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2

Metacognition and Cognitive Variability: A Dual-Process Model of Decision Making and Its Development

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Jim, Dave, and Keith are brothers, ages 9, 11, and 14, respectively. On their father's advice, they decided to spend the day playing golf at a small par-3 course. The daily special, "$10 for all the golf you can handle," thrilled them. Although none had played the game previously, the mere idea of smacking a 1.68″ diameter ball around, trying to sink it into each of the course's nine 4.24″ diameter cups, seemed like a great way to spend an otherwise slow summer day. After all, they had worked hard completing their chores and had earned the $15 their father had given each of them.

But what seemed like a good idea at the time took a few bad turns. The day, which began pleasantly enough, was hot and humid by the time the boys reached the fourth hole. Worse, the difficulties—and the concomitant frustrations—of the game were dawning on them. Shot after shot was sliced, hooked, duffed, or otherwise misplayed. No evidence suggested that their games were improving. And so, the initial fire for the game that had burned in the boys' hearts dimmed to a small, barely glowing ember.

It may seem obvious that the boys should quit, end the humiliation, and move on to an activity from which they could derive at least a modicum of enjoyment. The question must nonetheless be asked: How likely is it that any of the boys will actually quit? Given their different ages, is one of the boys more likely than the others to opt out of the game?

The dilemma would be less apparent, and the decision to quit much easier, if not for the $10 investment the boys made to play "all the golf they could handle." Indeed, had they played for free, had they not "sunk" well-

earned dollars into the activity, the brothers would likely leave the golf course behind and head for greener pastures. Yet, cognitions that the irretrievable investment, the "sunk cost," would be wasted if they stopped playing will likely compel the boys to stay (on) the course. To answer the first question, the boys—like the millions of golfers who spend hundreds of dollars for equipment and the "privilege" of playing, and like adults in numerous other situations involving unrecoverable investments—are likely to commit the "sunk cost" fallacy. The second question, "Are the boys equally likely to commit the fallacy?" can be answered in the negative. Recent evidence (Klaczynski, 2001b, 2004; Klaczynski & Cottrell, 2004) pointed to the conclusion that, in contrast to the recent speculations of Arkes and Ayton (1999), Keith, the 14-year-old, is more likely than his younger brothers to realize that the money already "flushed down the toilet" on golf should not govern his decision about future activities. But even for Keith, the eldest of the boys, the probability of committing the fallacy is rather high.

Although the tendency to "honor" sunk costs has been the subject of considerable research and speculation, this fallacy is but one of the many foibles that seem to typify the decision making of children and adults (for discussions, see Byrnes, 1998; Kahneman, Slovic, & Tversky, 1982; Klaczynski, Byrnes, & Jacobs, 2001; Reyna, Lloyd, & Brainerd, in press; Stanovich, 1999). Research on this fallacy—like research on other common phenomena, such as the *conjunction fallacy*, base rate neglect, unrealistically optimistic judgments, belief biases, ratio bias, and numerous other errors and biases studied by decision-making theorists—is illustrative of an unfortunate tendency in the decision-making literature. That is, until quite recently (e.g., Stanovich & West, 2000), the concern of most of this research has been on college students' judgments and decisions on specific tasks. Although inferred by many theorists, the generality of these processes across tasks has been studied by few (Klaczynski, 2001a; Stanovich & West, 1998, 2000) and developmental changes in these processes have been almost completely ignored. The focus of this chapter is therefore not on the sunk cost fallacy per se; instead, my concern is with the development of the information-processing mechanisms that underlie decisions across a variety of situations. I argue that these mechanisms can account for nonnormative decisions and judgments involving sunk costs, conditional inferences, precedents, ratios, counterfactual thinking, and the evaluation of scientific evidence and everyday arguments. The bedrock on which this argument rests is an increasingly solid corpus of evidence that cognitive development is supported by two, mutually influential, but independently functioning, information-processing systems: an "experiential" system and an "analytic" system (Klaczynski, 2001a; Jacobs & Klaczynski, 2002).

The *experiential processing system* involves the preconscious activation of procedural memories that can be used to guide judgments and decisions

(Chen & Chaiken, 1999; Epstein, 1994; Epstein & Pacini, 1999). Specifically, development is in part characterized by the acquisition of judgment and decision heuristics. Although some of these heuristics may be learned explicitly, by and large they are acquired through implicit cognitive processes (see Reber, 1992). Once acquired, judgment and decision heuristics are activated automatically by situational cues. For instance, the circumstances of the three brothers brought into conflict the desires to quit playing and to get their money's worth. The latter goal is likely to take precedence over the former because the situation has activated a general heuristic that implores decision makers to guard against waste (i.e., the $10 investment; see Arkes & Ayton, 1999). The application of heuristics is not only "fast and frugal" (Gigerenzer, 1996), but also leads (at least sometimes) to outcomes that are beneficial—or at least not harmful—to the decision maker. Yet, because their activation is effortless and automatic, because people have only a fleeting awareness that they have been activated, and because their activation elicits intuitions or "gut" feelings that they are "right" for the immediate situation, decision heuristics are often used in situations for which their relevance is dubitable—as appears to be the case on the golf course.

Knowing that an increasingly diverse repertoire of heuristics is acquired from early childhood through adolescence and adulthood suffices to explain neither the frequency with which heuristics are applied to judgment and decision situations nor occasions on which heuristics, although activated, are not exercised. Put more succinctly, and discussed in more depth throughout this chapter, because a particular heuristic is stored in procedural memory does not mean that it will be used when it is activated. The experiential processing system, functioning with little or no conscious awareness on the decision maker's part, continuously assimilates information and matches internal and external cues to memory procedures; this matching process, in turn, activates and makes available specific heuristics for utilization in specific situations.

In general, experiential processing is fast, operates automatically and at the "periphery" of consciousness (Epstein, 1994). This system facilitates information mapping onto and assimilation into existing knowledge categories, operates to convert conscious strategies and tactics into automatic procedures and strategies (e.g., we typically do not "know" or are not consciously aware that a strategy is undergoing or has undergone the transformation from a declarative memory to a procedural, automatic memory) and aids and abets the activation of decision-making heuristics and other memories (e.g., beliefs, vivid episodic memories) that bias judgments and interfere with attempts to reason objectively. Because it likely evolved before the analytic processing system and, more importantly, because it requires little cognitive effort and expends few cognitive resources, experiential processing is often considered the overall system's default (Brainerd & Reyna, 2001; Epstein, 1994).

If not for the codevelopment of the more deliberate analytic processing system, judgments and decision making might well be dominated by "off-the-

cuff," automatically activated and *employed* heuristics and biases. This second processing system comprises consciously controlled, effortful thinking, and the numerous competencies that have traditionally been considered essential to cognitive development and normative decision making (Evans & Over, 1996; Stanovich, 1999). Of critical importance to the present discussion are age-related progressions in the abilities to reflect on and evaluate decision options, monitor the progress of reasoning and decision making, and inhibit interference from memories activated by logically irrelevant task contents.[1]

Because the instantiation of analytic competencies in performance is often highly effortful, if they are to benefit developing individuals, analytic competence acquisition must be accompanied by increases in the tendency to consciously employ these competencies. As recent discussions of metacognitive development (e.g., Kuhn, 2000; Moshman, 1990, 1999) and "thinking dispositions" (e.g., Stanovich & West, 2000) highlight, for everyday reasoning and decision making to approach normative ideals, development must proceed beyond the abilities to inhibit memory-based interference, reflect on the processes of reasoning and decision making, and evaluate the quality of decision options. Specifically, developments in analytic competence must be coupled with the acquisition of the dispositions (i.e., personal qualities, such as the "need for cognition") that increase an individual's motivation to use these abilities (the tendency to seek and enjoy intellectual challenges; see Cacioppo, Petty, Feinstein, & Javis, 1996).

METACOGNITIVE ABILITIES, METACOGNITIVE DISPOSITIONS, AND METAKNOWLEDGE DEVELOPMENT

The analytic competencies of greatest concern to the present discussion are those involved in evaluating beliefs, justifying beliefs and decisions, assessing beliefs about decision-making procedures, planning decisions (e.g., setting

[1]Throughout this chapter, normative responses refer to those historically advocated by logicians, philosophers, and decision theorists. Although arguments have been made that certain nonnormative responses (e.g., the "sunk cost fallacy" discussed earlier) are, in fact, normative, the Stanovich and West (1998a, 1998b) program of research on individual differences in "rational" responses, as well as Stanovich and West's (1999) research on the "understanding/acceptance" principle, supports assertions that the responses labeled as *normative* in this chapter should, in fact, be considered normative. Although this stance remains controversial, I have retained the normative/nonnormative distinction because it is useful, at the very least, for expository purposes. However, the following caveats are worth noting: (a) The distinction between normative and nonnormative is a loose one and is not absolute; (b) responses traditionally termed *normative* are sometimes maladaptive and responses traditionally termed *nonnormative* are sometimes adaptive (see Evans & Over, 1996; Jacobs & Narloch, 2001; Kahneman, Slovic, & Tversky, 1982; Klaczynski, 2001b; Reyna et al., in press).

goals and subgoals, selecting strategies for goal attainment), and monitoring the progress of goal-directed activities. At the most general level, developments in these abilities represent progressions in metacognitive and executive functioning.

Under the rubric of metacognition are *metacognitive abilities* and *metacognitive dispositions*. Three components of metacognitive ability—likely to function in a partially independent manner and possibly developing at different rates—are central to developments in reasoning and decision making. Briefly, these components include metaprocedural, metacognitive monitoring, and metaknowledge abilities.

