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CHAPTER 22

Intelligence and the Cognitive Unconscious

Scott Barry Kaufman

The definition of genius is that it acts unconsciously; and those who have produced immortal works, have done so without knowing how or why. The greatest power operates unseen, and executes its appointed task with as little ostentation as difficulty.

– *William Hazlitt*[1]

Intelligence tests were originally created with the practical goal of identifying students in need of alternative education (Binet & Simon, 1916). Because intelligence tests were originally devised to predict school grades, the items were intentionally designed to measure a general ability to profit from explicit instruction, concentrate on a task, and engage in intellectual material. Indeed, research shows that such a general ability does seem to exist. Over a century ago, Spearman (1904) discovered that when a wide range of cognitive tests that have explicit instructions and require effortful concentration is administered to a diverse group of people, all of the tests tend to be positively correlated with one another, a finding often referred to as a "positive manifold." Spearman labeled the factor on which all individual tests loaded *g*, for general intelligence.

Over the past 100 years, the existence of *g* as a statistical phenomenon is one of the most replicable findings in all of psychology (Carroll, 1993; Chabris, 2007; Jensen, 1998). Nonetheless, there is still work to be done to determine what explains the positive manifold (see Maas et al., 2006), the cognitive mechanisms that support *g* (see Chapter 20, Working Memory and Intelligence, this volume; Kaufman, DeYoung, Gray, Brown, & Mackintosh, 2009; Sternberg & Pretz, 2005), and whether there are other forms of cognition that display meaningful individual differences and predict intelligent behavior above and beyond *g* and the cognitive mechanisms that support *g*.

This chapter presents evidence that mechanisms relating to the *cognitive unconscious* – "mental structures, processes, and

[1] William Hazlitt (1846), "Essay IV. Whether Genius Is Conscious of Its Powers?" in *Table Talk: Opinions on Books, Men, and Things*, Second Series, Part I (pp. 37–49). New York, NY: Wiley & Putnam.

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states[2] that can influence experience, thought, and actions outside phenomenal awareness and voluntary control" (Dorfman, Shames, & Kihlstrom, 1996, p. 259) also make an important contribution to intelligent behavior. Although intelligence testers have done a remarkable job developing tests that measure individual differences in explicit, controlled cognitive processes, the investigation of individual differences in implicit, nonconscious processes has not received nearly as much attention (Kaufman, 2009a, b).

Furthermore, researchers have created clever experiments to probe the nature of the cognitive unconscious by looking at implicit memory, implicit perception, and other forms of implicit cognition and thought[3] (for reviews, see Kihlstrom, 1987, and Litman & Reber, 2005), but they have focused primarily on group-level data, ignoring individual differences (see Cronbach, 1957). Additionally, some researchers have downplayed the existence of continuous individual differences in the cognitive unconscious that are meaningfully related to important life outcomes (Reber, 1993; Stanovich, 2009).

There have been some recent studies, however, that look at *individual differences* in the cognitive unconscious. This chapter focuses on individual differences and reviews recent empirical work on relations among the cognitive processes underlying psychometric intelligence and the cognitive processes underlying the cognitive unconscious, attempting to bridge two major research programs that, until recently, have traveled on separate but parallel paths.

Integrating Two Research Traditions

The 20th century witnessed at least two major paradigm shifts within psychological science. One major shift was from behaviorism to the "cognitive revolution," which brought along with it a shift in focus from learning and conditioning toward investigating the mental processes involved in conscious thought, including memory, thinking, and problem solving (Miller, 2003). This shift has had an enduring effect on conceptualizations of human intelligence as well as research methodology. Indeed, one of the earliest investigators of the development of intelligence in children was Jean Piaget (1952), whose focus was on conscious higher order reasoning and how children at different ages think. This emphasis on age differences in thought as well as the notion that intelligence involves conscious, deliberate reasoning also underlies the logic behind the first widely administered intelligence test, the Binet-Simon Scale (Binet & Simon, 1916). Furthermore, the discovery that performances on diverse tests of explicit cognitive ability tend to correlate with one another – Spearman's (1904) so-called positive manifold – further supported the idea that intelligence tests are tapping into a "general cognitive ability."

Around the same time the shift from behaviorism to the cognitive revolution was taking place, another dramatic shift in psychology was occurring. The conceptualization of the unconscious that was predominant with psychodynamic theories of personality was slowly being transformed into an unconscious recognized to serve many adaptive functions among both modern-day humans and our evolutionary ancestry (Epstein, 1991; Hassin, Uleman, & Bargh, 2005; Wilson, 2004). Over 30 years of research in cognitive science reveals that a considerable amount of information processing takes place on a daily basis automatically – without our intent, awareness, and deliberate encoding – and plays an important role in structuring our skills, perceptions, and behavior (Epstein, 1991; Hassin et al., 2005; Kihlstrom, 1987; Lewicki & Hill,

[2] I include "implicit thought" in this definition as well, although Kihlstrom tends to refer to "implicit cognition" differently from the "cognitive unconscious" (Dorfman, Shames, & Kihlstrom, 1996).

[3] I assume in this chapter that intelligent "thought" can operate either with or without awareness of that thought. As Dorfman, Shames, and Kihlstrom (1996) astutely note, the idea of "implicit thought" is a difficult concept because the notion of thinking has traditionally been equated with notions of consciousness. For instance, William James (1890) thought the notion of "unconscious thought" was a contradiction in terms!

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1987; Reber, 1993; Stadler & Frensch, 1997) as well as facilitating problem solving and creativity (Dijksterhuis & Nordgren, 2006; Dorfman, Shames, & Kihlstrom, 1996; Litman & Reber, 2005).

Kihlstrom (1987) distinguishes between three types of nonconscious mental structures that together constitute the domain of the "cognitive unconscious." *Unconscious* representations fit within the domain of procedural knowledge and are inaccessible to introspection under any circumstances. "By virtue of routinization (or perhaps because they are innate), such procedures operate on declarative knowledge without either conscious intent or conscious awareness, in order to construct the person's ongoing experience, thought, and action" (p. 1450; also see Anderson, 1982). Subliminal perception, implicit memory, and implicit learning fit the category of *preconscious* declarative knowledge structures. In contrast to unconscious representations, preconscious structures can be available to phenomenal awareness and can be introspected upon, but they can also influence ongoing experience, thought, and action without ever entering into working memory. Finally, Kihlstrom describes *subconscious* declarative knowledge mental representations such as those activated during hypnosis, which can be quite available to introspection but inaccessible to phenomenal awareness.[4]

Note that even though some nonconscious representations have such high levels of activation that they enter working memory, they still might not meet the criteria of conscious awareness. As noted by Kihlstrom, William James (1890) suggested over a century ago in his *Principles of Psychology* that the key to consciousness is *self-reference*:

> *In order for ongoing experience, thought, and action to become conscious, a link must be made between its mental representation and some mental representation of the self as agent or experiencer – as well, perhaps, as some representation of the environment in which these events take place. These episodic representations of the self and context reside in working memory, but apparently the links in question are neither automatic nor permanent, and must be actively forged . . . without such linkages certain aspects of mental life are dissociated from awareness, and are not accompanied by the experience of consciousness. (Kihlstrom, 1987, p. 1451)*

A great deal of research has demonstrated the sophisticated and intelligent nature of the cognitive unconscious (Epstein, 2001; Lewicki, Hill, & Czyzewska, 1992; Loftus & Klinger, 1992). For instance, after reviewing the literature on the nonconscious acquisition of information, Lewicki, Hill, and Czyzewska (1992) asked, "Is the nonconscious information-processing system 'intelligent'?" – to which they concluded:

> *The answer to the question about intelligence would be affirmative if intelligence is understood as "equipped to efficiently process complex information." In this sense, our nonconscious information-processing system appears to be incomparably more able to process formally complex knowledge structures, faster and "smarter" overall than our ability to think and identify meanings of stimuli in a consciously controlled manner. (p. 801)*

The idea that the unconscious can be smart is also illustrated by the title of a recent popular summary of the fast-and-frugal heuristics literature: *Gut Feelings: The Intelligence of the Unconscious* (Gigerenzer, 2007).[5] Today there is a strong consensus

4 Note that only Kihlstrom's (1987) notion of "unconscious" mental structures meets all four of Bargh's (2004) horsemen of automaticity: lack of awareness, lack of intention, high efficiency, and inability to control. Kihlstrom's notion of the preconscious lacks intention, but only under some circumstances is efficient, lacks awareness, and can't be controlled. Kihlstrom's notion of the subconscious can be intentional and efficient, and even can be controlled, but the key to defining the subconscious according to Kihlstrom is the lack of phenomenal awareness.

