CHAPTER 6

Rationality, Intelligence, and the Defining Features of Type 1 and Type 2 Processing

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The idea that the brain comprises many different subsystems has recurred in conceptualizations in many different disciplines— from the society of minds view in artificial intelligence (Minsky, 1985) to Freudian analogies (Ainslie, 1982) to discussions of the concept of multiple selves in philosophy, economics, and decision science (Ainslie, 2001). Just how ubiquitous dual-process models are in psychology and related fields is illustrated in Table 6.1, which lists a variety of such theories that have appeared during the last couple of decades.

Some common terms for the dual processes are listed in Table 6.1. The terms *heuristic* and *analytic* are two of the oldest and most popular terms for the two processes. However, in order to attenuate the proliferation of nearly identical theories, Stanovich (1999) suggested the more generic terms *System 1* and *System 2*. Although these terms have become popular (see Kahneman, 2011), there is an infelicitousness to the System 1–System 2 terminology. Such terminology seems to connote that the two processes in dual-process theory map explicitly to two distinct brain systems. This is a stronger assumption than most theorists wish to make. For similar reasons, Evans (2008, 2009) has suggested a terminology of Type 1 processing versus Type 2 processing. The Type 1–Type 2 terminology captures better than previous terminology that a dual-process theory is not necessarily a dual-*systems* theory (see Evans & Stanovich, 2013, for an extensive discussion). Thus, we adopt the Type 1–Type 2 terminology here, as it more accurately characterizes how each refers to sets of systems rather than single systems.

DEFINING VERSUS INCIDENTAL FEATURES OF DUAL-PROCESS MODELS

In the same book where the System 1–System 2 terminology was introduced, Stanovich (1999) attempted to bring together some of the pairs of properties that had been posited in the literature to indicate the differences between the two processes. We have reproduced a slightly updated version of the property list in Table 6.2. The purpose of this original table in Stanovich (1999) was simply to bring together the many properties assigned to the two processes in the proliferation of dual-process theories of the 1990s. The list was not intended as a strict theoretical statement of necessary and defining features. As Stanovich noted in his discussion, he was searching for "family resemblances" among the various theories. The

TABLE 6.1. Some Alternative Terms for Type 1 and Type 2 Processing Used by Various Theorists

Theorist	Type 1	Type 2
Bargh & Chartrand (1999)	Automatic processing	Conscious processing
Bazerman, Tenbrunsel, & Wade-Benzoni (1998)	Want self	Should self
Bickerton (1995)	Online thinking	Offline thinking
Brainerd & Reyna (2001)	Gist processing	Analytic processing
Chaiken et al. (1989)	Heuristic processing	Systematic processing
Evans (1984)	Heuristic processing	Analytic processing
Evans & Over (1996)	Tacit thought processes	Explicit thought processes
Evans & Wason (1976); Wason & Evans (1975)	Type 1 processes	Type 2 processes
Fodor (1983)	Modular processes	Central processes
Gawronski & Bodenhausen (2006)	Associative processes	Propositional processes
Haidt (2001)	Intuitive system	Reasoning system
Johnson-Laird (1983)	Implicit inferences	Explicit inferences
Kahneman & Frederick (2002, 2005)	Intuition	Reasoning
Lieberman (2003)	Reflexive system	Reflective system
Loewenstein (1996)	Visceral factors	Tastes
Metcalfe & Mischel (1999)	Hot system	Cool system
Norman & Shallice (1986)	Contention scheduling	Supervisory attentional system
Pollock (1991)	Quick and inflexible modules	Intellection
Posner & Snyder (1975)	Automatic activation	Conscious processing
Reber (1993)	Implicit cognition	Explicit learning
Shiffrin & Schneider (1977)	Automatic processing	Controlled processing
Sloman (1996)	Associative system	Rule-based system
Smith & DeCoster (2000)	Associative processing	Rule-based processing
Stanovich (2004)	Autonomous processes	Decoupled simulation
Strack & Deutsch (2004)	Impulsive system	Reflective system
Thaler & Shefrin (1981)	Doer	Planner
Toates (2006)	Stimulus-bound	Higher order
Wilson (2002)	Adaptive unconscious	Conscious

list was descriptive of distinctions drawn in the literature—not a full-blown theory of necessarily co-occurring properties. No one at the time could have made such a list of necessarily co-occurring properties, because the unsystematic and non-cross-referenced work of the 1990s meant that no one could have known such a thing. In the past decade however, several investigators have made an attempt to zero in on the crucial defining features of the two types of processing—and by inference make a statement about which properties are incidental correlates. We sketch out our own theoretical attempt below, but first we indicate how Table 6.2 has been misused in the literature in an effort to discredit dual-process theory.