Metaprocedural skills include the abilities to assess the type of reasoning (e.g., inductive, deductive), memory strategy, problem-solving procedure, or decision-making tactic called for in a particular situation (see Kuhn, 2000, 2001; Kuhn & Pearsall, 1998, 2000). *Metacognitive monitoring* (see also Byrnes, 1998, chap. 1, this volume; Sternberg, 1985) is similar to metaprocedural ability in its relation to executive functioning. Simply, metacognitive monitoring is the ability to consciously track the course of one's reasoning and decision making, discover flaws and inconsistencies in relevant "online" cognitions, and alter one's approach to a problem and plan for goal achievement as a function of these discoveries. Key to effective metaprocedural and metamonitoring are the abilities to inhibit irrelevant memories (e.g., beliefs) from skewing the evaluation process and to inhibit the "thoughtless" application of automatically activated heuristics. Research on metaprocedural understanding, metacognitive monitoring, and their development is still in its infancy, although Kuhn, Garcia-Mila, Zohar, and Andersen's (1995) microgenetic research on scientific reasoning and research on belief-biased reasoning (Klaczynski, 2000; Klaczynski & Robinson, 2000) suggested that these abilities emerge late in development and/or that, if these abilities do fully develop, neither adolescents nor adults are often disposed to using them.

Metaknowledge includes the abilities to assess what one knows (including knowledge of strategies) and understand the nature of knowledge and the process of knowing (i.e., epistemological theories; e.g., beliefs about the certainty or uncertainty of knowledge). Thus, metaknowledge includes the abilities to distinguish among accepted facts, beliefs, assertions, and evidence, and to understand how and when to apply these distinctions to everyday situations (Kuhn, 2001). Metacognitive knowledge thus involves (but is not limited to) an understanding of the epistemic constraints on beliefs and inferences and the importance of constructing and evaluating justifications for beliefs and decisions (Kuhn, 1991). Thus, as noted by Moshman (1998, 1999), Kuhn (2001), Stanovich (1999), and others (e.g., Schommer, 1994), developments in epistemological understanding and in the dispositions to apply this understanding are essential if adolescents are to make reasoned and justifiable decisions.

Although "theory of mind" theorists (e.g., Gopnik & Wellman, 1992; Perner, 1991) argued that the core ingredients of an advanced epistemological understanding are present by the end of the preschool years, this claim has been heavily criticized (e.g., Chandler, Hallett, & Sokol, 2002; Kuhn & Weinstock, 2002) because substantial evidence for qualitative advances in epistemological thought has been found both during later childhood and adolescence (e.g., Boyes & Chandler, 1992; Kuhn & Weinstock, 2002) and during adulthood (Kitchener, King, Wood, & Davison, 1989; Perry, 1970). Further, some theoretical consensus is now emerging that, at least to some degree, epistemological development is domain-specific (see Hofer & Pintrich, 2002). Together with conflicting theoretical claims, often based on research that relies on different methodologies (ranging from simple theory of mind and false belief tasks to in-depth interviews to questionnaires), this realization makes precise statements concerning the developmental course of epistemological development difficult (Chandler et al., 2002). Nonetheless, some broad conclusions about epistemological development can be drawn. Because it is beyond the scope of this chapter to review the literature on epistemological development (see Hofer & Pintrich, 2002), only a brief overview of epistemic development and individual differences in this development is presented here. Among the key conclusions researchers have reached in recent years are the following:

- Across knowledge domains (e.g., physical, social, aesthetic, etc.), epistemic development occurs in a predictable and possibly invariant, sequence (described further subsequently; Kuhn, Cheney, & Weinstock, 2000).
- Epistemic development is, to some extent, domain-specific. That is, (a) progress is evident earlier in some knowledge domains (e.g., aesthetics) than in others (e.g., values); and (b) it is typical of both children and adults to attain different levels of epistemological understanding in different domains (Kuhn et al., 2000).
- Domain-general limitations in basic information processes and developments in these processes place boundaries on the degree to which epistemic developments can be domain-specific. Thus, the rate at which higher order epistemic stances develop is constrained by the rate at which basic information processes and reasoning capabilities develop.
- Domain-general experiences, in conjunction with metacognitive awareness of inconsistencies between domain epistemic beliefs, make it increasingly likely that as children develop, their epistemologies will become more coherent and internally consistent.
- Many adolescents and adults never fully attain the highest levels of epistemological development (Boyes & Chandler, 1992; Kuhn & Weinstock, 2002; Moshman, 1999).

With the aforementioned qualifications in mind, for expository purposes it is nonetheless useful to discuss epistemic progressions as if they occurred in a domain-general fashion. Thus, using Moshman's (1999) terminology, children initially adopt an absolutist/objectivist epistemology. During early adolescence, this stance is succeeded by a diametrically opposed, radically different subjectivist—and necessarily relativist—epistemology. Finally (for some adolescents and adults), a rationalist epistemology evolves.

Absolutist/objectivists believe that knowledge is a direct copy of experience and that "facts" are accounts of reality that can be stated with certainty. Because they represent the truth, these accounts are not open to question. Because absolutists have a "copy" theory of knowledge, two witnesses to the same event should have the same knowledge of that event. If not, then the knowledge (because, perhaps, of poor memory or perception) of at least one witness must be false or incomplete (an understanding children demonstrate on false-belief tasks). In principle, such correspondence epistemologies assume that differences in understandings of "facts" and "truths" can be resolved by way of empirical observation or appeal to authority (e.g., scientists, priests, God). However, having attained their knowledge from experience, respected authorities, and treasured sources of authority (e.g., the Bible), absolutists often fail to recognize the fallibility of knowledge, particularly of those "truths" they personally accept. Although empirical observations are an accepted means of resolving discrepant truth claims, all too often absolutists rely on any number of nonlogical tactics (e.g., nonevidence-based assertions, the belief that only their own personal observations are trustworthy, and heuristics [e.g., "authorities know best"]) to deny the possibility that their "truths" can be repudiated.

Experiences with diverse belief systems, coupled with cognitive developments that enable the construction and appreciation of multiple realities, allow a transformation from absolutism toward subjectivism to occur. In this epistemic stance, knowledge is considered a construction intimately dependent on the observer's perspective. This relativism leads to the belief that even personal "truths" are tenuous and that the known, as well as the knower, are susceptible to moment-to-moment change. No single point of view is considered right or wrong in an absolute sense. The individual considers "perspective"—as coconstructed, for example, with immediate situational factors or, on a broader scale, cultural forces—as the primary influence on the individualization of knowledge. According to Boyes and Chandler (1992), subjectivists:

> embrace openly the know-nothing consequence of unbridled relativism, and assume that because no source of absolute or undoubtable knowledge is to be found, all authority is undermined and all hope for rational consensus is lost. . . . the rallying cry of such adolescent skeptics is that everyone should be allowed to "do their own thing" . . . (p. 285)

This "believe and let believe" position contrasts starkly with that of the absolutist, and implies a tendency to avoid argumentation because one belief system is no better (or worse) than any other. Yet, implicit in and inherent to this epistemology is a sort of dogmatism and a frequently overlooked contradiction: The subjectivist relies on, and cannot in principle defend, the assertion that nothing can be known with certainty. To maintain consistency, subjectivists must allow for the possibility that their stance is inaccurate. However, unlike other beliefs, because it is the bedrock on which their belief system rests, the assertion of relativism is not questioned by most subjectivists.

A minority of adolescents do question this assertion and realize that to resolve conflicts, make commitments, and justify decisions, a set of ground rules for knowledge acceptance must be laid. Like subjectivists, these "rationalists" acknowledge the inherent uncertainty of knowledge and recognize knowing as a constructive process. The subjectivist view that truth claims and beliefs ought not to be evaluated or contrasted is rejected on pragmatic grounds, however: For the sake of effective discourse, cooperative enterprises, and social progress, and to avoid the "epistemic confusion" of which Boyes and Chandler (1992) wrote, the rationalist believes that "ideas and viewpoints can be meaningfully evaluated, criticized, and justified" (cited in Moshman, 1999, p. 28; see also Kuhn, 1991, 2001). Justifiable beliefs and knowledge claims should be adhered to more closely than beliefs for which less evidence exists or for which weaker reasons can be provided (Kuhn & Weinstock, 2002). A truth or belief is maintained as a basis for action until its justifiability is called into question or a more justifiable claim is discovered.

Within knowledge domains, the absolutist → subjectivist → rationalist sequence may be developmentally invariant and depends on both a set of cognitive attainments and social experiences (Kitchener et al., 1989; Moshman, 1999). However, progress from the absolutism that characterizes much of children's thinking to rationalism during adolescence and adulthood is neither necessary nor inevitable. Some, and perhaps most, individuals never become rationalists, some leave absolutism but remain steadfast subjectivists (or as steadfast as is possible for subjectivists), others vacillate between absolutism (for beliefs in some domains, such as religion and the object world) and subjectivism (for beliefs in other domains, such as aesthetics), and still others remain firmly committed to the objectivity promised by absolutism (Boyes & Chandler, 1992; Chandler, Boyes, & Ball, 1990; Kuhn et al., 2000; Perry, 1970; Schommer, 1994).

The development of epistemic understanding is important to understand because differences in epistemological understanding imply (but do not necessitate) individual differences in the extent to which children and adolescents appreciate the need for engaging in metaprocedural and metamonitoring activities. That is, adolescents who understand the importance of evidence and logical justification (i.e., rationalists) are more likely than absolutist or subjectivist adolescents to engage in principled reasoning and decision making (Klaczynski, 2000). Personal epistemologies are prescriptive in the sense that they include not only beliefs about how one comes to know, but also beliefs about how one should come to know and about how knowledge should be treated. In the domain of religion, for instance, an absolutist adolescent is likely to justify his or her belief that abortion is inherently evil by appeal to authority, to assert that such a justification is the best possible justification, and to argue that anyone with a different perspective must have wrongheaded reasons for that perspective. Concerning decision making, a rationalist is more apt than a subjectivist to consciously weigh the pros and cons of different courses of action and to value evaluating evidence for different decisions.

As important as epistemological development and other metaknowledge developments are to reasoning and decision making, the development of dispositions to use these cognitive abilities is equally important. That is, as with other cognitive competencies, the development of a sophisticated epistemological understanding does not guarantee that an adolescent will use that understanding on a consistent basis. Unfortunately, few theorists (e.g., Keating & Sasse, 1996; Kuhn, 2001; Moshman, 1999; Perkins, Jay, & Tishman, 1993; Stanovich, 1999; Stanovich & West, 1998, 2000) have recognized the importance of distinguishing between *metacognitive abilities* and *metacognitive dispositions*. The former comprises a cluster of skills or competencies that are strictly cognitive in nature; the latter is a constellation of values and motivational attributes that may develop independently from cognitive and metacognitive abilities. For instance, an adolescent may develop a rationalist epistemology, and as such possess an advanced understanding of knowledge and knowing, but (e.g., because he or she prizes cognitively economical processing or is not particularly intellectually curious) may rarely put this epistemology "to work."