5 But note that Gigerenzer (2007; Gigerenzer & Brighton, 2009), in contrast to those who view the cognitive unconscious as able to process complex information, views the cognitive unconscious as operating by the principle "less is more," selecting the right rule of thumb for the right situation.

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among contemporary researchers in cognitive science, philosophy, cognitive psychology, social psychology, reasoning, and morality that humans possess two quite distinct modes of thought – one controlled and the other more automatic (Epstein, 2003; Evans & Frankish, 2009; Stanovich & West, 2002). Indeed, dual-process theories of cognition are becoming increasingly necessary for explaining a wide variety of cognitive, personality, social developmental, and cross-cultural phenomena (Evans & Frankish, 2009). For instance, Klaczynski (2009) makes a case for adopting and developing a comprehensive dual-process theory of development, reviewing studies from such diverse research topics as memory, judgments and decisions, reasoning, motivated reasoning, stereotypes, and magical reasoning to support his argument.

Dual-Process Theories of Cognition

Type 1 processes[6] are thought to comprise a set of autonomous subsystems (Stanovich, 2004) that include both innate input modules (Fodor, 1983) and domain-specific knowledge acquired by domain-general learning mechanisms that operate automatically and efficiently (Reber, 1993). Type 1 processes process information fast (relative to type 2 processes); are heavily influenced by context, biology, and past experience; and aid humans in mapping and assimilating newly acquired stimuli into preexisting knowledge structures.

An advantage of type 1 processes over type 2 processes is that the former require little conscious cognitive effort and free attentional resources for computationally complex reasoning. According to Lewicki, Hill, and Czyzewska (1992),

> *Data indicate that as compared with consciously controlled cognition, the nonconscious information-acquisition processes are not only much faster but are also structurally more sophisticated, in that they are capable of efficient processing of multidimensional and interactive relations between variables. Those mechanisms of non-conscious acquisition of information provide a major channel for the development of procedural knowledge that is indispensable for such important aspects of cognitive functioning as encoding and interpretation of stimuli and the triggering of emotional reactions. (p. 796)*

The advantages of type 1 processes can also become disadvantages under certain circumstances. When thinking is dominated by type 1 processes, task representations are highly contextualized. This contextualization can lead to the thoughtless application of judgment and decision heuristics. According to Stanovich and West (2000), this mode of thought is in fact the "default" mode in humans. They refer to this tendency toward automatic contextualization of problems as the "fundamental computational bias" in human cognition (Stanovich & West, 2000). A similar idea can be found in Chaiken's (1987) heuristic systematic model of persuasion, according to which people are guided in part by a "principle of least effort." Because people have limited cognitive resources, and because heuristic processing is easy and adequate for most tasks, heuristic processing from type 1 is generally used unless there is a special need to engage in systematic processing (see also Simon, 1979). In line with this idea, Klaczynski and Cottrell (2004) have argued that "metacognitive intercession" often occurs, whereby responses derived from intuition are available in working memory, where reflection is possible. However, according to Klaczynski, most people do not take advantage of the opportunity to reflect on the contents of working memory, taking the contents from the experiential system as self-evidently valid. Finally, the view of type 1 processes as the default mode of human cognition is also present in Haidt's (2001)

[6] Many dual-process theorists refer to two "systems" (see Kahneman & Frederick, 2002). In recent years, however, critics of dual-system theorists have called for the use of a different name, arguing that "system" carries with it a lot of conceptual baggage (see Evans, 2008; Keren & Schul, 2009). In line with Evans's (2008) suggestion, I refer here to "types" of thought processes instead of "systems."

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social intuitionist model of moral reasoning, in which it is posited that intuitive processing is the default process, with deliberate reasoning called upon only when intuitions conflict with reason (see also Stanovich & West, 2000).

In contrast, *type 2 processes* are typically characterized by deliberately controlled, effortful, and intentional cognition. Individual differences in this system have been linked in the past to psychometric intelligence (see Stanovich, 2009). According to Stanovich and West (1997), a hallmark of this type of thought is the ability to decontextualize task representations.[7] Type 2 processes can deal with abstract content under conditions of awareness[8] and are not dominated by the goal of attributing intentionality nor by the search for conversational relevance (Margolis, 1987). It has been posited that type 2 processes are evolutionarily more recent and uniquely developed in humans than type 1 processes (Epstein, 2003; Evans, 2008; Gabora & Kaufman, 2009).

Note that while some aspects are common across most dual-process theories, there are also distinct differences (Evans, 2008). Most dual-process theorists agree on the automatic/controlled distinction between the two modes of thought, as well as the idea that type 2 processes are constrained by a central working memory system whereas type 1 processes are unconstrained by a central pool of resources. Dual-process theorists differ, however, in terms of other features they attribute to the two modes of thought. For instance, some dual-process theorists emphasize the affective nature of type 1 processes (Epstein, 1994; Metcalfe & Mischel, 1999; Zajonc, 1980), whereas emotions are not a key component of other models of implicit cognition (e.g., Reber, 1993).

Also, as Evans (2008) rightly points out, some of the distinctions between the two modes of thought (e.g., abstract vs. contextualized, associative vs. rule-based, shared with other animals vs. unique to humans) are not as neat and clear-cut when one considers that type 1 isn't a unitary system, but includes a set of autonomous systems, some of which are innately specified and some of which come about through learning and practice (Stanovich, 2004; but see Epstein, 2010). Evans (2008) also points out that "type 2" is most likely not a unitary system, suggesting that not all type 2 processes are consciously controlled. Additionally, Cokely and Kelley (2009) and Cokely, Parpart, and Schooler (2009) have noted that even controlled processes may rely on automatic processes for processing, even at the stage of early attentional selection. Other criticisms (see Aczel, 2009; Gigerenzer & Regier, 1996; Keren & Schul, 2009) have been leveled against dual-system models, a sign that the study of the dual-process nature of the mind is an active area of research and debate. In line with these criticisms, the remainder of this chapter will refer to "dual-process" theories instead of "dual-system" theories and will assume that the various processes are not completely independent but can interact with each other and facilitate (or inhibit) each other in important ways.

Indeed, in his review of dual-process accounts of reasoning, judgment, and social cognition, Evans (2008) notes two distinct kinds of dual-process theories. One kind, which he refers to as "parallel-competitive" forms of dual-process theory, states that there are two forms of learning that lead to two forms of knowledge (explicit and implicit) and each form competes for the control of behavior. Evans refers to another category of dual-process researchers as the "default-interventionists," who assume that rapid preconscious processes supply content for conscious processing and that the explicit system can intervene with the application of controlled processes. It should be noted that not all dual-process theories fall neatly into one category or the other. For instance, Epstein (2003) assumes that the two systems operate in parallel and are bi-directionally

7 Although note that this system can also deal with contextualized content (see Cokely & Kelley, 2009; Cokely, Parpart, & Schooler, 2009).