The main misuse of such tables is to treat them as strong statements about necessary co-occurring features—in short, to aid in the creation of a straw man. The longer the list of properties in any one table, the easier it is to create the complete straw man claim that if all of these features do not always co-occur, then the dual-process view is incorrect. Kruglanski and Gigerenzer (2011) most recently created such a straw man with their claim that dual-process views fail because "these dimensions are unaligned rather than aligned" (p. 98). They explicitly construct their straw man by considering six dichotomies to carry the assumption that all are defining and must therefore co-occur: "Assuming six dichotomies, one would end up with a $2^6 = 64$ cell matrix of which only two cells (those representing the conjunction of all six dichotomies) had entries. Again, such logical implication of the alignment assumption has never been considered seriously or tested empirically" (p. 98).

But the so-called "alignment assumption" here is not attributed to a specific dual-process theorist in their article. This is not surprising, because dual-process theory does not stand or fall on the full set of properties necessarily co-occurring. Tables of properties such as those seen in Table 6.2 appeared in publications over a decade ago (see Stanovich, 1999) and were meant to organize a nascent theoretical literature, not to lay out an absurdly specific prediction about the co-occurrence of features that had been generated from over two-dozen different dual-process conceptions. *All* of these dichotomies were *never* necessary to establish the two types of processing (which itself suggests that this was not the purpose of such lists)—the only thing needed is *one* fairly

TABLE 6.2. Commonly Listed Properties of Type 1 and Type 2 Processing

Type 1 processes	Type 2 processes
Holistic	Analytic
Automatic	Controlled
Relatively undemanding of cognitive capacity	Capacity demanding
Relatively fast	Relatively slow
Acquisition by biology, exposure, and personal experience	Acquisition by culture and formal tuition
Parallel	Sequential
Evolutionarily old	Evolutionarily recent
Implicit	Explicit
Often unconscious or preconscious	Often conscious
Lower correlations with intelligence	Higher correlations with intelligence
Short-leashed genetic goals	Long-leashed goals that tend toward personal utility maximization

dichotomous property that is necessary and sufficient. As argued previously, the whole pedantic "2 out of 64" exercise collapses if the each of the dichotomous characteristics were never viewed as essential characteristics in the first place—that is, if it was never assumed that each of the properties listed was necessary in order to define qualitatively different types of processing.

In our model (Stanovich, 2004, 2009, 2011), the defining feature of Type 1 processing is its autonomy: The execution of Type 1 processes is mandatory when their triggering stimuli are encountered, and they are not dependent on input from high-level control systems. Autonomous processes have other correlated features: Their execution tends to be rapid, they do not put a heavy load on central processing capacity, and they tend to be associative—but these other correlated features are not defining. Into the category of autonomous processes would go some processes of emotional regulation; the encapsulated modules for solving specific adaptive problems that have been posited by evolutionary psychologists; processes of implicit learning; and the automatic firing of overlearned associations (see Evans, 2008, 2009; Shiffrin & Schneider, 1977).

These disparate categories make clear that Type 1 processing is a grab bag—encompassing *both* innately specified processing modules/procedures and experiential associations that have been learned to automaticity. Their only uniform commonality is their autonomy. The point that Type 1 processing does not arise from a singular system is stressed by both Evans (2008, 2009) and Stanovich (2004, 2011; see Evans & Stanovich, 2013). The many kinds of Type 1 processing have in common the property of autonomy, but otherwise, their neurophysiology and etiology might be considerably different.