Little is known of the development of the dispositions that motivate children and adolescents to engage their epistemological stances, monitor their reasoning, assess the processes by which they make decisions, and evaluate the inferences and decisions produced by these processes. Such metacognitive dispositions could develop as a function of socialization or could develop alongside (and indeed, could be both products and producers of) metacognitive abilities. For instance, although research on the development of curiosity is scant and has typically been restricted to early childhood (Alberti & Witryol, 1994; Henderson & Wilson, 1991), individual differences in curiosity during childhood may well be precursors to such motivational dispositions as the "need for cognition" (see Cacioppo et al., 1996). Unfortunately, hypotheses such as this have received little attention.

Despite the paucity of developmental research, numerous arguments have been forwarded that the acquisition of metacognitive dispositions contributes something unique to reasoning and decision making above and beyond metacognitive abilities per se. Perkins et al. (1993), for instance, argued for "a small set of seven 'master' dispositions" (p. 3). Among the dispositions Perkins et al. (see also Nickerson, Perkins, & Smith, 1985) consider key to "good thinking" are: "Toward sustained intellectual curiosity" (similar to NFC), "to clarify and seek understanding," "to seek and evaluate reasons," "to be intellectually careful," and "to be metacognitive" (p. 6). The essential point is that for metaknowledge, metaprocedural, and metamonitoring abilities to have an impact on reasoning and decision making, dispositions that motivate their usage must also be acquired. Some of these dispositions may be acquired early in development (e.g., to be intellectually curious), but others may develop only as children move beyond an absolutist epistemic stance.

THE ANALYTIC–EXPERIENTIAL THEORY OF REASONING, JUDGMENTS, AND DECISION MAKING

Until recently, cognitive developmental research on decision making has concentrated on the emergence of abilities that are frequently associated with intellectual maturity and on the correlations between these abilities and aspects of decision making (e.g., awareness of costs and benefits). The unfortunate outcome of this exclusive focus on higher order competencies (e.g., formal operations) has been a misleading picture of the cognitive foundations on which decision making rests (see also Jacobs & Klaczynski, 2002).

This claim is founded, in part, on findings that have taken to task the long-held assumption that logical, computational processing is essential for rational decision making (Reyna et al., chap. 3, this volume; Reyna & Brainerd, 1995). Advocates of "two-process" theories have instead emphasized the influence of preconscious processes on judgments and decisions (e.g., Bargh & Chartland, 1999; Evans & Over, 1996). Many (but not all) of those in this theoretical camp believe that rational decision making is dependent on both conscious, "analytic" processing and preconscious, "experiential" processing.

In these theories, cognition is believed to develop along two trajectories—one directed toward increases in computational processing, metacognitive abilities, and the capacity to decontextualize reasoning from problem content; the second directed toward highly contextualized processing (Stanovich, 1999) that relies heavily on both vivid, personal memories and implicit, procedural memories. Several basic assumptions of two-process theories pose serious challenges to most theories of cognitive development. These include

the assumptions that (a) experiential and analytic processing occur simultaneously, (b) these systems develop independently, (c) experiential processing is the system's default, and (d) experiential processing is predominant over analytic processing in a multitude of everyday situations. If these assumptions are borne out, theoretical construals of development as a unidirectional progression within a single processing system, with progress defined (at least in part) as progress from intuitive processing to logico– mathematical processing (e.g., Inhelder & Piaget, 1958; Piaget & Inhelder, 1951/1975) will no longer be tenable.

Over the past 10 years, two-process theories have become increasing prominent in social (e.g., Chen & Chaiken, 1999), personality (e.g., Epstein, 1994; Epstein & Pacini, 1999), cognitive (e.g., Evans, 1989; Evans & Over, 1996; Sloman, 1996; Stanovich, 1999), and, most recently, developmental psychology (Klaczynski, 2001a, 2001b; Reyna et al., chap. 3, this volume; Reyna & Brainerd, 1995). Although theorists disagree over the terms used to label the two systems (e.g., *analytic* vs. *heuristic processing*, *rational* vs. *experiential processing*, *systematic* vs. *heuristic processing*, *explicit* vs. *tacit*; see Stanovich, 1999, p. 145, for a more complete listing), descriptions of analytic and experiential processing tend to focus on similar properties. The general properties and functions of each system are now listed.

Experiential processing:

- Is holistic and "peripheral" in the sense that it involves a cursory grasp of the entirety of a situation. When experiential processing is predominant, responses have no basis in reasoning in the "usual" sense (i.e., componential analyses are circumvented) and attempts to break problems down into discrete components are absent.
- Is fast, occurs with minimal conscious awareness, and requires little cognitive effort.
- Consequently, enables the automatic recognition and encoding of information that is peripheral to the individual's current focus of attention and frees attentional resources for computationally complex reasoning.
- Simultaneously, this "peripheral" processing enables the detection of unusual information that could cue shifts in attentional focus.
- Generally operates on "contextualized" representations that are heavily dependent on problem content (e.g., familiarity), information gleaned from the proximal context, and semantic memory structures (e.g., stereotypes, beliefs, "theories").

Among other things, the activation of stereotypes, personal theories (e.g., of personalities), vivid or salient memories (Kahneman & Tversky, 1972; Klaczynski, 2000), and procedural memories often leads to experiential pre-

dominance. This predominance may (i.e., without intercession on the part of analytic processing) lead to heuristically based judgments and decisions that have the intuitive "feel" of being correct (Epstein, 1994). Hence, when experiential processing is predominant, preconsciously activated heuristics are applied "thoughtlessly" (i.e., without concern for their limitations; see Arkes & Ayton, 1999); that is, individuals often make decisions on the basis of automatically activated heuristics and, in doing so, do not often wonder why a given heuristic should or should not have been used.

According to Sloman (1996): "[Experiential] thought *feels* like it arises from a different cognitive mechanism than does deliberate, analytical reasoning. Sometimes conclusions simply appear at some level of awareness, as if the mind goes off, does some work, and then comes back with a result . . ." (p. 3).

As discussed subsequently, it is important to note that the automatic activation of a heuristic does not necessarily entail the automatic application of that heuristic. That is, the product of the mind going off and doing some work at a preconscious level is often a heuristic that is, at least momentarily, available in working memory. As such, it is possible (although the heuristics and biases literature indicates that, for most people, it is not likely) for the reasoner to critically reflect on the value of the solution. The ability to reflect on and pass judgment on experientially produced solutions is a quality of analytic processing.[2]

Analytic processing is consciously controlled, effortful, and deliberate. Although preadolescents clearly engage in analytic processing under certain task conditions (see, e.g., Harris & Leevers, 2000), on most tasks in the judgment- and decision-making literature, successful analytic processing depends on the acquisition and utilization of abilities that are frequently prescribed as normative for reasoning and decision making (Epstein, 1994; Sloman, 1996). These competencies include the higher order abilities that enable reasoning consistent with the rules of formal logic, decisions based on comparisons between a priori probabilities, accurate calibration of one's abilities, explicit inductive and deductive reasoning, an understanding of the limitations of induction and deduction, and a host of more specific skills and abilities.

In contrast to experiential processing, analytic processing is less personal, less context-dependent, and more reliant on context-independent principles.

[2]Although a great deal of information processing takes places at the "truly" unconscious level, experiential processing may involve various degrees of consciousness. Despite vagaries surrounding definitions of unconscious, minimally conscious, and peripherally conscious processing, experiential processing produces responses with little, if any, effort. Obviously, additional theoretical clarity is needed if two-process theories are to progress. For the present, however, I use the term *unconscious* to mean "minimally conscious" or "on the periphery" of consciousness. This usage is consistent with the belief of some two-process theorists (e.g., Epstein, 1994) that experiential processing is "felt" at some level. Attention to these intuitive feelings may bring the products of experiential processing fully into consciousness, where they may be evaluated analytically.

Unlike experiential processing, analytic processing is directed toward breaking down problems into their component elements, carefully examining these elements, and, from this analysis, deriving a problem solution, judgment, decision, or argument. In further contrast to experiential processing, analytic processing operates on "decontextualized" representations. However, the ability to consciously decontextualize task structure and requirements from logically irrelevant contextual forces (e.g., pressure to conform), superficial task contents, and misleading memories activated by contexts and contents depends largely on the metacognitive abilities (e.g., metaprocedural) discussed earlier and on general executive function abilities (e.g., planning, impulse control, ability to inhibit memory-based interference). The process of decontextualization, in turn, is essential if other analytic competencies are to be engaged consistently and effectively (Stanovich, 1999; Stanovich & West, 1997). Decontextualized task representations—wherein the underlying structure (e.g., logical components) of a problem has been decoupled from superficial contents (e.g., counterfactual information)—thus provide working memory a "structure" on which logico-computational processing can operate (Stanovich & West, 1997; see also Donaldson, 1978).

The relationship between processing systems and task representations is more complex than this portrayal suggests, however (see Reyna et al., in press). First, some degree of experiential processing is necessary (e.g., to automatically process text) even when the analytic system is predominant (for additional detail and examples, see Evans & Over, 1996). Second, the motivation to engage in analytic processing and shift away from the default (i.e., experiential) system leads individuals to attempt the construction of decontextualized representations. However, these attempts may be unsuccessful (e.g., such failures appear to be common on counterfactual reasoning tasks and syllogisms containing belief-relevant premises). Third, although the successful derivation of a decontextualized representation increases the probability of additional analytic processing, these representations do not guarantee normatively correct judgments or decisions (see Reyna et al., in press). Even when working on decontextualized representations, individuals may apply inappropriate decision-making principles, misapply appropriate principles, or fall back on experiential processing (e.g., if a problem appears computationally overwhelming). Further, despite analytic predominance and conscious attempts to reason independently from irrelevant task contents, experiential processing sometimes creates interference that biases the outcomes of these conscious efforts.