8 Although note that some researchers have argued that aspects of System 1 (e.g., implicit learning) can also deal with abstract material (see Reber, 1989).

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interactive. As the implicit system has a faster reaction time it is more likely to initiate an action sequence. Nonetheless, Evans (2008) does offer a useful classification of different dual-process theories.

There is evidence for both categories; fMRI evidence suggests that the type of processes are independent – under processing conditions that favor automatic processing, automatic cognitive processes and the brain regions supporting those processes are more active than the brain regions supporting controlled cognition. Conversely, under conditions that favor controlled processing, controlled cognitive processes and the brain regions supporting those processes (such as the dorsolateral prefrontal cortex) are more active than the brain regions supporting automatic cognitive processes (Lieberman, 2007).

There is also support for the default-interventionists' view in that humans on average have a tendency to contextualize information (i.e., automatic cognition is the default mode in most humans) and that in some instances it is important for controlled cognition to reflect on that contextualization and potentially override the outputs of automatic cognition (Kahneman & Frederick, 2002; Chapter 22, Intelligence and Rationality, this volume). Nonetheless, in some situations the output of the automatic system is beneficial for intelligent behavior, and controlled cognition is not necessary, or can even get in the way.

Interestingly, a number of neuroimaging studies in humans and lesion studies on rodents have found that the basal ganglia and medial temporal lobe (mTL) function competitively (Packard, Hirsh, & White, 1989; Poldrack & Packard, 2003). In an interesting study, Packard, Hirsh, and White (1989) found that rats with basal ganglia lesions performed better than normal rats on an mTL-specific task, and rats with mTL lesions performed better than normal on the basal ganglia–specific task. These results suggest that the presence of a normally functioning medial temporal lobe may interfere with performance on tasks that strongly recruit basal ganglia functions, and performance is thus improved on these tasks when the medial temporal lobe is removed (Lieberman, 2007).

Therefore, intelligence and the cognitive unconscious mostly work in concert with each other during our daily lives, but in some situations they may be competitive – and depending on the situation, either controlled or spontaneous cognitions will be the more important contributor to intelligent behavior.

Interestingly, while various dual-process theories of *cognition* have been proposed over the years, only two are explicitly theories of *human intelligence*. Below I will review both: Anderson's (M. Anderson, 2005) *theory of the minimal cognitive architecture underlying intelligence and development* and the recent *dual-process (DP) theory of human intelligence* (Kaufman, 2009a).

The Theory of the Minimal Cognitive Architecture underlying Intelligence and Development

Based on Fodor's (1983) distinction between central processes of thought and dedicated processing input modules, Anderson's (2005) theory synthesizes the idea of general and specific abilities and incorporates the notion of development. Anderson argues that knowledge is acquired through two different "processing routes," with central processes (route 1) being tied to individual differences and input modules being tied to cognitive development (route 2). According to Anderson, route 1 involves "thoughtful problem solving" and is constrained by the speed of a basic processing mechanism. Anderson argues that "it is this constraint that is the basis of general intelligence and the reason why manifest specific abilities are correlated" (p. 280). Anderson's basic processing mechanism comprises both a verbal and a spatial processor that are normally distributed, uncorrelated with each other, and each having their own predictive powers.

In contrast, the second route for acquiring knowledge in Anderson's model is tied to

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dedicated information-processing modules, such as perception of three-dimensional space, syntactic parsing, phonological encoding, and theory of mind. According to Anderson, this route is tied to cognitive development as these modules undergo developmental changes in cognitive competence across the life span. Anderson acknowledges that modular processes can be acquired through extensive practice, but both are similar in that they operate automatically and independently of the first route and are therefore unconstrained by the speed of the basic processing mechanism.

Anderson makes the case that the modular component of his cognitive theory allows for an integration of Gardner's "multiple intelligences" and "general intelligence," as the theory includes domain-specific modular functions as well as a basic processing mechanism. Anderson also argues that his theory explains how low-IQ individuals can be capable of remarkable cognitive feats (e.g., "savant" abilities), including various practical skills, such as the ability to acquire language or see in three dimensions that are considerably more computationally complex than the abilities that are tapped by IQ tests. Anderson argues that his theory also can explain how developmental disabilities such as dyslexia and autism can exist in the presence of typical or even above-average IQ (Anderson, 2008).

Note that in Anderson's model there is little room for individual differences in route 2. Furthermore, Anderson does not propose any domain general learning mechanisms that are part of route 2, focusing instead on the Fodorian definition of modules. By limiting the cognitive mechanisms associated with each "route," the total amount of other research that could be brought to bear on the cognitive processes underlying the two information-processing routes becomes unnecessarily restricted. Nonetheless, Anderson's model makes an important contribution to investigation of intelligence by expanding modes of thought and incorporating development.

Dual-Process (DP) Theory of Human Intelligence

The dual-process theory of human intelligence aims to integrate modern dual-process theories of cognition (e.g., Evans & Frankish, 2009) with research on intelligence (Kaufman, 2009a). The theory is an organizing framework for various constructs relating to human cognition that are at least partially separable and display individual differences that are meaningfully related to a wide range of socially valued intelligent behaviors. A main goal of the theory is to expand both the range of methodologies and the dependent measures traditionally studied by intelligence researchers in order to more clearly define the cognitive mechanisms underlying each construct and to develop interventions to increase these abilities in everyone.

According to the theory, performance across a wide range of intelligent behaviors can be predicted through a hierarchical structure of controlled and spontaneous cognitive processes. Controlled cognitions are goal directed and consume limited central executive resources, whereas spontaneous cognitions aren't constrained by the same limited pool of attentional resources. An assumption of the theory is that both controlled and spontaneous cognitive processes to some degree jointly determine all intelligent behaviors, although in varying degrees. For instance, prediction of performance on an IQ test will maximize the measurement of controlled cognitive processes whereas performance on a test that requires the incidental learning of a complex pattern or performance in a domain in which someone has acquired a large body of expertise will maximize the measurement of spontaneous cognitive processes.

Echoes of this idea can be found in Hammond, Hamm, Grassia, and Pearson (1987) when they argue that different decision-making situations will draw on different strategies in a continuum between pure intuition and pure rational analysis. According to the dual-process theory, neither component is more important than the

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other, but what is important is the ability to flexibly switch between modes of cognition depending on the task requirements (for applications of this idea to creativity, see Chapter 17, The Evolution of Intelligence, this volume; Gabora & Kaufman, 2009; Howard-Jones & Murray, 2003; Martindale, 1995; Vartanian, 2009). According to the theory, what has traditionally been labeled general intelligence (*g*) is primarily tapping into explicit cognitive ability, and the theory predicts that individual differences in *spontaneous cognition* will predict variance in a wide variety of intelligent behaviors above and beyond the variability in *g*, which itself is thought to be only a part of *controlled cognition*.

Both forms of cognition involve the *ability* and the *tendency* to *engage* in each mode of thought. The two are related because people tend to engage in things they are good at and avoid engaging in things they aren't good at. A key assumption of the dual-process theory is that abilities are not static entities but are constantly changing through the life span as the person continually engages with the world. The more a person engages in a mode of thought, the more that individual will develop skills in that modality, which in turn increases the desire for engaging with that skill. Indeed, research on expertise skill acquisition shows that engagement in a domain through many hours of deliberate practice contributes to the generation of mental structures that can surpass information-processing limitations when performing within that domain (Ericsson & Charness, 1994; Ericsson & Kintsch, 1995; Ericsson & Lehmann, 1996, but see Kaufman, 2007).