All of the different kinds of Type 1 processing (processes of emotional regulation, Darwinian modules, associative and implicit learning processes) can produce responses that are nonoptimal in a particular context if not overridden. For example, humans often act like cognitive misers (an old theme in cognitive–social psychology) by engaging in *attribute substitution*—the substitution of an easy-to-evaluate characteristic for a harder one, even if the easier one is less accurate (Kahneman, 2011). For example, the cognitive miser will substitute the less effortful attributes of vividness or affect for the more effortful retrieval of relevant facts. Most times, such Type 1 processing will be adequate for the situation, but it is not designed for the type of fine-grained analysis called for in situations of unusual importance (financial decisions, fairness judgments, employment). When we are evaluating important risks—such as the risk of certain activities and environments for our children—we do not want to substitute vividness for careful thought about the situation. In such situations, we want to employ Type 2 override processing to block the attribute substitution of the cognitive miser.

In order to override Type 1 processing, Type 2 processing must display at least two related capabilities. One is the capability of interrupting Type 1 processing and suppressing its response tendencies. Thus, Type 2 processing involves inhibitory mechanisms of the type that have been the focus of work on executive functioning (Miyake & Friedman, 2012). But the ability to suppress Type 1 processing gets the job only half done. Suppressing one response is not helpful unless there is a better response available to substitute for it. Where do these better responses come from? One answer is that they come from processes of hypothetical reasoning and cognitive simulation (Evans, 2007, 2010). When we reason hypothetically, we create temporary models of the world and test out actions (or alternative causes) in that simulated world. In order to reason hypothetically we must, however, have one critical cognitive capability—we must be able to prevent our representations of the real world from becoming confused with representations of imaginary situations. These cognitive decoupling operations are the central feature of Type 2 processing that make this possible (Stanovich, 2004, 2009, 2011). In an article much-cited in developmental psychology, Leslie (1987) modeled pretense by positing a secondary representation (see Perner, 1991) that was a copy of the primary representation but decoupled from the world, so that it could be manipulated—that is, be a mechanism for simulation. Nichols and Stich (2003) model this cognitive decoupling as a separate "possible world box" (PWB) in which the simulations are carried out without contaminating

the relationship between the world and primary representation.

The important issue for our purposes is that decoupling secondary representations from the world, then maintaining the decoupling while simulation is carried out is the defining feature of Type 2 processing. To engage in exercises of hypotheticality and high-level cognitive control, one has to represent explicitly a psychological attitude toward the state of affairs, as well as the state of affairs itself. Thus, decoupled representations of actions about to be taken become representations of potential actions, but the latter must not infect the former while the mental simulation is being carried out. However, dealing with secondary representations—keeping them decoupled—is costly in terms of cognitive capacity. Evolution has guaranteed the high cost of decoupling for a very good reason. As we were becoming the first creatures to rely strongly on cognitive simulation, it was especially important that we not become "unhooked" from the world too much of the time. Thus, dealing with primary representations of the world always has a special salience that may feel aversive to overcome.

Nevertheless, decoupling operations must be continually in force during any ongoing simulations. Stanovich (2004, 2009, 2011) has conjectured that the raw ability to sustain such mental simulations while keeping the relevant representations decoupled is likely the key aspect of the brain's computational power that is being assessed by measures of fluid intelligence. Decoupling—outside of certain domains such as behavioral prediction (so-called "theory of mind")—is a cognitively demanding operation. Decoupling and autonomy are antagonistic in our view: Autonomous processes do not have the capacity to decouple, and decoupling requires central processing capacity and is hence nonautonomous, except for a few exceptions (e.g., the theory of mind module).

