology Review, 4,* 108–131.

Smith, E. R., & Zárate, M. A. (1992). Exemplar-based model of social judgment. *Psychological Review, 99,* 3–21.

Spencer, S. J., Fein, S., Wolfe, C. T., Fong, C., & Dunn, M. A. (1998). Automatic activation of stereotypes: The role of self-image threat. *Personality and Social Psychology Bulletin, 24,* 1139–1152.

Srull, T. K., & Wyer, R. S. (1989). Person memory and judgment. *Psychological Review, 96,* 58–83.

Taylor, S. E. (1981). A categorization approach to stereotyping. In D. L. Hamilton (Ed.), *Cognitive processes in stereotyping and intergroup behavior* (pp. 83–114). Hillsdale, NJ: Erlbaum.

Teasdale, J. D. (1999). Multi-level theories of cognition–emotion relations. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 665–681). Chichester, England: Wiley.

Tomkins, S. S. (1962). *Affect, imagery, consciousness: Vol. 1. The positive affects.* New York: Springer Publishing.

Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environment. *Ethology and Sociobiology, 11,* 375–424.

Towse, J. N., Hitch, G. J., & Hutton, U. (2000). On the interpretation of working memory span in adults. *Memory & Cognition, 28,* 341–348.

Trope, Y. (1986). Identification and inferential processes in dispositional attribution. *Psychological Review, 93,* 239–257.

Trope, Y., & Gaunt, R. (2000). Processing alternative explanations of behavior: Correction or integration? *Journal of Personality and Social Psychology, 79,* 344–354.

Tuholski, S. W., Engle, R. W., & Baylis, G. C. (2001). Individual differences in working memory capacity and enumeration. *Memory & Cognition, 29,* 484–492.

Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language, 28,* 127–154.

Uleman, J. S., Newman, L. S., & Moskowitz, G. B. (1996). People as flexible interpreters: Evidence and issues from spontaneous trait inference. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 28, pp. 211–279). San Diego, CA: Academic Press.

van Reekum, C. M., & Scherer, K. R. (1997). Levels of processing for emotion-antecedent appraisal. In G. Matthews (Ed.), *Cognitive science perspectives on personality and emotion* (pp. 259–300). Amsterdam: Elsevier.

von Hippel, W., Silver, L. A., & Lynch, M. E. (2000). Stereotyping against your will: The role of inhibitory ability in stereotyping and prejudice among the elderly. *Personality and Social Psychology Bulletin, 26,* 523–532.

Waters, G. S., & Caplan, D. (1996). The capacity theory of sentence comprehension: Critique of Just and Carpenter (1992). *Psychological Review, 103,* 761–772.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review, 101,* 34–52.

Wegner, D. M. (2002). *The illusion of conscious will.* Cambridge, MA: MIT Press.

Wegner, D. M., & Bargh, J. A. (1998). Control and automaticity in social life. In D. T. Gilbert & S. E. Fiske (Eds.), *The handbook of social psychology* (4th ed., Vol. 2, pp. 446–496). New York: McGraw-Hill.

Wenzlaff, R. M., Rude, S. S., & West, L. M. (2002). Cognitive vulnerability to depression: The role of thought suppression and attitude certainty. *Cognition & Emotion, 16,* 533–548.

Wenzlaff, R. M., & Wegner, D. M. (2000). Thought suppression. *Annual Review of Psychology, 51,* 59–91.

Whewell, W. (1971). *On the philosophy of discovery.* New York: Franklin. (Original work published 1860)

Whitney, P., Ritchie, B. G., & Clark, M. B. (1991). Working-memory capacity and the use of elaborative inferences in text comprehension. *Discourse Processes, 14,* 133–145.

Wilson, T. D., & Brekke, N. (1994). Mental contamination and mental correction: Unwanted influences on judgments and evaluations. *Psychological Bulletin, 116,* 117–142.

Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological Review, 107,* 101–126.

Wilson, T. D., & Schooler, J. W. (1991). Thinking too much: Introspection can reduce the quality of preferences and decisions. *Journal of Personality and Social Psychology, 60,* 181–192.

Wittenbrink, B., Judd, C. M., & Park, B. (1997). Evidence for racial prejudice at the implicit level and its relationship with questionnaire measures. *Journal of Personality and Social Psychology, 72,* 262–274.

Zárate, M. A., Sanders, J. D., & Garza, A. A. (2000). Neurological disassociations of social perception processes. *Social Cognition, 18,* 223–251.

Received February 3, 2003
Revision received October 27, 2003
Accepted October 28, 2003 ■