Controlled cognition is at the top of the hierarchy (alongside *spontaneous cognition)* because the capacity for goal-directed action is an important component of human intelligence. Controlled cognition consists of a class of cognitive processes that involve the ability and tendency across situations to think about thinking (i.e., "metacognition" – see Dennett, 1992; Hertzog & Robinson, 2005), reflect on prior behavior, and use that information to modify behavior and plan for the future.[9] Constructs that are part of the controlled cognition hierarchy include central executive functions (updating, cognitive inhibition, and mental flexibility), reflective engagement, explicit cognitive ability (the skill sets that lie at the heart of highly *g*-loaded tasks), intellectual engagement, and elementary cognitive tasks that support explicit cognitive ability.[10] What links all of the processes together is that they all draw on a limited capacity pool of attentional resources.

The second main component (alongside *controlled cognition*) of the dual-process theory, and the component that contains processes relating to the cognitive unconscious, is *spontaneous cognition*. At the broadest level, individual differences in spontaneous cognition reflect the *ability* to acquire information automatically and the *tendency* to engage in spontaneous forms of cognition. For instance, whereas most people have the *ability* to spontaneously experience emotions and daydream, there may be individual differences in the extent to which people are willing to *engage* in their emotions and to daydream (see Pacini & Epstein, 1999; Zhiyan & Singer, 1997).[11] Constructs that are part of the spontaneous cognition hierarchy include spontaneous information acquisition abilities (implicit learning, reduced latent inhibition, etc.), spontaneous forms of engagement (affective engagement,

9 Note that other definitions of "controlled cognition" have been put forward (see Schneider & Shiffrin, 1977).

10 It should be noted, however, that elementary cognitive tasks (ECTs) are not process pure, and motivation, strategy use, and the allocation of attentional resources play an important role in performance (see Chapter 38, Intelligence and Motivation, this volume; Cokely, Kelley, & Gilchrist 2006; Fox, Roring, & Mitchum, 2009).

11 Note that the distinction between controlled and spontaneous cognition is not always the same as the distinction between conscious and unconscious modes of thought. Spontaneous cognitions can be either conscious, such as when individuals are consciously aware of their daydreaming, fantasy, or mind wandering, or nonconscious such as when individuals are dreaming, daydreaming without conscious awareness, or implicitly learning the underlying rule structure of the environment without awareness of how that tacit knowledge is affecting their behavior.

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aesthetic engagement, and fantasy engagement), and various implicit domains of mind that are universal human domains pertaining to knowledge of people, language, numbers, animals, music, visual images, aesthetics, or the inanimate physical world (see Carey & Spelke, 1994; Feist, 2001; Hirschfeld & Gelman, 1994).[12]

Other technical details about the theory, including the hierarchical nature of the model can be found in Kaufman (2009a). Thus far, there is support for the theory from different branches of psychology and neuropsychology. The theory has not received many criticisms, but it is still new; thus, the extent to which the dual-process theory of human intelligence advances the field by making new, testable predictions and the extent to which the theory more clearly defines various constructs relating to intelligence is still to be determined.

The rest of this chapter reviews recent empirical work on linkages between the cognitive processes underlying psychometric intelligence and various aspects of the cognitive unconscious. First, relations between individual differences in controlled cognitive processing and individual differences in two forms of preconscious processing, implicit learning, and latent inhibition will be discussed. Because intuitions and insights generally follow preconscious processing, the next section of this chapter reviews evidence on the relation between intelligence and individual differences in both intuition and insights. The following section will then look at the implications of intelligence and the cognitive unconscious for two major domains of human cognitive functioning: social cognition and creative cognition. The chapter will then conclude with a call for more research. The review of studies in this chapter is by no means exhaustive but is meant to highlight some of the latest thinking and research on the relation between individual differences in psychometric intelligence and individual differences in the cognitive unconscious.

Intelligence and Preconscious Processing

Intelligence and Implicit Learning

According to Reber (1993), implicit learning is "a fundamental root process . . . that lies at the very heart of the adaptive behavioral repertoire of every complex organism" and can be characterized as "the acquisition of knowledge that takes place largely independent of conscious attempts to learn and largely in the absence of explicit knowledge about what was acquired" (p. 5; for a similar view see Epstein & Meier, 1989). We frequently encounter many complex contingencies and patterns, and the ability to preconsciously learn patterns and then use that knowledge to recognize and detect patterns in the future is an important component of intelligence (see Hawkins, 2005).

What is the link between psychometric intelligence and implicit learning? According to Reber (1993) and Epstein and Meier (1989), individual differences in implicit learning should be unrelated to individual differences in measures of explicit cognition. Applying principles of evolutionary biology, they argue that the capacity for explicit cognition arrived later on the evolutionary scene than did implicit cognition. Nonetheless, the older implicit learning mechanisms were unaffected by the emergence of explicit thought and continue to function autonomously.

Thus far, the majority of the evidence supports the notion that implicit learning ability is independent of IQ. Some implicit learning tasks have never demonstrated a relation with explicit cognitive ability

12 Implicit domains of mind are similar to group factors in hierarchical models of intelligence. Indeed, research shows that group factors, such as mathematical, spatial, and verbal reasoning abilities provide incremental validity for predicting associated vocations above and beyond general intelligence (Achter, Lubinski, Benbow, & Eftekhari-Sanjani, 1999; Humphreys, Lubinski, & Yao, 1993). These domains of mind are also related to Howard Gardner's "multiple intelligences" (Gardner, 1993, 1999), although the dual-process theory acknowledges that there are also more general forms of cognition that contribute to intelligent behavior, a criticism that is often leveled against theories of multiple intelligences (see Lohman, 2001).

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(e.g., *artificial grammar learning*; Gebauer & Mackintosh, 2007; McGeorge, Crawford, & Kelly, 1997; Reber, Walkenfeld, & Hernstadt, 1991), whereas other tasks have not shown a significant association in the majority of the studies (e.g., *serial reaction time learning*; Feldman, Kerr, & Streissguth, 1995; Kaufman, DeYoung, Gray, Jiménez, Brown, & Mackintosh, 2010; Pretz, Totz, & Kaufman, 2010; Unsworth & Engle, 2005 – but see Salthouse, McGuthry, & Hambrick, 1999). One other implicit learning task, which involves unintentional exposure to pictures, did show an association once with explicit cognitive ability (Fletcher, Maybery, & Bennett, 2000). These results may be mixed as different implicit learning tasks are only weakly correlated with each other (Gebauer & Mackintosh, 2007, 2009; Salthouse et al., 1999). Further, some implicit learning paradigms may better capture implicit cognition than others, which may draw more on explicit cognition (e.g., Seger, 1994). An important future line of research to better understand the relation of implicit learning to psychometric intelligence will be to construct reliable measures that more accurately assess implicit learning. Then, the factorial structure of implicit learning tasks can be assessed and the convergent-discriminant validity can be compared to other measures of psychometric intelligence.