FROM DUAL-PROCESS THEORY TO A TRIPARTITE MODEL OF MIND

Figure 6.1 represents a preliminary model of mind, based on what has been outlined thus far, with one important addition. The addition stems from the fact that instructions to
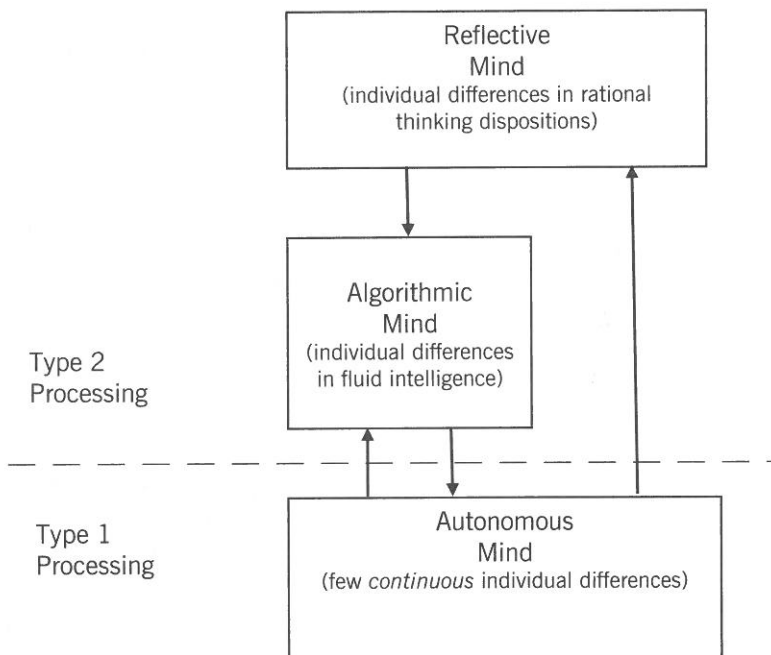

FIGURE 6.1. The tripartite structure and the locus of individual differences.

initiate override of Type 1 processing (and to initiate simulation activities) must be controlled by cognitive machinery at a higher-level than the decoupling machinery itself. Type 2 processing needs to be understood in terms of two levels of cognitive control— what are termed in Figure 6.1 the algorithmic level and the reflective level. There, we have presented the tripartite proposal in the spirit of Dan Dennett's (1996) book *Kinds of Minds*. He used that title to suggest that within the brain of humans are control systems of very different types—different kinds of minds. We have labeled the traditional source of Type 1 processing as the autonomous mind but differentiated Type 2 processing into the algorithmic mind and the reflective mind. The autonomous mind can be overridden by algorithmic-level mechanisms, but override itself is initiated by higher-level control. That is, the algorithmic level is conceptualized as subordinate to the higher-level goal states and epistemic thinking dispositions of the reflective mind.

Work on individual differences in psychological function supports the distinction between the algorithmic and reflective levels of cognition that support Type 2 processing. Psychometricians have long distinguished typical performance situations from optimal (sometimes termed *maximal*) performance situations. Typical performance situations are unconstrained, in that no overt instructions to maximize performance are given, and the task interpretation is determined to some extent by the participant. The goals to be pursued in the task are left somewhat open. The issue is what a person would typically do in such a situation given few constraints. Typical performance measures are measures of the reflective mind—they assess in part goal prioritization and epistemic regulation. In contrast, optimal performance situations are those in which the task interpretation is determined externally. The person performing the task is instructed to maximize performance. Thus, optimal performance measures examine questions of the efficiency of goal pursuit—they capture the processing efficiency of the algorithmic mind. All tests of intelligence or cognitive aptitude are optimal performance assessments, whereas measures of critical or rational thinking are often assessed under typical performance conditions.

The difference between the algorithmic mind and the reflective mind is captured in another well-established distinction in the measurement of individual differences—the distinction between cognitive ability and thinking dispositions. The former are, as just mentioned, measures of the efficiency of the algorithmic mind. The latter travel under a variety of names in psychology—thinking dispositions or cognitive styles being the two most popular ones. Many thinking dispositions concern beliefs, belief structure and, importantly, attitudes toward forming and changing beliefs. Other thinking dispositions that have been identified concern a person's goals and goal hierarchy. Examples of some thinking dispositions that have been investigated by psychologists include actively open-minded thinking, need for cognition, consideration of future consequences, need for closure, superstitious thinking, and dogmatism.