As this last statement implies, it is important to recognize that decision making results from the confluence of experiential and analytic processing (Epstein, 1994) and that preconsciously extracted (i.e., not effortful) representations often form the basis for consciously made decisions (Evans & Over, 1996). The former claim requires the caveat that task characteristics

(e.g., familiarity), context (e.g., social demands for accuracy), and individual differences (e.g., age, epistemic beliefs, intelligence) interact to determine which processing system is predominant on a given task (Stanovich, 1999). The latter claim is critical in that representations are also essential determinants of the processing system accessed in a given situation; at the same time, representations are partially determined by the extent to which individuals are motivated to derive "correct," precise, and justifiable solutions (see Klaczynski & Narasimham, 1998b).

The experiential–analytic processing theory requires an important and fundamental distinction between process and product (see also Moshman, 2000). Yet, this distinction is often blurred by decision and social-cognitive theorists. For example, it is not unusual for theorists to conflate evidence that a heuristic has been used with evidence that the processes underlying that decision were experiential. However, although processing may be predominantly experiential or predominantly analytic, the products of either system may be normative or nonnormative decisions. Thus, for example, automatically activated heuristics may, at least momentarily, be available in working memory for inspection (Klaczynski, 2001a). Individuals may then consciously decide whether to use or reject these heuristics as guides for their decisions. Thus, the probability of normative decisions increases when analytic system processing is predominant and experiential processing is inhibited, but analytic processing by no means guarantees adaptive decisions and experiential processing is not necessarily tied to nonnormative decisions. In short, all good decisions are not necessarily outcomes of analytic processing; all bad decisions are not necessarily products of experiential processing.

Empirical Evidence for Two Cognitive Systems

Considerable evidence accumulated over the past 30 years or so has not only falsified predictions generated from traditional cognitive developmental perspectives (e.g., Piagetian, information processing), but has also shown that satisfactory accounts of intellectual growth must explain the perplexing frequency of errors on simple logical problems, the relationships between reasoning and memory (Reyna & Brainerd, 1995), and the observation that variability, rather than consistency, is the hallmark of everyday cognition and its development (Jacobs & Klaczynski, 2002; Klaczynski, 2000; Kuhn et al., 1995; Reyna & Brainerd, 1995; Siegler, 1996).

In this section, I briefly review some of the developmental research that supports the claims of two-process theorists. In the next section, I focus more specifically on my own research on developments in reasoning, the belief–motivation–cognition interface, and decision making. Although no individual finding suffices to establish the existence of two processing systems, when examined as a whole, these studies—in combination with work on the

prevalence of "magical" thinking in both children and adults (e.g., Subbotsky, 2000), implicit and explicit memory (e.g., Lie & Newcombe, 1999; Newcombe & Fox, 1994), and memory–reasoning independence and dependence (see Brainerd & Kingma, 1985; Reyna et al., in press)—render difficult (if not impossible) arguments that development proceeds within a single system.

Several developmental studies indicate that judgment heuristics are used more often by older than by younger children (e.g., Davidson, 1995; Jacobs & Narloch, 2001; Jacobs & Potenza, 1991; Markovits & Dumas, 1999; Reyna & Ellis, 1994). The importance of these findings is not that it establishes developments in experiential processing per se, but instead that it illustrates increases in the availability of (what have traditionally been considered) nonnormative strategies for decision making. The acquisition of these heuristics, in combination with developments in computational abilities, affords increases in the flexibility of children's and adolescents' decision making, increases the likelihood of "cognitive variability" (problem-to-problem shifts in reasoning or decision quality)—which, in turn, increases the extent and type of feedback on which analytic processing (via metamonitoring of outcomes) can operate—and provides an increasingly diverse arsenal on which experiential and analytic processing can rely.

Findings of age-related increases in certain nonnormative responses are difficult to explain without reference to two cognitive systems. Jacobs and Potenza (1991), for instance, found that reliance on statistical evidence on asocial decision tasks (e.g., about bicycles) increased with age (presumably because of increased analytic competence). On logically isomorphic social problems, however, the opposite trend was observed: With increasing age, children relied more on the "representativeness heuristic" (i.e., the extent to which individual cases conform to existing schemata) and less on statistical evidence (presumably because of increased reliance on experiential processing). Under some conditions, older children commit the "conjunction fallacy" (i.e., judge p[AB] as more likely than p[A] or p[B]) more than younger children, a finding that has also been attributed to increased reliance on representativeness (Davidson, 1995).

Similar evidence can be found across disparate methodological paradigms and dimensions of cognitive development. Despite knowledge of normative computational strategies, age (under certain conditions) is positively associated with (a) making probability judgments based on simple, cognitively economical, strategies (e.g., ignoring denominators in ratio problems; Brainerd, 1981); (b) changing decisions as a function of the "framing" of logically identical problems (Reyna & Ellis, 1994); (c) making nonlogical "transitive" inferences regarding social relationships (e.g., "A is a friend of B. B is a friend of C. Therefore, A and C are friends"; Markovits & Dumas, 1999; a "friends of friends are friends" heuristic); (d) committing deductive reasoning fallacies (Klaczynski & Narasimham, 1998a; Wildman & Fletcher, 1977); (e) im-

puting false beliefs to others (Mitchell, Robinson, Isaacs, & Nye, 1996); (f) misinterpreting the premises of syllogistic reasoning problems (Noveck, 2001), and rejecting evidence on the basis of nonlogical heuristics (Klaczynski, 2000). Although some of these findings could be due to the overextension of logical rules of inference, such overextension is unlikely to be governed primarily by conscious processes. Therefore, because these developmental trends are systematic and yet violate formal rules of inference, they likely arise from a cognitive system that does not rely on logico-mathematical processing.

RESEARCH ON ADOLESCENT REASONING, JUDGMENTS, AND DECISIONS

Despite numerous reports of counterintuitive developmental trends, considerable care must be taken before assuming that experiential processing increases in predominance with age or that the use of decision heuristics increases monolithically with age. Specifically, not all research on heuristics and biases has demonstrated developmental increases in nonnormative responding. In the present section, research on motivated reasoning biases and decision heuristics is described. Embedded in these descriptions is the argument that developmental advances in metacognitive skills can at least partially explain why heuristics are sometimes used more by children than adolescents.

Adolescent Development and the Belief–Motivation–Reasoning Interface

In several investigations, my colleagues and I (e.g., Klaczynski & Aneja, 2002; Klaczynski & Gordon, 1996a; Klaczynski & Narasimham, 1998b) studied how children and adolescents process everyday arguments and "scientific" evidence. The basic tactic in these studies has been to present logically flawed arguments or methodologically flawed scientific investigations, the contents of which are relevant to strongly held beliefs. The conclusions drawn by the "arguers" or "scientists" in these scenarios are either consistent, inconsistent, or neutral with respect to these beliefs. In each scenario, information participants had provided concerning their beliefs and/or groups to which they belonged (e.g., concerning their religious affiliations) was inserted to make the scenarios as personally meaningful as possible. Consider the scenario presented now (adapted from Klaczynski & Narasimham, 1998b), designed for an adolescent who believed that being a Baptist makes a person morally superior to members of other religious affiliations:

> Dr. Robison is a psychologist interested in finding out whether sexual harassment is more likely to occur in some religious groups than in others. To conduct his research, he conducted a study of Baptists, Catholics, Methodists, Hindus, Muslims, and Lutherans. In each religious group, he asked 40 people to be in the study. To measure sexual harassment, Dr. Robison observed people in each group at church meetings and picnics and counted the number of times each person told jokes with sexual content. At the end of his study, Dr. Robison found that the average Baptist told 6.5 sexual jokes per month. Members of the other religions . . . told an average of only 2.0 sexual jokes per month. . . . Based on this, Dr. Robison concluded that Baptists are involved in more sexual harassment than . . . members of other religions.

This conclusion contrasts rather clearly with the adolescent's previously expressed belief. Like most adults, adolescents process such belief-threatening information with considerably more care than information that is either belief-neutral or belief-supportive. Specifically, the evidence is processed analytically and scrutinized closely for flaws; problem representations are based on decontextualizations of the logical structure of the evidence and/or arguments. On the basis of this processing, the evidence is rejected, often by invoking normative principles of logic, argumentation, and scientific reasoning. In dealing with this scenario, the adolescent is likely to display rather sophisticated reasoning by arguing that the operationalization of sexual harassment lacks construct validity. For example, one respondent claimed, "The amount of jokes about sex a person tells hasn't got anything to do with sexual harassment. Plus, you don't know who they're telling the jokes to." Other problems—involving sample size, selection, and experimental confounds—are also much more likely to be detected when evidence (if it appears plausible) threatens beliefs than when evidence is supportive or neutral.

When evidence supports beliefs, experiential processing is usually predominant. Specifically, the evidence is processed at a relatively cursory level, and representations appear to be highly contextualized (i.e., based on superficial contents that support relevant beliefs). Justifications for evidence acceptance derive from personal experiences, category exemplars, positive stereotypes of in-groups, negative stereotypes of comparison out-groups, and simple assertions as to the validity of the evidence.

In the within-subjects designs used in these investigations, participants are presented randomly determined sequences of belief-threatening, supportive, and neutral evidence. This approach provides the opportunity to examine problem-to-problem variability in processing. Of particular importance is the surprising finding that children, adolescents, and adults are very similar in the extent to which they vacillate between experiential processing on supportive and neutral problems and analytic processing on belief-threatening problems. This within-individual variability in processing suggests several hypotheses concerning the relationship between reasoning biases and meta-

cognition (specifically, metamonitoring). First, adolescents in this work may not have used their metamonitoring skills to track the course of reasoning for consistency (e.g., because they were not aware that these skills were relevant). Second, adolescents may have tried to use their metamonitoring skills, but these skills may not have been sufficiently developed to be useful. Third, adolescents may have successfully monitored their reasoning and realized that it was inconsistent between problems, but may not have believed that maintaining consistency is important or valuable (a belief more likely among absolutists and subjectivists than among rationalists; see Kuhn, 2001).