Another methodology with which to investigate the link between implicit and explicit cognition is to compare implicit and explicit versions of the same task. In one condition, experimenters instructed participants to find the pattern, whereas in another condition participants received no such instruction, thereby making learning unintentional. When this methodology is employed, psychometric intelligence is more highly correlated with the task under explicit instructions compared with the condition in which participants are not instructed to intentionally search for the pattern (Gebauer & Mackintosh, 2007; Unsworth & Engle, 2005). Using a similar methodology, Feldman, Kerr, and Streissguth (1995) separated an intentional declarative component of an implicit learning task from the procedural component using a sample of 455 adolescents; they found that while the declarative learning component significantly correlated with explicit cognition, the procedural component did not. In another line of research, using a population of individuals with autistic spectrum condition (ASC), Brown et al. (2010) found that matching for IQ, there was statistical equivalence between participants with ASC and typically developing individuals on four implicit learning tasks. Further, this finding was not a consequence of compensation by explicit learning ability or IQ. Taken together, the research supports the separation of explicit and implicit cognition and the notion that individual differences in psychometric intelligence are only weakly if at all associated with individual differences in implicit learning (e.g., McGeorge et al., 1997; Reber et al., 1991).

Recent research has found that individual differences in implicit learning make an independent contribution to complex cognition above and beyond psychometric intelligence. Gebauer and Mackintosh (2009) administered a large battery of implicit learning and intelligence tests to 195 German students. A factor analysis of all the tasks revealed two second-order principal components: the first consisting primarily of the intelligence measures and the second consisting of the measures of implicit learning. Both factors were only weakly related to each other. Additionally, the implicit learning second-order factor was significantly related to math and English grades, subjects that were foreign languages for the German students in the sample. Controlling for the intelligence second-order factor, the association between the implicit learning factor and English remained whereas the association with math was no longer significant.

Consistent with this finding, Pretz, Totz, and Kaufman (2010) found a relation between a probabilistic sequence learning task and both the American College Testing (ACT) math and English scores, and these effects were in the middle third of effect sizes reported in psychology ($r = .2$ to $.3$; Hemphill, 2003). In another recent

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study, Kaufman et al. (2009) investigated the association of individual differences in implicit learning with a variety of cognitive and personality variables in a sample of English 16- to 17-year-olds. Probabilistic sequence learning was related to intentional associative learning more strongly than psychometric intelligence, and it was not associated with working memory. Furthermore, structural equation modeling revealed that individual differences in implicit learning were independently related to verbal analogical reasoning and processing speed, and implicit learning was significantly correlated with academic performance on two foreign language exams (French and German). Implicit learning also was positively related to self-report measures of personality, including intuition, Openness to Experience, and impulsivity. Also, a double dissociation was found between a latent Intellect factor and a latent Openness to Experience factor – with Intellect relating to working memory (.29) but not implicit learning (.00) and Openness to Experience relating to implicit learning (.31) but not working memory (.13).

This lack of association between implicit learning and working memory is consistent with other research on attention and executive functioning. Research shows that those high in working memory are better able to control their attention and stay on task when there is interference (Kane, Bleckley, Conway, & Engle, 2001) and this ability is associated with psychometric intelligence (see Chapter 20, Working Memory and Intelligence, this volume). There is an emerging consensus that implicit learning requires selective attention to the relevant stimuli but then learning about the selected stimuli operates automatically, independent of an intention to learn and without drawing on further central executive processing (e.g., Baker, Olson, & Behrmann, 2004; Frensch & Miner, 1995; Jiang & Chun, 2001; Jiménez & Mendez, 1999; Turke-Browne, Junge, & Scholl, 2005).

Indeed, researchers have proposed that central executive functions should be engaged only under intentional learning conditions to aid in focusing attention, whereas only selective attention processes are necessary for learning stimuli incidentally (Cowan, 1988; Frensch & Miner, 1995, Johnson & Hirst, 1993). In support of this view, Unsworth and Engle (2005) found that variations in working memory were associated with an implicit learning task only when participants were instructed to explicitly detect the covariation, but no association with working memory was found when participants were not given that instruction. Feldman, Kerr, and Streissguth (1995) also found no relation between implicit learning and measures of working memory.

In sum, while the literature is not large, the evidence that does exist suggests that implicit learning is often unrelated to psychometric intelligence or working memory but is independently associated with specific forms of complex cognition, academic achievement, and particular aspects of personality related to Openness to Experience and impulsivity. Future research on the topic is needed to clarify and extend these findings.

Intelligence and Latent Inhibition

It can be important in our everyday lives to be able to automatically distinguish relevant from irrelevant stimuli and to filter out information irrelevant to the task at hand. For instance, when trying to concentrate on writing poetry, it's important to filter out the rattle of the radiator. Such a mechanism has been investigated and is called latent inhibition (Lubow, 1989). Latent inhibition is often characterized as a preconscious gating mechanism that screens from current focus those stimuli that have previously been regarded as irrelevant (Lubow, 1989). Those with *increased* latent inhibition show higher levels of this form of inhibition (Peterson, Smith, & Carson, 2002). Variation in latent inhibition has been documented across a variety of mammalian species and, at least in other animals, has known biological substrates (Lubow & Gewirtz, 1995). Prior research has shown a relation between *decreased* latent inhibition and acute-phase

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schizophrenia (Baruch, Hemsley, & Gray, 1988a, 1988b; Lubow, Ingberg-Sachs, Zalstein-Orda, & Gewirtz, 1992). People with schizophrenia also tend to have reduced ability for central executive functioning (Barch, 2005).

Recent research suggests that reduced latent inhibition can also have its advantages. In students with a high IQ (and presumably a high level of central executive functioning), *decreased* latent inhibition is associated with higher scores on a self-report measure of creative achievement (Carson, Peterson, & Higgins, 2003). Interestingly, the researchers did not find a correlation between fluid intelligence and latent inhibition. Kaufman (2009a) also did not find an association between variations in *g* and variations in latent inhibition. Additionally, Kaufman (2009a, b) examined the relationship between latent inhibition and individual differences in the tendency to rely on intuition to make decisions. Indeed, latent inhibition is conceptually related to intuition: Jung's original conception of intuition is "perception via the unconscious" (Jung, 1921/1971, p. 538). Kaufman hypothesized that an intuitive cognitive style would be related to reduced latent inhibition. Results showed that those with higher scores on a faith in intuition factor (consisting of intuition items related to affect) tended to have reduced latent inhibition. Further, latent inhibition was not associated with an intuition factor consisting of items having to do with holistic processing of information or a rational cognitive style. There was also a tendency for those scoring high (as compared to medium or low) on the faith in intuition factor to benefit more from a preexposure condition where participants received the relevant stimuli in the first part of the task. Therefore, current research suggests that decreased latent inhibition is unrelated to general intelligence or a rational cognitive style. Since decreased latent inhibition may make an individual more likely to perceive and make connections that others do not see, this ability in combination with high psychometric intelligence can lead to the highest levels of creative achievement.

Intelligence, Intuition, and Insight

Various researchers have come to the conclusion that in many naturalistic situations, such as decision making in groups, very little controlled cognition is required (Klein, 1999; also see Gladwell, 2007, for a summary of relevant research). Instead, they note that expertise seems to be related to recognition of a situation that had been encountered previously and the retrieval of schemas that match the situation.[13] They argue that while controlled cognition is sometimes important, the key to intelligent behavior is the automatic retrieval process.

Similarly, Reyna (2004) argued that experts acquire knowledge that allows them to make fast, intuitive, and effective decisions whereas novices need to rely on deliberate, effortful reasoning. Reyna noted, however, that automatic processes can lead to bias and error when experts are presented with novel problems (also see Chabris & Simons, 2010, for a summary of research showing the potential perils of relying on intuition when making expert as well as novel decisions). Wilson and Schooler (1991) also showed the importance of automatic processing in decision making – they demonstrated that when making a decision that is complex and multi-attributed, people do better when conscious deliberation is intentionally prevented. This idea is also a major tenet of the unconscious thought theory (UTT), in which it is argued that decisions about simple issues can be better tackled by conscious thought, whereas decisions about complex matter can be better approached with unconscious thought (Dijksterhuis & Nordgren, 2006, but see Aczel, 2009; Newell, Wong, & Cheung, 2009; Payne, Samper, Bettman, & Luce, 2008; Thorsteinson & Withrow, 2009).