The types of cognitive propensities that these thinking disposition measures reflect include the tendency to collect information before making up one's mind, the tendency to seek various points of view before coming to a conclusion, the disposition to think extensively about a problem before responding, the tendency to calibrate the degree of strength of one's opinion to the degree of evidence available, the tendency to think about future consequences before taking action, the tendency to explicitly weigh pluses and minuses of situations before making a decision, and the tendency to seek nuance and avoid absolutism. In short, individual differences in thinking dispositions are assessing variation in people's goal management, epistemic values, and epistemic self-regulation— differences in the operation of the reflective mind. They are psychological characteristics that underpin rational thought and action.

The cognitive abilities assessed on intelligence tests are not of this type. They are not about high-level personal goals and their regulation, or the tendency to change beliefs in the face of contrary evidence, or about how knowledge acquisition is internally regulated when not externally directed. People have indeed come up with *definitions* of intelligence that encompass such things. Theorists often define intelligence in ways that encompass rational action and belief; nevertheless, *the actual measures of intel-*

ligence in use assess only algorithmic-level cognitive capacity. No current intelligence test that is even moderately used in practice assesses rational thought or behavior (Stanovich, 2009).

Figure 6.1 represents the classification of individual differences according to the tripartite view. The broken horizontal line represents the location of the key distinction in older, dual-process views. Figure 6.1 identifies variation in fluid intelligence (Gf) with individual differences in the efficiency of processing of the algorithmic mind. Individual differences in rational thinking dispositions indicate variation in the properties of the reflective mind. Whereas the reflective and algorithmic minds are characterized by continuous individual differences and substantial variability, there are fewer continuous individual differences in the autonomous mind and less variability. Disruptions to the autonomous mind often reflect damage to cognitive modules that result in very discontinuous cognitive dysfunction, such as autism or the agnosias and alexias.

RATIONALITY AND THE TRIPARTITE STRUCTURE

When a cognitive scientist terms a behavior *irrational*, he or she means that the behavior departs from the optimum prescribed by a particular normative model. The scientist is not implying that no thought or reason was behind the behavior (see Stanovich, 2012). Cognitive scientists recognize two types of rationality: epistemic and instrumental. *Epistemic rationality* concerns how well beliefs map onto the actual structure of the world. The simplest definition of *instrumental rationality* is behaving in the world so that one gets exactly what one most wants given the resources (physical and mental) available. Somewhat more technically, we could characterize *instrumental rationality* as the optimization of the individual's goal fulfillment. Economists and cognitive scientists have refined the notion of optimization of goal fulfillment into the technical notion of expected utility. The model of rational judgment used by decision scientists is one in which a person chooses options based on which option has the largest expected utility (see Baron, 2008). One of the fundamen-

tal advances in the history of modern decision science was the demonstration that if people's preferences follow certain patterns (the so-called "axioms of choice"—things such as transitivity and freedom from certain kinds of context effects), then they are behaving as if they are maximizing utility—they are acting to get what they most want (Luce & Raiffa, 1957). This is what makes people's degrees of rationality measurable by the experimental methods of cognitive science.

Figure 6.1 highlights an important sense in which rationality is a more encompassing construct than intelligence. To be rational, a person must have well-calibrated beliefs and must act appropriately on those beliefs to achieve goals—both properties of the reflective mind. The person must, of course, have the algorithmic-level machinery that enables him or her to carry out the actions and to process the environment in a way that enables the correct beliefs to be fixed and the correct actions to be taken. Thus, individual differences in rational thought and action can arise because of individual differences in fluid intelligence (the algorithmic mind), or because of individual differences in thinking dispositions (the reflective mind).

The conceptualization in Figure 6.1 has several advantages. First, it conceptualizes intelligence in terms of what intelligence tests actually measure. IQ tests do not attempt to measure directly any aspects of epistemic or instrumental rationality, nor do they examine any thinking dispositions that relate to rationality. It is also clear from Figure 6.1 why rationality and intelligence can become dissociated. Rational thinking depends on thinking dispositions, as well as algorithmic efficiency. Thus, as long as variation in thinking dispositions is not perfectly correlated with fluid intelligence, there is the statistical possibility of dissociations between rationality and intelligence.