The variability adolescents demonstrate in studies of belief-biased reasoning is a pattern of reasoning like that shown in Fig. 2.1. As the figure illustrates, fluctuations in reasoning and strategy use are not random; rather, they are largely a function of evidence type. The line depicting adolescents' "reasoning" is intended to illustrate their general tendency to invoke their (relative to children) superior analytic competencies. The generally parallel nature of adolescent and child reasoning shows that, despite differences in basic analytic competencies (e.g., argumentation skills, scientific reasoning abilities), the amount of variability—and, by implication, the amount of experiential processing interference—differs little, if at all, with age. What is not shown in the figure is the additional finding (Klaczynski, 2000; Klaczynski & Aneja, 2002; Klaczynski & Fauth, 1997) that the heuristics and other nonlogical strategies used to justify the acceptance of belief-supportive evidence do sometimes differ with age. Because the amount of experiential interference is similar (on these tasks), this last finding illustrates that the use of different heuristics by children and adolescents does not necessarily reflect age differences in reliance on experiential processing. This description also implies that information processing is dualistic: Regardless of evidence

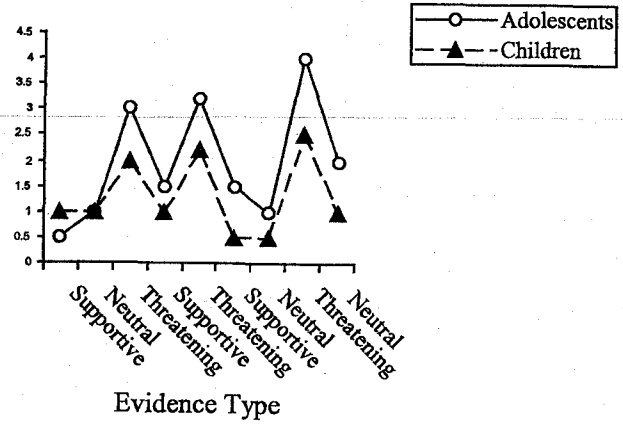

FIG. 2.1. Variability in belief-biased reasoning.

type and age, elements of both analytic and experiential processing are often apparent in individuals' evidence assessments. It is the predominance of processing systems—rather than the complete "switching off" of one system or the other—that changes with evidence type.

Two sets of evidence illustrate the importance of metacognition in belief-biased reasoning. The first set of evidence is from two studies in which we examined the effects of extrinsic "accuracy" motivation on belief-based reasoning biases. In these studies (Klaczynski & Gordon, 1996b; Klaczynski & Narasimham, 1998b), adolescents were instructed that if they gave confusing, thoughtless, or inaccurate responses, they would be contacted during the next week and required to meet individually with the experimenters to justify their responses. The effect of these instructions was considerable in the sense that reasoning across problem types (i.e., belief-threatening, neutral, and supportive) was much more complex than in the control conditions. However, what did *not* change was the degree of bias in participants' reasoning. That is, although reasoning overall improved, the magnitude of the differences between reasoning on belief-threatening and belief-supportive problems was as large in the "accuracy motivation" conditions as in the control conditions. These findings suggest that participants could not consciously control the biases they introduced into their reasoning; from the improvements in reasoning complexity observed in the "accuracy" motivation conditions, it is apparent that participants made efforts to reason "objectively" and more effectively than control participants. Yet, despite these efforts, biases—evidenced by between-problem type differences in reasoning complexity—did not diminish. This was as true for adolescents who scored poorly on measures of intellectual ability as it was for adolescents whose ability scores were high.

The second set of evidence illustrating the role of metacognition in belief-bias reasoning comes from examination of the data from each of the aforementioned studies. In each study, some participants were not biased in their reasoning, despite holding beliefs as strong as those of their more biased peers (see also Stanovich & West, 1997; for detailed discussions of individual differences in rational thought, see Baron, 1985; Stanovich, 1999; Stanovich & West, 1998, 2000). Perhaps the most obvious individual difference variable that could explain differences in reasoning biases is general intelligence. However, in several investigations, intellectual ability has explained virtually no variance in biases (e.g., Kardash & Scholes, 1996; Klaczynski, 1997, 2000; Klaczynski & Gordon, 1996a, 1996b; see, however, Stanovich & West, 1997). In light of these data, Klaczynski (2000) and Klaczynski and Fauth (1997; see also Klaczynski, Gordon, & Fauth, 1997, Experiments 3 and 4; Stanovich & West, 1997) explored whether individual differences in epistemological beliefs (e.g., "People should always take into consideration evidence that goes against their beliefs"; from Stanovich & West, 1998, p.

167) and metacognitive dispositions (e.g., "It is more important for me than to most people to behave in a logical way"; from Epstein, Pacini, Denes-Raj, & Heier, 1995; see Epstein & Pacini, 1999, p. 996) could explain between-subject variability in biases. Although these investigations relied heavily on self-report questionnaires, they nonetheless accounted for significant and unique variance in each study.

To an extent, relationships between metacognitive dispositions and reasoning biases argue for roles of metaknowledge, metaprocedural understanding, and metamonitoring capabilities. Specifically, each of these aspects of metacognitive ability is necessary for individuals to act effectively on the types of dispositions just listed. Thus, the results implicate metaknowledge (e.g., understanding that personal beliefs should be as open to scrutiny as others' beliefs), metaprocedural competence (e.g., understanding which computational abilities to use under which conditions), and metamonitoring ability (e.g., possibly indexed by items tapping intellectual curiosity and carefulness) as playing important roles in reducing the experiential processing interference with analytic processing and in attempts to reason independently from beliefs (Stanovich, 1999).

Decision Heuristics and Analytic Competence

In three recent investigations (Klaczynski, 2001a, 2001b, 2004; Klaczynski & Cottrell, 2004), I explored the relationships among age, heuristic and analytic processing, and task conditions. In one study (Klaczynski, 2001a), I presented adolescents with a series of problems derived from the "heuristics and biases literature." Among other tasks, participants were presented indicative and deontic versions of Wason's (1966) selection task, several "conjunction fallacy" problems, as well as problems involving covariation detection, statistical decision making, the gambler's fallacy, outcome bias, and hindsight bias. Several findings are noteworthy. First, normative reasoning, judgments, and decisions were, with few exceptions, more common among middle adolescents than among early adolescents. Second, the associations between normative responding and a measure of general intellectual ability were not uniformly positive or significant. For example, although statistical decision making and covariation judgments were related positively to ability, neither the tendency for outcomes to bias judgments nor hindsight biases were linked to ability. Third, principal components analyses revealed two readily interpretable factors. The analytic factor comprised normative statistical reasoning, deontic reasoning, covariation judgments, and the metacognitive abilities involved in assessing the accuracy of one's judgments. The heuristic factor comprised a host of nonnormative fallacies and biases (e.g., outcome bias, hindsight bias, the conjunction fallacy). Whereas the analytic factor

was positively related to age and ability, the heuristic factor was related negatively to age and was scarcely related to ability at all ($r = .03$).

Two problems from this study are displayed in Table 2.1. These two problems, each of which requires but a modest degree of statistical reasoning competence, are useful in illustrating one of the more important findings. Solutions to the "law of large numbers" (LLN) problem had high loadings on the analytic processing factor and were related to both verbal ability and age. Outcome bias solutions, although also positively related to age, loaded highly on the heuristic (i.e., experiential) factor and were not related to ability. Questions these findings raise include: Why, despite similar relations to age, would such problems as these load on different factors? Why would they bear

TABLE 2.1
Examples of Judgment Tasks From Klaczynski (2001a)

Outcome Bias
A priori failure probability high, outcome nonetheless favorable
A businessman owned a company that was not making very much money. The man was, of course, very upset; if he did not make more money, he would be forced to shut the company down in the next 4 years. He just learned that he might be able to save his company if he became partners with another company. By joining together, he could make enough money to keep the company going at least 8 more years. However, there was a 10% chance that both companies would go bankrupt and lose all their money if he became partners with the other company.
The person decided to go ahead and become partners. The partnership worked; now the company will last at least 8 more years. Was the man's decision to become partners with the other company a good decision? (Judgments made on 7-point scale)
A priori failure probability low, outcome nonetheless unfavorable
A man has been running a small market for 10 years, but the market has never made very much money. He has learned that, because of a new shopping mall, he will be forced to close his market within 3 years. But he could move his store into the mall. If he moves into the mall, he could keep his market open for at least 9 more years. However, there was a 4% chance that his store would completely fail if he moved it into the mall.
The man decided to go ahead and open a new store in the mall. It failed and he had to close his store. Was the man's decision to move his store into the mall a good decision?
Statistical Decisions
Ken and Toni are teachers who are arguing over whether students enjoy the new computer-based teaching method that is used in some math classes.
Ken's argument is, "Each of the 3 years that we've had the computer-based learning class, about 60 students have taken it. At the end of each year, they have written essays on why they liked or didn't like the class. Over 85% of the students say that they have liked it. That's more than 130 out of 150 students who liked the computer class!"
Toni's argument is, "I don't think you're right. Stephanie and John—the two best students in the school, both are high honors students—have come to me and complained about how much they hate the computer-based learning class and how much more they like regular math classes. They say that a computer just can't replace a good teacher, who is a real person."

different relations to general intellectual ability? Why was age related to responses to both types of problem?

Each question requires in-depth task analyses that are beyond the scope of this chapter. Nevertheless, required on each task is decontextualization of the formal requirements of the problems from misleading contents. In the case of the statistical reasoning problems, the relatively vivid personal arguments create an "experiential attraction"—"pulling" for predominantly experiential processing and the activation and utilization of such heuristics as, "they saw it with their own two eyes." Reasoners must inhibit the attraction of such heuristics and recognize that one can have more confidence in decisions based on large evidential samples than in decisions based on small samples. Ability is linked to decontextualization skills (Stanovich, 1999; Stanovich & West, 2000) and, to an extent, other metaprocedural skills (e.g., recognition that the problems require application of the law of large numbers).

The outcome bias problem also requires separation of formal requirements from misleading contents. Unlike the LLN problems (and other ability-related problems, such as the contingency detection problems), the two components of the outcome bias problems (e.g., low probability of success versus [relatively] high probability of success) were separated by a number of other problems. In making a judgment, the two logical components (success probabilities in the two problems) that were pitted against one another were not obvious—explicit comparison required both memory for one's judgment on the initial problem and metamonitoring to know that a similar problem had been presented previously. Perhaps more importantly, the low probabilities of success, in combination with explicit knowledge of actual success and failure, may activate "success = good," "failure = bad" heuristics, as well as tendencies to engage in post hoc theorizing and commit the "if only" fallacy (e.g., "If only the man hadn't moved his store into the mall . . ."). Because outcomes are easier to process than probabilities, and because reliance on either usually leads to the same evaluation, the analytic–experiential conflict thought to occur for higher ability adolescents on the more "transparent" LLN problems is considerably less likely on outcome bias and similar problems.