[13] For more on the relations between intelligence and the acquisition of expertise more generally, see Ackerman (Chapter 41, Intelligence and Expertise, this volume). In this section I focus instead on the relation between intelligence and intuition, particularly from an individual differences perspective.

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Along similar lines, Hogarth (2005) distinguished between deliberate and tacit cognitive processes. According to Hogarth, complex decisions will benefit from tacit processing whereas less complex decisions will benefit from deliberate processing. An additional component in Hogarth's model is the degree of bias in the original learning environment. If the feedback presented in the original learning environment regarding decision accuracy is clear and immediate, the environment is considered "kind," and accurate causal relationships can be learned. Environments in which feedback is unclear and not available in a timely manner are considered "wicked" and are considered highly biased. In wicked learning environments, the intuitive system is prone to errors. According to Hogarth, intentional, deliberate thought is best suited to biased learning environments where the complexity of the task is low, whereas intuitive processing is best suited to learning environments in which bias is low and complexity of the task is high (see Epstein, 2003, and Kahneman, 2009, for related ideas, including the notion that the quality of an intuitive judgment is dependent upon the predictability of the environment in which the judgment is made and the individual's opportunity to learn the regularities in that environment).

Recently, researchers have investigated the role of individual differences in the use of intuition. With the aim of integrating the psychodynamic focus on unconscious processing with the cognitive focus on rational conscious thinking, Seymour Epstein put forth the cognitive-experiential self-theory (CEST; Epstein, 1994), which was an outgrowth of ideas presented in Epstein (1973). The theory posits that humans have two parallel but interacting modes of information processing. The *rational system* is analytic, logical, abstract, experienced actively and consciously, is slower to process information, and requires justification via logic and evidence. In contrast, the *experiential system* is holistic, affective, concrete, experienced passively, processes information automatically, and is self-evidently valid (experience alone is enough for belief).

Epstein's experiential system is related to intuition in the sense of "gut-feelings" that guide behavior. Based on his theory, Epstein developed the Rational-Experiential Inventory (REI; Pacini & Epstein, 1999), which measures individual differences in the tendency to rely on each mode of thought. His research program has discovered that the intelligence of each system is independent of, or very weakly correlated with, the intelligence of the other (Epstein & Meier, 1989), and each subscale (analytical and experiential) has unique predictive validity for a wide range of intelligent behaviors (see Epstein, 2003, for a review). In general, the rational scale is more strongly *positively* related to measures of intellectual performance such as scores on the Scholastic Aptitude Test (SAT) and grade point averages (GPA) than is the experiential scale, whereas the experiential scale is more strongly positively related to extroversion, agreeableness, favorable interpersonal relationships, empathy, creativity, emotionality, sense of humor, and art appreciation than is the rational scale. The rational scale is more strongly *negatively* associated with neuroticism, depression, anxiety, stress in college life, subtle racism, extreme conservatism, alcohol abuse, and naïve optimism than is the experiential scale, whereas the experiential scale is more strongly negatively associated with distrust and intolerance than is the rational scale. Many of these relations held even after controlling for the NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1989), which measures the Big Five factors of personality. Other researchers have used the REI to investigate human cognition. For instance, Klaczynski (2009) reviews a number of studies he and his collaborators conducted using the REI to investigate the development of dual processes across the life span.

Pretz (2008) has extended both the experimental work on intuition and the cognitive styles approach by looking at the effects of individual differences in an analytical versus intuitive strategy and level of experience on practical problem solving. Pretz reasoned that the more experienced an individual is

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with a task, the less complex the task and the more decomposable the problem will appear to that individual. Pretz noted that the relevant knowledge associated with an everyday problem-solving task is likely to be acquired through informal experience, and individuals with more experience will therefore have more tacit knowledge but will also be able to better articulate that knowledge. As a result, the expert can use metacognitive skills to explicitly identify the main problem, identify the most relevant information, and identify the consequences of various courses of action (Antonakis et al., 2002).

In Pretz's study, college students were instructed to use either holistic intuition (bringing to mind all relevant information and trusting hunches) or analysis (defining the problem, distinguishing the relevant from irrelevant information, and monitoring the problem carefully) when solving various practical problems dealing with college life. Pretz found that the effectiveness of the strategy on task performance interacted with the participant's level of experience: analysis worked better for more experienced individuals whereas novices were slightly more successful when they employed a holistic, intuitive strategy. A similar pattern was found looking at existing individual differences in strategy preference.

Pretz's study suggests that among individuals with an intermediate level of expertise, analytical problem solving can be helpful in perceiving the logic and structure of the problem, and intuition can distract the expert from this critical information. In contrast, intuitive, holistic thought may be best suited for novices in a domain who see the task as ill-defined and need to bring to mind the relevant information. An implication of Pretz's study is that intermediate experts should rely on an analytical strategy when solving complex, practical problems. Full-blown experts who have fully automatized their task may benefit from an intuitive mode of thought.

This distinction between holistic intuition (of the sort studied in Pretz's study) and inferential intuition (full automatization) was made by Hill (1987–1988); the ideas are consistent with Baylor's (Baylor, 2001) U-shaped model of expertise and intuition and research showing the facilitation of intuition for complex, high-stakes decision making (Klein, 1999). Indeed, Pretz and Totz (2007) have developed a scale to measure individual differences in the tendency to rely on three different forms of intuition: affective, heuristic, and holistic. Another implication of Pretz's study is that many social problems may be better suited to the cognitive unconscious, as they may be more complex than nonsocial problems. Whereas individual differences in the cognitive unconscious can be adaptive for some social problems, there may be instances of social cognition in which the cognitive unconscious can lead to undesirable outcomes (see Implicit Social Cognition section).

Another line of research has investigated the intimate connection between intuition and insight. Anecdotally, insight has played a crucial role in the generation of creative ideas. The great French mathematician Henri Poincaré (1921) described incidents in which an answer came to him only after his conscious attention was directed away from the problem and he wasn't consciously deliberating on the problem. Poincaré argued that these moments of sudden inspiration are the result of unconscious thinking. Based on reflections of his creative thought process, he argued that the creative process starts with conscious work on a problem, followed by unconscious work, and then, if insight is successful, another stage of conscious work to verify that the ideas makes sense and to work out the implications of the idea. Indeed, insight is considered an important component of the creative process (Wallas, 1926).

Empirical work supports these anecdotes. In reviewing a number of experiments relating to implicit thought, intuition, and insights, Kihlstrom, Shames, and Dorfman (1996) have this to say about the nature of intuition:

From the experiments described in this chapter, it appears that the processes underlying intuitions closely resemble those

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> *which underlie implicit memory. In recognition, people's intuitions about the past – the feeling of familiarity, in the absence of full recollection – seems to be based on the perceptual fluency that comes with priming. . . . We actually think of these mental states as implicit thoughts: instances in which an idea or image influences experience, thought, or action in the absence of conscious awareness of what that idea or image is.*

As for the link between intuitions and insight, they then go on to say:

> *. . . it is clear that problem solutions, like memories, are not discontinuous, all-or-none affairs, remaining entirely unconscious until they emerge full-blown into the full light of consciousness. There is a point, as they approach and cross what Wallas (1926), following William James (1890), called the "fringe" of consciousness, when we know they are coming, even when we do not know what they are. This is the point, between preparation and insight, where intuitions occur. (p. 19)*

Other researchers have investigated the controlled and spontaneous cognitive mechanisms that underlie insight (see Sternberg & Davidson, 1995, for a review of research on insight). A methodology that is often employed is the Accumulated Clues Task (ACT), in which participants must discover a word, but are given clues (e.g., words that are associated with the answer) along the way. After each clue is presented, participants are required to provide an answer. The clues get increasingly helpful (are more related to the answer) and the answers given by the participants get objectively closer to the answer in an incremental fashion that occurs before their subjective ratings of feeling close to an answer, which they often report occurring to them in a sudden flash of insight (Bowers, Farvolden, & Mermigis, 1995; Dorfman, Shames, & Kihlstrom, 1996). Research has shown that individual differences in how long it takes participants to arrive at the correct answer correlate with verbal intelligence.