In fact, substantial empirical evidence indicates that individual differences in thinking dispositions and intelligence are far from perfectly correlated. Many different studies involving thousands of subjects (Stanovich, 2011) have indicated that measures of intelligence display only moderate to weak correlations (usually less than .30) with some thinking dispositions (e.g., actively open-minded thinking, need for cognition) and

near-zero correlations with others (e.g., conscientiousness, curiosity, diligence). Other important evidence supports the conceptual distinction made here between algorithmic cognitive capacity and thinking dispositions. For example, across a variety of tasks from the heuristics and biases literature, it has consistently been found that rational thinking dispositions predict variance after the effects of general intelligence have been controlled (Bruine de Bruin, Parker, & Fischoff, 2007; Finucane & Gullion, 2010; Kokis, Macpherson, Toplak, West, & Stanovich, 2002; Parker & Fischhoff, 2005; Stanovich & West, 1997, 1998, 2000; Toplak, Liu, Macpherson, Toneatto, & Stanovich, 2007; Toplak & Stanovich, 2002; Toplak et al., 2011; West, Toplak, & Stanovich, 2008). The model we have outlined predicts that both rational thinking dispositions and fluid intelligence are necessary for rational performance—an interactive relationship.

The functions of the different levels of control in the tripartite theory are illustrated more completely in Figure 6.2, in which it is clear that the override capacity itself is a property of the algorithmic mind and it is indicated by the arrow labeled A. However, previous dual-process theories have tended to ignore the higher-level cognitive function that initiates the override function in the first place. This is a dispositional property of the reflective mind that is related to rationality. In the model in Figure 6.2, it corresponds to arrow B, which represents (in machine intelligence terms) the call to the algorithmic mind to override the Type 1 response by taking it offline. This is a different mental function than the override function itself (arrow A). The evidence cited earlier indicates that the two functions are indexed by different types of individual differences (rational thinking dispositions and fluid intelligence).

Figure 6.2 represents another aspect of cognition that has been somewhat neglected by previous dual-process theories. Specifically, the override function has loomed large in dual-process theory but less so has the
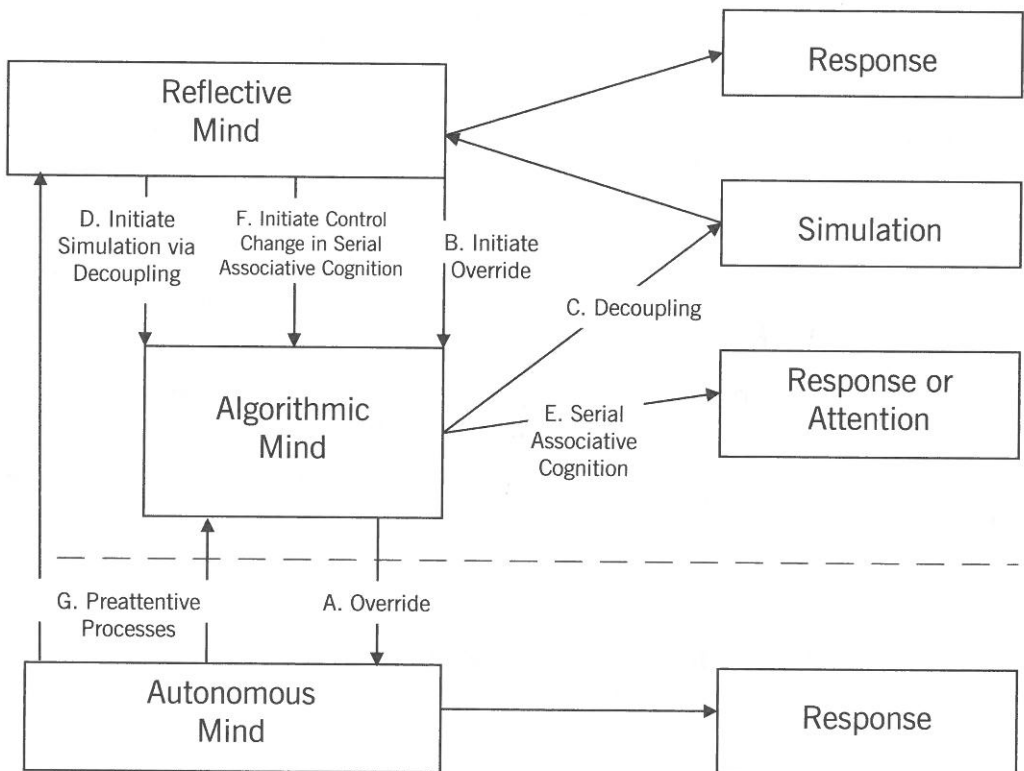