On the surface, neither the LLN nor the outcome bias problems are particularly complex. Given that a rudimentary understanding of the role of probabilities and sample size in making judgments develops prior to adolescence (Jacobs & Narloch, 2001; Jacobs & Potenza, 1991; Klaczynski & Aneja, 2002; S. Kreitler & H. Kreitler, 1986), neither the differences among same-age adolescents nor between differently aged adolescents can be easily explained by reference to differences in intellectual ability (as traditionally measured). Indeed, consistent with the arguments others have voiced (e.g., Ceci, 1990; Berg & Sternberg, 1985; Sternberg, 1985), the metacognitive skills—decontextualizing, inhibiting interference, monitoring reasoning, determining appropriate procedures—important to solving such problems normatively are not well-captured by standard ability tests. As results from tasks that strongly "draw" adolescents toward experiential processing (e.g., outcome bias, hindsight bias, "gambler's fallacy," etc.) illustrate, it would seem that age is not merely an index of raw intellectual talent. Rather, what age may capture that standard measures of ability do not are the higher order decontextualization abilities and metacognitive dispositions that motivate the utilization of those abilities.

Two other studies illustrate the importance of highlighting developmental progressions in metacognition in theories of decision making. In the first investigation (Klaczynski, 2001b), early adolescents, middle adolescents, and young adults made judgments and decisions on sunk cost, ratio bias, and counterfactual reasoning problems. Participants were instructed to solve each problem as they usually would and from the perspective of a perfectly logical person (see Denes-Raj & Epstein, 1994; Epstein & Pacini, 1999; Kirkpatrick & Epstein, 1993). The intent of the usual "frame" was to elicit participants' default manner of processing (presumably experiential). The "logic" frame was intended to elicit a shift to analytic processing. An example of a "usual" ratio problem is:

> You are playing a lottery in which you can win $1,000. There are two jars from which you can select a winning ticket. In the first jar, there are only 10 tickets, and 1 of these is the winning ticket. In the second jar, there are 100 tickets and 10 winning tickets. Think about this situation as you normally would. Which jar, if either, would you select from to have a better chance of winning the lottery?
>
> A. The jar with 1 winning ticket
> B. The jar with 10 winning tickets
> C. It would not matter which jar I selected from.

An example of a "usual" sunk cost problem is:

> A. You are staying in a hotel room on vacation. You paid $10.95 to see a movie on pay TV. After 5 minutes, you are bored and the movie seems pretty bad. How much longer would you continue to watch the movie?
> B. You are staying in a hotel room on vacation. You turn on the TV and there is a movie on. After 5 minutes, you are bored and the movie seems pretty bad. How much longer would you continue to watch the movie?

(For A and B, participants selected from the following options: stop watching entirely, watch for 10 more minutes, watch for 20 more minutes, watch for 30 more minutes, watch until the end; the sunk-cost fallacy occurred when participants indicated that they would spend more time in A than in B; adapted from Frisch, 1993.)

The third type of problem involved a type of counterfactual thinking referred to as the "if only" fallacy. The "if only" fallacy occurs when behaviors

are judged more negatively when it appears that a negative consequence could have been easily anticipated, and therefore avoided, in one of two logically identical and equally unpredictable situations. Consider the example below (adapted from Epstein & Pacini, 1999):

> Tom parked his new car in a parking lot that was half empty. His wife asked him to park in a spot closer to where she wanted to shop, but he parked, instead, in a spot closer to where he wanted to shop. As luck would have it, when he backed out after shopping, the car behind him backed out at the same time, and both cars sustained about $1,000 worth of damage.
>
> Robert parked his car in the same parking lot when there was only one parking place left, so he took it. As luck would have it, when he backed out after shopping, the car behind him backed out at the same time, and both cars sustained about $1,000 worth of damage.

Participants indicated which, if either, of the two involved parties acted "more foolishly." Note that in both cases, the accidents were not actually under the control of the involved parties. Yet representations based on cursory task analyses (e.g., Tom had control, Robert had no control) may activate heuristics that link control to fault (i.e., similar to the *fundamental attribution error*—the tendency for observers to overestimate the role of dispositional factors when assessing another person's actions). Tom, whose accident appeared avoidable (if only he had heeded his wife), is believed by most young adults to have made a worse decision than Robert (Denes-Raj & Epstein, 1994; Epstein & Pacini, 1999)—whose parking decision was "forced" on him by uncontrollable circumstances.

Findings from this study were revealing in several ways. First, in both the "usual" and the "logic" frames, the normative judgments were infrequent. For instance, in the usual frame, only the young adult college students' responses were normative on what appear to be the simplest, most straightforward problems (the ratio problems). Second, in both frames, normative responding increased with age on all three tasks. Third, and perhaps most importantly, normative responses were much more frequent in the logic than in the usual frame, regardless of age and task. Even in the logic frame, however, responding was far from perfect and in some cases remained close to or only slightly above chance. The findings, collapsed over the three types of decision tasks, are presented in Fig. 2.2.

The fact that normative responding was better in the logic frame suggests experiential predominance in the usual frame. However, what occurred in the logic frame? It appears that an effortful shift from experiential to analytic processing took place. To achieve such a shift, adolescents must inhibit the "prepotent" response to a problem, evaluate the quality and/or appropriateness of that response, and consider alternative solutions. The main effect of the logic frame indicates that early adolescents may be as able to control

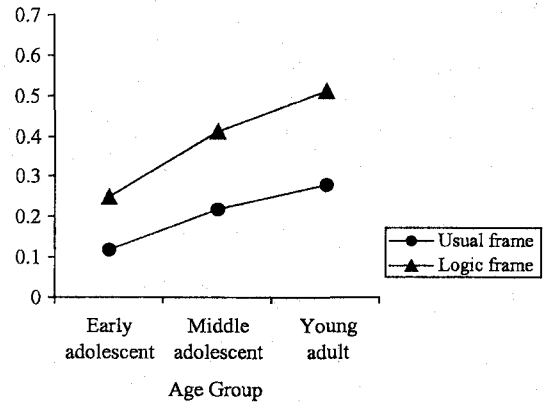

FIG. 2.2. Results from Klaczynski (2001b), collapsed across sunk cost, counterfactual, and ratio bias problems.

such experiential-to-analytic shifts as older adolescents and adults—although at none of these ages did a simple cue to switch processing modes have an overwhelmingly positive impact. At least in the case of the ratio problem, poor performance in the logic frame is probably not attributable to lack of the computational and/or analytic competencies this task calls for, as even preadolescents are capable of solving ratio problems and comparing ratios against one another (S. Kreitler & H. Kreitler, 1986). Rather, there are several possible explanations for participants' poor performance. For instance, participants may have had trouble defining and decontextualizing the logical task. Alternatively, the logic instructions may have been insufficient to induce an experiential-to-analytic shift, (in the case of the counterfactual and sunk-cost tasks) participants may have lacked knowledge of the relevant logical principles, or the heuristics activated by the tasks may have been too compelling for participants to dismiss easily. Indeed, at least in the case of the sunk-cost problems, subsequent research lends some credence to this last possibility.

In other investigations (Klaczynski, 2004; Klaczynski & Cottrell, 2004), a first goal was to determine how often adolescents use heuristics to respond to different decision tasks. A second goal was to examine the effects of arguments for either the normative decision or the heuristic decision on adolescents' decisions. This latter goal was particularly important because of its relevance to the analytic–experiential theory outlined earlier and to questions of adolescent decision-making competence. Specifically, the results of the two previously discussed investigations of adolescent decision making illustrated that under conditions with no instructions to engage in analytic processing (Klaczynski, 2001a) or rather minimal instructions to think analytically (Klaczynski, 2001b), adolescents' decisions are often nonnormative and

appear to rely heavily on heuristics. However, it is possible that, if adolescents were instructed to closely inspect arguments for heuristically based responses, they would reject these arguments. In subsequent decisions, adolescents might then rely more heavily on responses produced through analytic processing and thus show evidence of more decision-making competence than the two previous studies suggested.

In this research (Klaczynski, 2004; Klaczynski & Cottrell, 2004), decision tasks involving sunk costs and precedent setting were presented to 8-, 11-, and 14-year-olds (Study 1) and 9-, 12-, and 15-year-olds (Study 2). In the precedent setting problems, each scenario contained information about a publicly established rule (e.g., for classroom behavior, household chores), a rule infraction committed by a particular child, and the circumstances surrounding the rule infraction. The task was to decide whether to enforce the punishment associated with the rule or to make an exception. In Study 1, the circumstances surrounding infractions either appeared extenuating or more clearly fell under the purview of the rule. An example of a "no-mitigating circumstance" problem (adapted from Baron, Granato, Spranca, & Teubal, 1993) is:

> Mr. Miller, the coach of the basketball team, says that every person on the team has to go to all of the team's practices if they want to play in the games. If a person misses a practice, then he will not be allowed to play in the next game. Bill is the best player on the team. He missed three practices in a row, just because he wanted to watch TV instead. Bill is *so* good that the team will probably win if he gets to play, but the team will probably lose if Bill doesn't get to play. Now, it's the day before the game. What should Mr. Miller do?

The normative principle in cases such as this appears straightforward: Unless there are mitigating conditions, failure to enforce the rule establishes a negative precedent for future violations. Thus, if Mr. Miller does not enforce the rule, the rule is likely to lose its moral force and open the door for Bill (and his teammates) to question the rule in the future (see Moshman, 1998). When positive precedents are established by enforcing rules, they should serve to deter future violations; negative precedents, however, provide those expected to heed the rule grounds for arguing for the permissibility of violations.