Recent research, however, suggests that different components of the task may differentially relate to controlled cognition. Reber, Ruch-Monachon, and Perrig (2007) first replicated earlier research on the ACT by finding that participants often underestimated their degree of closeness to the answer; these subjective reports of closeness exhibited a positive slope, suggesting that participants possessed implicit knowledge about the task and indeed felt hunches about their progress that weren't necessarily aligned with objective incremental progress. The researchers then distinguished between performance level, processing style, implicit knowledge, and subjective feeling of closeness to the solution on the ACT. While performance level correlated with verbal intelligence, processing style and implicit knowledge were not correlated with verbal intelligence. Further, a faith in intuition cognitive style and the Big Five personality traits Openness to Experience and Conscientiousness were all correlated with processing style, but not with implicit knowledge on the task. These results suggest that a promising research direction is to decompose problem-solving tasks into their processing style and intuitive components and investigate relations between individual differences in these components and individual differences in various processes and thinking styles relating to intelligence and the cognitive unconscious.

Domains

Implicit Social Cognition

There is an emerging consensus in the social cognition literature that many of our social behaviors and judgments are made automatically, without intention, effort, or awareness (Bargh & Chartrand, 1999; Bargh & Morsella, 2008). Research on automatic evaluation, impression formation, and automatic characterization all demonstrate the prevalence of automaticity in social life. It is generally thought now that mere perception of a stimulus can lead instantly and

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automatically to a judgment without any conscious reflection or reasoning. Indeed, until the 1980s, attitudes were mostly assumed to rely on consciously available information (Nosek, Greenwald, & Banaji, 2007).

Recently, researchers have investigated individual differences in implicit social cognition, using a variety of measures "that avoid requiring introspective access, decrease the mental control available to produce the response, reduce the role of conscious intention, and reduce the role of self-reflective, deliberative processes" (Nosek et al., 2007, p. 267). Greenwald and Banaji (1995) have been among the most active researchers investigating the role of implicit cognition in various social psychology constructs such as attitudes, stereotypes, and self-esteem. In their research, they attempt to "reveal traces of past experience that people might explicitly reject because it conflicts with values or beliefs, or might avoid revealing because the expression could have negative social consequences. Even more likely, implicit cognition can reveal information that is not available to introspective access even if people were motivated to retrieve and express it" (Nosek et al., 2007, p. 266; see Wilson, Lindsey, & Schooler, 2000, for related ideas about attitudes).

One of the best-validated measures of implicit social cognition is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT requires the participant to categorize various stimulus exemplars representing four concepts (e.g., men, women, good, bad) using two response options. When concepts that share a response are strongly associated, it is expected that the sorting task will be easier for the participant (as indexed by faster responses and fewer errors) than when the concepts are weakly associated. Thus, the IAT affords insight into automatic associative processes that are introspectively inaccessible. Over the last decade, the IAT has been adapted for use in various disciplines (see Nosek et al., 2007, for a review) and to assess implicit attitudes related to categories such as race, gender, and even insects. In studies that involve some measure of discrimination toward a social group, both explicit and IAT measures predict behavior, with the IAT offering superior prediction (Greenwald, Poehlman, Uhlmann, & Banaji, 2009). Furthermore, it has been demonstrated that people with the strongest automatic racial biases are most likely to engage in a wide variety of discriminatory behavior, including overt behavior (Rudman & Ashmore, 2007, but see van Ravenzwaaij, van der Maas, & Wagenmakers for an alternative account).

Therefore, research on how individual differences in intelligence and the cognitive unconscious interact to produce stereotyping and attitude formation is of both theoretical and practical interest. Recent research utilizing fMRI techniques provides some clues. Chee, Sriram, Soon, and Lee, 2000) used fMRI to examine participants while these individuals were taking the IAT. The researchers found that the left dorsolateral prefrontal cortex and to a lesser degree the anterior cingulate were most active during conditions in which items from incongruent categories (e.g., insect + pleasant) shared a response key than when items from congruent categories (e.g., flower + pleasant) shared a key. According to the researchers, this suggests that greater controlled cognition was required in conditions in which it was necessary to overcome the prepotent tendency to map emotionally congruent items to the same response key. In another study, Phelps et al. (2000) had White participants view faces of unfamiliar Black and White males. Participants who showed greater activation of the amygdala (a region of the brain associated with fear and negative emotions) while viewing Black faces relative to White faces tended to score higher on two measures of unconscious race evaluation: the IAT and the eyeblink response. In a second experiment, the researchers did not find the same pattern of brain activation when the faces were familiar and the participants regarded the Black and White individuals positively. In a

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related study, Cunningham et al. (2004) had participants view Black and White faces either subliminally or supraliminally during fMRI. When presented subliminally, the amygdala was more active for Black faces relative to White faces. This effect was reduced when the faces were presented supraliminally. Further, control regions in the prefrontal cortex (which are also activated during working memory and psychometric intelligence tests) showed greater activation for Black faces than White faces when presented supraliminally. Race bias as assessed by the IAT was related to a greater difference in amygdala activation for Black faces relative to White faces, and activity in the prefrontal cortex predicted a reduction in amygdala activation from the subliminal to the supraliminal condition. According to the researchers, this provides evidence for neural distinctions between automatic and controlled processing of social groups, suggesting that controlled processes (which support performance on measure of psychometric intelligence) may modulate automatic evaluation.

These results suggest that individual differences in measures of controlled cognition may predict the extent to which automatic evaluations influence behavior. To expand the range of individual differences in implicit social cognition investigated, it may be useful to construct new implicit learning tasks that consist of stimuli relating to the learning of real-world contingencies in the social domain. Tasks that already exist that could be adapted include the task used by Lewicki, Hill, and Sasaki (1989), in which participants implicitly learn to judge the intelligence of individuals from brain scans or the adaptation of that task employed by Woolhouse and Bayne (2000), in which participants implicitly learn to judge the job suitability of job candidates based on their personality profile. Such research can help distinguish between situations in which individual differences in the cognitive unconscious contribute to intelligent behavior (for example, when a person is engaging in an area of expertise or generating novel ideas), and situations in which controlled cognition may be the better predictor of intelligent behavior (since it helps override generalizations that can lead to explicit prejudice and stereotyping). Such research would further illustrate the need for measuring individual differences in both controlled and automatic cognitive processes in order to predict various forms of intelligent behavior.