FIGURE 6.2. A more complete model of the tripartite structure.

simulation process that computes the alternative response that makes the override worthwhile. Figure 6.2 explicitly represents the simulation function, as well as the fact that the call to initiate simulation originates in the reflective mind. The decoupling operation (indicated by arrow C) itself is carried out by the algorithmic mind, and the call to initiate simulation (indicated by arrow D) by the reflective mind. Again, two different types of individual differences are associated with the initiation call and the decoupling operator—specifically, rational thinking dispositions with the former, and fluid intelligence with the latter. The arrows labeled E and F reflect the decoupling and higher-level control of a kind of Type 2 processing (serial associative cognition) that does not involve fully explicit cognitive simulation (see Stanovich, 2011, for a much more detailed description of this framework). Also represented is the fact that the higher levels of control receive inputs from the computations of the autonomous mind (arrow G) via so-called preattentive processes (Evans, 2008, 2009). These preattentive processes include Thompson's (2009) feeling of rightness mechanism, which the reflective level uses in part to determine whether an override will be triggered.

Within the tripartite framework, rationality requires mental characteristics of three different types. Problems in rational thinking arise when cognitive capacity is insufficient to sustain autonomous system override, when the necessity of override is not recognized, or when simulation processes do not have access to the knowledge necessary for the synthesis of a better response. The source of these problems, and their relation to intelligence, help to explain one data trend that has been uncovered—that some rational thinking problems show surprising degrees of dissociation from cognitive ability (Stanovich, 2009, 2011; Stanovich & West, 2007, 2008a, 2008b; West et al., 2008). Myside bias, for example, is virtually independent of intelligence (Stanovich & West, 2007, 2008a, 2008b; Toplak & Stanovich, 2003). Individuals with higher IQs in a university sample are no less likely to process information from an egocentric perspective than are individuals with relatively lower IQs.

CONCLUSIONS AND IMPLICATIONS

Many critics of dual-process models have mistaken long lists of descriptive terms in the literature for a full-blown theory of necessarily co-occurring properties. These critiques have distracted attention from the cumulative progress being made in identifying the much smaller set of properties that truly do define Type 1 and Type 2 processing. Our view of the literature is that autonomous processing is the defining feature of Type 1 processing.

Even more convincing is the converging evidence that the key feature of Type 2 processing is the ability to sustain the decoupling of secondary representations. The latter is a foundational cognitive requirement for hypothetical thinking. Through the process of cognitive decoupling, we are able to create temporary models of the world and test the outcomes of imaginary actions. By taking early representations triggered by Type 1 processing offline and substituting better responses that have survived the cognitive selection process of simulation, Type 2 processing exemplifies activities often labeled as executive or inhibitory control. Decoupling for the purpose of offline simulation is a cognitively demanding operation. The raw ability to sustain such simulations while keeping the relevant representations decoupled is one key aspect of the brain's computational power that is being assessed by measures of fluid intelligence. The high degree of overlap in individual differences in working memory and other executive functioning tasks and individual differences in fluid intelligence is probably due to the necessity for sustained decoupling operations on all the tasks involved (Kane, Hambrick, & Conway, 2005).

Our studies of individual differences have led us to the important conclusion that Type 2 processing needs to be understood in terms of two levels of processing—the algorithmic level and the reflective level. We can see this if we consider the logic of autonomous system override. Type 1 processing will determine the response unless overridden by the algorithmic mechanisms of the analytic system. But override itself is initiated by higher-level control. That is, the algorithmic level of the analytic system is conceptualized as

subordinate to higher-level goal states and epistemic thinking dispositions. These goal states and epistemic dispositions exist at what might be termed the *reflective level of processing*—a level containing control states that regulate behavior at a high level of generality. Efficient functioning at both levels is necessary to sustain rational behavior.

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