However, under some conditions a clearly stated rule can be violated without establishing a negative precedent. Specifically, if the conditions surrounding a violation were not anticipated when the rule was created (or, if they were anticipated, they were not communicated to potential violators), then the question of whether the violation establishes a negative precedent is much more ambiguous. For example, in the "mitigating circumstance" version of the just-cited problem, the midsentences of the problem read: "Bill is the best player on the team. He missed three practices in a row because he had promised to do charity work at a hospital instead. Bill is *so* good that the team will probably win if he gets to play, but the team will probably lose the game if Bill doesn't get to play."

The results, depicted in Fig. 2.3, indicated that 9-year-olds responded at chance on both the mitigating and the no-mitigating circumstance problems. By contrast, on the no-mitigating circumstance problems, the 11- and 14-year-olds generally opted for rule enforcement (the normative decision). The opposite was found for the mitigating circumstance problems. Thus, most of the 11- and 14-year-olds elected to "make exceptions" (arguably, the normative decision). These results shed light on an aspect of adolescent decision making that hitherto had been investigated only by Baron et al. (1993). In contrast to children, both early and early middle adolescents evinced flexibility in their decision making, as only the adolescents systematically considered the role of context in their decisions. Children seemed to vacillate between rule enforcement and making exceptions—regardless of the contextual variations that had a pronounced effect on adolescents' decisions.

Adolescents' ability to coordinate social contextual considerations with apparently context-independent rules argues for a developmental progression in the same types of skills involved in coordinating beliefs and evidence that Kuhn and her colleagues have studied extensively (e.g., Kuhn, Amsel, & O'Loughlin, 1988; Kuhn et al., 1995). The findings also suggest application of at least a partially developed rationalist epistemology: Absolutists would likely have focused on rule enforcement on both mitigating and no-mitigating circumstances problems. Subjectivists, on both the mitigating and the no-mitigating circumstance problems, would likely have been predisposed toward making exceptions (i.e., "live and let live"; rules are relative to the individual and to the situation). Rationalists, however, in seeking the most justifiable rea-

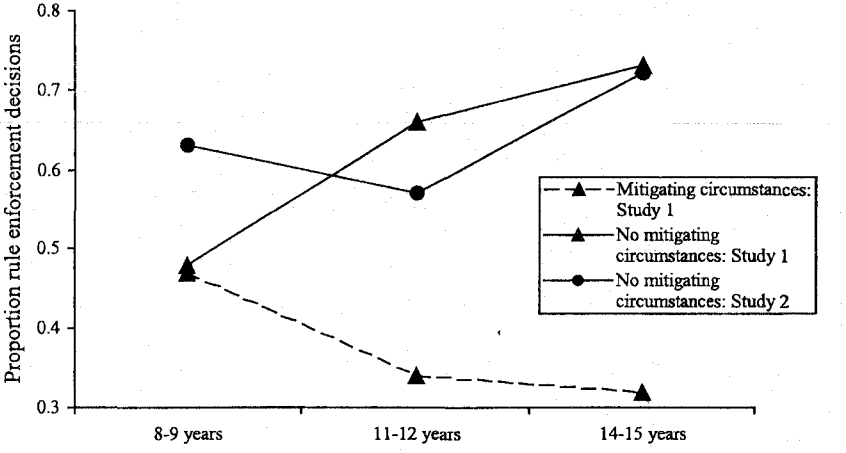

FIG. 2.3. Age trends in precedent-setting decisions.

sons for their decisions, would likely have considered the rule and the implications of its enforcement under the different conditions posed by the problems. Thus, rather than blindly applying rules about rules (e.g., enforce—regardless of context; make exceptions—regardless of context) adolescents (perhaps on the path toward becoming rationalists) were more likely than children to spontaneously apply their metacognitive knowledge.

Despite the attainment of a certain degree of metacognitive competence, adolescents' decision making remained characterized by substantial variability. To illustrate this variability, and again highlight the importance of metacognition in decision making, consider developmental trends in sunk cost decisions. For example:

> On parent's day at Julie's school, there will be a contest where all the students' paintings will be shown. Julie has spent the last 14 days working really hard on a drawing. She wants to win a prize pretty badly and thinks her drawing has a chance to win. Now, at long last, the drawing is almost finished.
>
> Then, just 4 days before the contest, Julie had an idea for a totally different drawing. She was positive that she could draw the new picture in 4 days, just in time for the contest. Not only that, but Julie thinks that the new drawing would be a lot better than the one she's been working on. The problem is that Julie has only one drawing board. That means that if she wants to draw the new picture, she will have to completely erase the picture she's been working on.

In both Study 1 and Study 2, children and adolescents demonstrated clear use of a nonnormative rule. As illustrated in Fig. 2.4, the majority honored sunk costs, presumably because of overreliance on a "waste not" heuristic (see Arkes & Ayton, 1999).

Although the age trends parallel those found on the precedent setting problems, these data illustrate two additional qualities of decision making and its development. First, on some decision tasks, children, like adults and adolescents, do not reply randomly; rather, they systematically use nonnor-

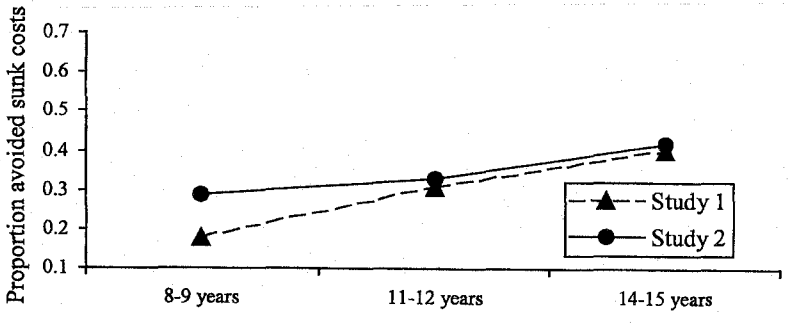

FIG. 2.4. Age trends in sunk-cost decisions.

mative heuristics (see also Davidson, 1995; Jacobs & Potenza, 1991). Second, despite age-related improvements, nonnormative rule use typified decisions at all three ages. In contrast to precedent setting, these data, as well as those from Klaczynski (2001b), suggested that most adolescents do not spontaneously demonstrate competence at making decisions involving sunk costs. However, the failure to spontaneously make normative decisions does not mean that adolescents do not have the competence to understand and make the normative decision. Instead, it could be that adolescents possess an understanding of the importance of avoiding sunk costs but do not engage this competence because the heuristic against waste is extremely appealing. That is, once activated, the "waste not" heuristic is momentarily available in working memory and can, during this time, be examined for its relevance to a given situation. The heuristic may seem so commonsensical, however, that neither children nor adolescents give any thought to analyzing it.

One way of determining whether the competence to understand sunk costs—and other decision making principles—has been acquired is to have participants evaluate arguments that illustrate the normative principle and arguments that favor the nonnormative heuristic. More so than simple instructions to respond logically, this task is likely to elicit analytic processing predominance because the task itself (i.e., make a judgment about a normative principle, a nonnormative heuristic, or both) requires that the participants' role is effortful and conscious. Thus, presentation of arguments for nonnormative heuristics functions to bring heuristics that are activated automatically into working memory. Once in working memory, analytic processing can be engaged to determine the value of the heuristics and contrast this value with that of the normative principle. If participants embrace the normative rule more often than the nonnormative rule and if they apply the normative rule more often than the nonnormative rule to subsequent decisions, then the case can be made that the requisite competence has, in fact, developed (Stanovich & West, 1999, describe this methodology and its usefulness in helping sort out arguments over adult rationality in greater detail).

Using a variant of the design developed by Stanovich and West (1999) in their work on adult decision making, in Study 2 (Klaczynski, 2004), participants made decisions on a set of "baseline" problems that involved either sunk costs or precedents (results for the baseline problems are shown in Fig. 2.3 and Fig. 2.4). After decisions had been made on the baseline problems (as already described), fairly detailed arguments were presented. Thus, for each baseline problem, an argument for the normative decision, an argument for the nonnormative decision, or arguments for both the normative decision and the nonnormative decision were presented. Examples of these arguments are presented in Table 2.2.

Subsequent to argument presentation, the original problems were represented and a set a transfer problems was administered. If nonnormative

TABLE 2.2
Examples of Normative and Nonnormative Arguments From Klaczynski (2004)

Normative Arguments	*Nonnormative Arguments*
Sunk costs Amy thinks that Julie should erase the old picture and draw the new one because "All the time that Julie put into the old picture doesn't make any difference. She wants to win, so she should use the new picture. She shouldn't worry about what she's already done. The work she put into the old one is in the past—she can't let that affect her now. Because she really wants to win, she's got to go with the best picture, even if she has to throw out a picture she worked hard on."	*Sunk costs* Tara thinks that Julie should keep working on the picture that she's spent 3 weeks on because "Julie's worked on this picture for 3 weeks. Even if the new picture would be better, all of her imagination and effort were in the old picture. She should show a picture that really means something to her. She worked really hard on that picture. If she doesn't use the one she worked so hard on, all of that time and effort will be wasted. If she doesn't use the old picture, she'll just be throwing away 3 weeks of work."
Precedent setting Mr. Ward thinks that Bill should *not* be allowed to play because "If Mr. Miller lets Bill play, other players might start breaking rules. He can't make an exception just because Bill is the best player. If Mr. Miller lets Bill break rules, the rest of the team could lose respect for him and might not listen to him if Bill gets away with skipping practice. It'd be better to lose a game than to make an exception."	*Precedent setting* Mr. Jones thinks that Bill *should* be allowed to play because "Bill has got to play or the team will lose. It's true that Mr. Miller set a rule, but in this case he has to make an exception. The rest of the team will understand—they probably want Mr. Miller to let Bill play. Nobody wants to lose, so for the good of the team, Mr. Miller should let Bill play."

responses were given on the baseline problems, and if at least some initial level of competence for understanding a particular decision principle had developed, then exposure to normative arguments should have resulted in more normative responding on problem re-presentation and on the transfer problems. Further, if responses on the baseline problems were normative and if the relevant competence was (to some extent) developed, then exposure to nonnormative, intuitively appealing arguments should not have had a negative impact (for a detailed discussion of the "understanding/acceptance" principle, its relevance to decision making, and its role in helping distinguish between responses purported to be normative and responses thought to be nonnormative, see Stanovich & West, 1999).