Creative Cognition

Creativity requires both novelty and usefulness (Kaufman, 2007). The Creative Cognition Approach endeavors to identify and investigate the role of mental processes in creative cognition at various stages in the creative process (Finke, Ward, & Smith, 1992, 1995; Ward, Smith, & Finke, 1999). Creative cognition researchers have identified two main phases of creative invention that occur in a cyclical fashion in ordinary individuals. During the *generative* phase, the individual generates numerous candidate ideas or solutions and forms a mental representation (referred to as a preinventive structure). Then during the *exploratory* stage, the individual examines the candidate mental representations and ideas and consciously and sometimes painstakingly works out their implications. Cognitive unconscious processes activated through defocused attention most likely play more of a role during the generative stage, whereas controlled cognitive processes activated through focused attention most likely play more of a role during the exploratory stage. The highest levels of creativity, however, most likely require the ability for both modes of thought and the flexibility to switch modes of thought throughout the creative process.

On the one hand, behavioral and brain studies suggest that creative people are characterized by a lack of inhibition (Eysenck, 1995; Martindale, 1999), and case studies repeatedly show that creative people do describe the creative process as effortless and lacking in deliberation (Csikzentmihalyi, 1996). However, studies also show that creative individuals defocus their attention when approaching a creative task but they

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are capable of focusing their attention when it comes time to make the ideas practical (Martindale, 1999). In recent years, Oshin Vartian and colleagues have extended this research by showing in a series of clever experiments that creative people are able to adjust their focus of attention, depending on the demands of the task.

In one study, Vartanian, Martindale, and Kwiatkowski (2007) found a *negative* correlation between creative potential (measured by fluency scores) and speed of information processing on two tasks that did not involve interference or ambiguity, and a *positive* correlation between creative potential and speed of information processing on two tasks that did require the inhibition of interfering information. Therefore, subjects with greater creative potential were better able to slow down or speed up their information processing, depending on the task demands. A follow-up study found similar results and extended the earlier results in a sample of high school students in Russia (2008). The same pattern was found between creative potential (as measured by fluency, flexibility, and originality) and response latency as in the earlier study, and the findings held, correcting for IQ. In a third study, participants were instructed to judge whether two concepts were related or unrelated (Vartanian, Martindale, & Matthews, 2009). The rationale was that creativity is frequently defined as the novel and useful association of concepts that are not traditionally related. Therefore, this important cognitive process relies at least in part on a person's ability to quickly assess the degree of relationship between concepts. The researchers manipulated the degree of association between word pairs. Participants with greater creative potential (assessed by a measure of divergent thinking) exhibited a faster reaction time when judging the relatedness of the concepts. Psychometric intelligence didn't account for additional variance above and beyond divergent thinking scores in predicting the variability in reaction time performance. The researchers conclude that the ability of individuals with higher creative potential to more quickly judge the degree of association between words can lead to an advantage over time in the total number of potentially relevant conceptual associations that can be considered. The researchers argued that the task they used involved unambiguous task instructions and associations and that it is just these conditions in which those with better divergent thinking skills focus their attention, which can result in a faster reaction time.

An interesting question raised by Vartanian, Martindale, and Matthews (2009) is whether the mechanism that regulates the focus of attention is itself automatic or requires self-control. They have argued that the unambiguous nature of their task led to automatic regulation of attention. They point to evidence that in other circumstances, top-down processing can also play an important role in creative cognition. Vartanian, Martindale, and Kwiatkowski (2003) investigated the role of strategic flexibility in creative problem solving. They administered a rule discovery task and found that participants with higher creative potential (as measured by fluency scores) were better at discovering the rules. Further, the strategy of generating disconfirmatory hypotheses played an important role for successful participants in the later stages of hypothesis testing after the first feedback was given. Having already formed a representation of the problem space after feedback, successful participants were flexibly able to switch to a more successful strategy following initial feedback. Similar results have been found by Gilhooly, Fiortou, Anthony, and Wynn (2007), who found that using think-aloud protocols that alternative uses for a task had generated earlier in the course of the task drew primarily on memory-based strategies, whereas uses generated later drew on a more limited range of strategies requiring executive processes, such as imagining the disassembly of the object and using the parts or recombining the parts into other objects that could be applied in other ways. Similar to the results of the Vartanian, Martindale, and Kwiatkowki (2003) study, novelty of responses was affected by the ability to use a specific strategy later in the course of

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problem solving, supporting the view that creative people switch strategies during the course of a task but also suggesting that top-down processing can play an important role in creative problem solving. Vartanian, Martindale, and Kwiatkowski (2003) suggested a bi-directional model of creativity in which the focus of attention is modulated according to top-down as well as bottom-up processes, with the use of bottom-up processing determined by the stage of the problem (bottom-up processing primarily during the earlier stages, and top-down processing primarily during the later stages). Both Vartanian, Martindale, and Kwiatkowski (2003) and Vartanian (2009) mentioned that an important future line of research will be to investigate the underlying mechanism(s) that enable the modulation of information-processing strategies during the course of creative problem solving.

Drawing more on the memory and brain literature, Bristol and Viskontas (2006) came to similar conclusions. They proposed that creative individuals are good at modulating inhibitory processes, so that they have both the capability for cognitive control and the capacity for disinhibition and can switch fluidly from one mode to another. In particular, they argue that creative individuals can defocus their attention at the early stages of creative cognition so that they grasp the whole set of potential covariations; then, during the retrieval and elaboration stage, they can control attention so that they can inhibit prepotent responses and thereby allow remote associations to enter into consciousness without intrusions. Therefore, the researchers argue that creative individuals are both able to overcome cognitive inhibition and are capable of suppressing undesired responses. They claim that this skill requires the ability to *activate* the dorsolateral prefrontal cortex and inhibit retrieval-related processes that may interfere with accessing remote associations, as well as to *deactivate* the dorsolateral prefrontal cortex, depending on the context of the task and the goals of the individual. They also left as an interesting open question determining the precise brain mechanisms that can modulate between the different brain activations and deactivations depending on the demands of the task.

Conclusion

In his 1957 presidential address to the American Psychological Association, Lee Cronbach pleaded his case for uniting the burgeoning field of cognitive psychology, with its focus on the experimental psychology of higher order information processing, with the study of individual differences in Spearman's *g*. Cronbach's call set off a great deal of research that would demonstrate that the newer theories regarding the nature of intelligence and the burgeoning field of information-processing psychology were indeed quite compatible. The work by Hunt (Hunt, Frost, & Lunneborg, 1973) and Sternberg (1977) helped lay the foundation for the experimental study of intelligent reasoning processes that are deliberate and effortful. Subsequent research has tended to focus on both lower level as well as higher level correlates of general intelligence.

One particular set of cognitive processes that has not been investigated as thoroughly as the others from an individual differences perspective is the set related to the cognitive unconscious. This situation of mutual neglect has had the unfortunate consequence of limiting our picture of the nature of both human intelligence and the cognitive unconscious, thus potentially limiting our understanding of the role of individual differences in information processing in complex cognition more generally. The study of individual differences in the cognitive unconscious can increase our understanding of the nature of intelligence by helping us find boundary conditions for so-called general intelligence (*g*) and by doing so, discovering where *g* breaks down. Similarly, the study of individual differences in general intelligence and its associated cognitive mechanisms can elucidate the nature of the cognitive unconscious by helping to clarify and delineate automatic, spontaneous, and rapid information-processing mechanisms.

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By charting new terrains, researchers can increase understanding of the determinants of intelligent behavior. A potentially fruitful line of research is to adapt already existing experimental paradigms and construct new tests that tap the cognitive unconscious. Individual differences in such tasks may not be strongly related to psychometric intelligence but may still explain intelligent behavior independent of psychometric intelligence. Researchers can then investigate the precise cognitive and neural mechanisms that underlie measures of the cognitive unconscious and develop interventions to raise these skills in everyone. By fostering collaborations across the various areas of psychology and related disciplines, and incorporating dual-process theory into our thinking, we should be able to come to a fuller, more complete understanding of human intelligence.

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