Importantly, the effects of both types of arguments were qualified by age and type of decision task. Specifically, regardless of age on the precedent-setting problems, normative arguments—both when these were presented by themselves and when presented with nonnormative arguments—led to more

normative precedent setting decisions when the original problems were re-presented; this effect carried over to the transfer problems only for the adolescent groups, however. By contrast, when presented by themselves (i.e., without the normative arguments), nonnormative arguments (involving appealing to a "make an exception" heuristic) led to declines in normative decisions at problem re-presentation for all three age groups and, on the transfer problems, for the 9-year-olds. Thus, when adolescents had the opportunity to evaluate the "make an exception" heuristic in working memory, it appears that the metaprocedural competence to recognize the heuristics' shortcomings had not fully developed, even by 15 years of age. However, unlike children, adolescents' reliance on heuristics was short-lived in the sense that they applied the "make an exception" heuristic only to the problems discussed in the arguments.

A very different picture emerged for sunk-cost decisions. First, following exposure to normative arguments, normative decisions by the 12- and 15-year-olds, but not the 9-year-olds, increased for the re-presented problems and the transfer problems. When normative arguments were presented alongside nonnormative arguments, however, only the 15-year-olds accepted and understood the superiority of the former type of argument over the latter. Second, the 15-year-olds were unaffected by exposure to nonnormative arguments (when presented without the normative arguments). By contrast, when the problems were re-presented, both the 9- and the 12-year-olds made more decisions in the nonnormative direction (although this effect did not carry over to the transfer problems). In contrast to the precedent-setting problems, this finding implies that the metaprocedural competence necessary to effectively evaluate the "waste not" heuristic and to evaluate the normative decision principle had developed by middle adolescence.

Findings such as these speak to the complexity involved in both making and disentangling arguments about age-related attainments in cognitive and decision-making competencies. In this case, it would appear (despite recent arguments to the contrary; e.g., Arkes & Ayton, 1999) that an understanding of sunk costs and of the reason for avoiding them does not develop prior to adolescence. Even so, at 12 years, this understanding seems somewhat fragile (given 12-year-olds' susceptibility to nonnormative arguments) and may not emerge "in full" until later in adolescence. But even at 15 years and beyond, people rely primarily on a "waste not, want not" heuristic. By contrast, children's responses to normative precedent-setting arguments appear to suggest some competence at 9 years and a greater degree (as indicated by positive transfer) by adolescence; yet, across ages, nonnormative arguments lowered the frequency of normative decisions. This latter finding illustrates that, once a competence has developed, its utilization is often overridden by situational factors that activate intuitively appealing heuristics. More broadly, decision-making competencies do not de-

velop in an all-or-none fashion and are not displayed under all apparently relevant conditions.

A theme underlying much of this chapter has been that, although all decisions are products of interactions between experiential and analytical processing, the system predominant at the moment of the decision is the more potent determinant of actual decisions. The aforementioned findings illustrate this interplay in that baseline decisions may well have been a function of automatically activated heuristics (e.g., "waste not," "make exceptions"), the "thoughtless" application of which was not (particularly for younger children and for sunk-cost decisions) prevented by metacognitive intercession. Both normative and nonnormative arguments cued analytic processing predominance and, in order to evaluate and apply the arguments, activated metaknowledge and metaprocedural understanding. Whether shifts were from the normative decision to the nonnormative decision (as usually occurred following normative arguments) or vice versa (which sometimes occurred following nonnormative arguments), postargument decisions involved the evaluation and acceptance of a decision rule different from that used at baseline. Further, this rule had to have been extracted from the arguments at some level of abstraction for transfer (whether positive or negative) to occur. Because the baseline, re-presentation, and transfer problems were separated by other problems (e.g., the baseline sunk-cost problems were separated from the re-presentation problems by both the arguments and precedent setting problems [as well as other problems not discussed here]), metamonitoring of decisions had to have been involved for participants to recognize the applicability of the decision rule to the novel problems. Finally, the findings illustrate that metaknowledge understanding and metamonitoring abilities are not always in perfect alignment with one another. For example, following nonnormative arguments, the negative transfer to novel precedent-setting problems can be taken as evidence for successful metamonitoring and, simultaneously, as evidence for miscomprehension at the metaknowledge level.

SUMMARY AND CONCLUSIONS

The principal aims of this chapter were fourfold. A first goal was to outline a two-process theory of reasoning and decision making that, until recently, has not been at the fore of discussions of cognitive development. A second goal was to illustrate the two forms of variability that characterize everyday reasoning, decision making, and development. One form involves moment-to-moment fluctuations in the sophistication of reasoning, analytic strategies, and heuristics that can be considered, to some extent at least, as evidence for rapidly shifting predominance between analytic processing and experiential processing. The second form involves developmental variability in the emergence of the competencies required to understand and apply normative decision rules. As the findings from Klaczynski (2004; Klaczynski & Cottrell, 2004) demonstrated, both in spontaneous decision making and in decision making following cues to process information analytically, there is no single age at which decision making competence is attained. A third goal was to highlight the role of three components of metacognition (metaknowledge, metaprocedural understanding, and metamonitoring) in analytic processing and in reducing moment-to-moment variability in reasoning and decision making. Finally, a fourth goal was to provide empirical evidence for a link between metacognitive development and decision making (see also Byrnes, 1998).

The evidence presented here supports the two-process assumption that, because it is the default system (i.e., that which is typically predominant), experiential processing, more often than not, is not overridden by analytic processing. Consequently, decisions are made and arguments are evaluated on the basis of cursory analyses of the circumstances and stereotypes, beliefs, and heuristics activated by these circumstances. Although this point was not emphasized here, often the outcomes of this processing are in line with those that would have been produced had analytic processing been predominant (see also Denes-Raj & Epstein, 1994; Stanovich & West, 1998, 2000). In other cases, although the decisions produced by the two systems may differ, they may be equally useful in achieving a goal (i.e., via different routes). In many cases, although experiential processing may lead to nonnormative decisions, the outcome of following the actions dictated by those decisions is not particularly harmful to the decision maker (e.g., the decision to continue playing golf by Jim, Dave, and Keith). In sum, reliance on the default-processing system sometimes has adaptive value (e.g., when it produces the same decisions as analytic processing, it does so more quickly, saving time and cognitive effort). A challenge for future research is to determine more precisely the conditions under which experiential processing predominance is more adaptive than analytic processing predominance.

Nonetheless, as research on belief-motivated reasoning illustrates, experiential processing often interferes with analytic processing to produce biases that not only preserve existing beliefs, but also perpetuate stereotypes and inhibit development. In the case of motivated reasoning, novel, but belief-threatening, information that may provide an adolescent new insights into the self and/or others is often rejected, but similar evidence that supports existing views of the self and others is accepted. Experientially biased decisions can have deleterious consequences, both in the short term and in the long term. Variable reinforcement (e.g., occasional winning) may be implicitly processed to create a "schema" for committing the "gambler's fallacy" and may contribute to addictive betting and gambling. Experiential processing of ratios, in combination with unrealistic optimism, may contribute to the wide-

spread tendency of adults to play lotteries. Clearly, there are numerous circumstances that call for analytic processing to override experiential processing. Indeed, as societies become increasingly complex, the need for analytic processing to override experiential processing may increase (Stanovich & West, 2000).

Equally clear is that there is variability—between decision and reasoning situations, between ages, and among individuals at particular ages—in the extent to which individuals can achieve analytic predominance (Stanovich, 1999). Studies of ratio bias and counterfactual decisions indicate that even simple cues to process information analytically can increase normative decisions from early adolescence through early adulthood. Likewise, studies of precedent setting and sunk-cost decisions show that arguments for normative decisions can produce shifts from nonnormative to normative decisions—shifts that require analytic predominance and that are easier to achieve by adolescents than by children. By contrast, as studies of the effects of accuracy motivations on belief-biased reasoning indicate, even adolescents and adults have difficulty inhibiting experiential interference when evaluating evidence bearing on strongly held beliefs.

These investigations indicate that the metacognitive abilities required to inhibit the implementation of automatically activated beliefs and heuristics are not always fully developed or, if they have in fact developed, the individuals possessing these abilities do not often expend the effort required to use them. Although there appear to be developmental improvements in metacognitive abilities, even by adulthood, they may not be fully developed (Kuhn, 2000; Moshman, 1999). It remains to be determined, however, whether poor decisions and biased reasoning are more a matter of acquiring dispositions to be "metacognitively oriented" than of possessing metacognitive abilities per se. Critical to further investigation of these issues will be improvements in the methodologies used to index both abilities and dispositions.

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3

Risky Decision Making in Childhood and Adolescence: A Fuzzy-Trace Theory Approach

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In this chapter, we discuss the psychological origins of judgment and decision making from childhood through adolescence, with an emphasis on developmental differences in risk taking. First, we outline a developmental theory—*fuzzy-trace theory*—that makes counterintuitive predictions about risk taking. The main prediction, in marked contrast to traditional theories, is that development progresses from compensatory trading off of risks and rewards to intuitive gist-based processing (e.g., Reyna, 1996; Reyna & Brainerd, 1991a, 1993, 1994, 1995a; Reyna & Ellis, 1994; Reyna, Lloyd, & Brainerd, 2003). A central tenet of fuzzy-trace theory is that judgment and decision making tend to be based on simple, gistlike mental representations of options ("fuzzy" memory traces), rather than detailed, quantitative representations of information (verbatim memory traces). *Gist* is defined as the individual's semantic representation of information—its meaning—which reflects his or her knowledge, worldview, culture, and developmental level (e.g., Reyna, 1996; Reyna & Brainerd, 1995b; Romo, 1995). As we discuss, fuzzy-trace theory encompasses social, affective, and neurological development, as well as cognitive development (e.g., Klaczynski & Fauth, 1997; Reyna, 1992; Reyna & Brainerd, 1998; Schacter, Curran, Galluccio, Milberg, & Bates, 1996).

Next, we relate these background principles provided by fuzzy-trace theory to situations of sexual risk taking in adolescence. We then review studies that show evidence of effectiveness in reducing sexual risk taking among adolescents. In that connection, we discuss how programs to reduce risk taking