INDIVIDUAL DIFFERENCES IN THINKING STYLES AND OVERCONFIDENCE

by

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(Under the Direction of ADAM S. GOODIE)

ABSTRACT

Overconfidence is a pervasive reasoning bias and refers to unwarranted confidence in one's knowledge or judgment. Most reasoning theories acknowledge that people reason both analytically and intuitively. Past research has revealed that intuitively-oriented individuals commit more reasoning biases. The hypothesis of this study was that heuristic processing contributes to the overconfidence bias. Two hundred seventeen participants completed a general-knowledge calibration task assessing overconfidence and Epstein's Rational Experiential Inventory (REI) measuring analytic and intuitive thinking styles. Results supported the hypothesis that intuitive thinking style is a significant predictor of overconfidence.

INDEX WORDS: Overconfidence, Thinking Styles, Individual Differences in Reasoning, Intuitive and Analytic Cognition

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DEDICATION

I would like to dedicate this thesis to Lawrence S. Meyers, Ph.D.

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INTRODUCTION

Overconfidence is one of several biases that have emerged from the heuristics and biases program in the judgment and decision-making field. Social psychologists propose that we are motivated to think highly of ourselves. Cognitive psychologists propose that mental capacity limitations trigger the use of heuristics or “mental shortcuts.” Both paradigms suggest that we distort information at some point ultimately sabotaging “good” reasoning. Despite variations, most overconfidence theories fundamentally link heuristic information processing with reasoning errors. The current investigation was motivated by the following logic: heuristic processing leads to biases, overconfidence is a bias, therefore people who more often use heuristic processing will be more overconfident. An individual differences approach is a novel way to test this potential association.

Overconfidence refers to the tendency to overestimate one’s own performance. In judgment and decision making, it refers to an overestimation of one’s knowledge. This effect has been replicated for decades across different populations and task domains, both inside and outside of the psychological laboratory. Typically, overconfidence is assessed in knowledge-calibration studies in which participants select answers to general knowledge questions and then supply confidence ratings after each answer. The pervasive finding is that mean subjective probability estimates (confidence ratings) exceed mean proportion correct (Lichtenstein & Fischhoff, 1977). Typical results indicate that a confidence rating of 70%, may be associated with an average accuracy of 60%.

Overconfidence is observed among physicians and nurses (Baumann, Deber, & Thompson, 1991), students with differing areas of expertise (Bradley, 1981), judges (Budescu and Rantilla, 2000), auditors (Hornik, 1999), real estate agents (Spence, 1996), black-jack dealers, and statistical experts (Wagenaar and Keren, 1985). Additional probability estimation biases include the failure to revise opinions in light of new information to the extent dictated by Bayes Theorem or "conservatism" (Edwards, 1968); judging two combined events as more likely than one of the events singly or "conjunction error" (Tversky & Kahneman, 1983); ignoring prior probabilities when estimating the likelihood of an occurrence or "base rate neglect," (Bar-Hillel, 1980); overestimating the predictability of an event after it has occurred or "hindsight bias," (Fischhoff, 1975); and finally, overestimating the likelihood of being correct or "overconfidence" (Lichtenstein & Fischhoff, 1977). These are judgment biases in which people fail to reason according to norms set forth by statistical principles. These systematic deviations along with the aforementioned probability estimation biases have been regarded as examples of suboptimal reasoning. The substantial body of research documenting reasoning errors has led some to call into question the rationality of human cognition. The contentious debate centers on the fundamental issue of deciding exactly who sets the norms for rationality (Goodie & Williams, 2000). For present purposes, the overconfidence effect will be accepted as a bias; but whether it should be regarded as an example of suboptimal reasoning or irrationality, while important, is beyond the scope of this paper. Attempts to improve the calibration (decrease overconfidence) of participants have remained largely unsuccessful (Fischhoff, 1982). Debiasing techniques included giving rewards, clarifying instructions, warning participants about the bias, and using alternative response modes.

Overconfidence is not confined to calibration tasks. A sampling of the literature reveals that people tend to think that they will be able to solve problems that they cannot; think they have solved problems that they have not; are highly confident that they are on the verge of a correct answer immediately before making a mistake; regard an answer as on the tip of their tongue when it never arrives; think they produced the correct answer when they did not; think they have learned and understood material when they have not; and finally, claim that they “knew it all along” (Metcalfe, 1998). This depressingly long list is not meant to illustrate how deluded we are, rather to illustrate the robustness of overconfidence and that it extends beyond general knowledge tasks.

Explanations of overconfidence fall under two main rubrics: motivational and cognitive. Motivational explanations are variations on the theme that we are motivated to view ourselves in a positive light (Taylor & Brown, 1988). Cognitive or information processing explanations attribute overconfidence to selective information retrieval and/or inappropriate evidence evaluation (Koriat, Lichtenstein, & Fischhoff, 1980). Among judgment and decision making researchers, there has been a schism between those who focus on suboptimality, usually within the heuristics and biases program (Kahneman and Tversky, 1982), and those who focus on adaptability (Gigerenzer, Hoffrage, & Kleinbolting, 1991). The former has generated a body of research that has advanced our knowledge about human cognition considerably. Likewise, the more recent emphasis on the adaptive nature of cognition continues to provide critical information and insight into the relationship between the organism and its environment. Despite (or perhaps because of) divergent approaches, the two complement each other and provide unique contributions to the complex picture of overconfidence. In addition, an individual differences approach can serve to inform both camps. As a methodology, the approach enjoys a specificity of analysis that the ontogenetic level affords, while maintaining neutrality on the rationality issue. Investigating individual differences in reasoning is likely to provide important implications for extant theories.

Traditional cognitive psychologists adhere to an information processing model of human cognition. Humans are forced to assimilate a vast amount of information generated both internally and externally in order to make sense of the world. How do we manage this formidable task? Due to cognitive limitations, we are forced to use “mental shortcuts” or heuristics when making judgments and decisions under conditions of uncertainty (Tversky & Kahneman, 1974). A tradeoff exists, however, because while the use of heuristics affords rapid processing, it often comes at the cost of accuracy. The concept of mental resource and capacity limitations is intimately linked to the idea that we are “cognitive misers” (Fiske, 1984) and generally avoid effortful thought. These widely-accepted ideas are consistent with the notion that humans are “satisficers” rather than optimizers (Simon, 1957), that is, we expend just enough effort to make a judgment or decision. However, the preference to minimize mental effort is qualified by evidence for individual differences in this construct.

Overconfidence has been widely investigated, but the underlying processes that cause it remain elusive. Cognitive psychologists have invoked information processing models to capture the mechanisms driving subjective probability estimation. Overconfidence has been explained in terms of selective retrieval of supporting evidence and neglect of disconfirming evidence. Koriat, Lichtenstein, and Fischhoff (1980) conceived of overconfidence in two main stages: 1) knowledge search and retrieval and

2) evidence evaluation and confidence assessment. Their results revealed a tendency to produce more reasons for, rather than against, selected answers, suggesting a favoritism towards supporting evidence known as the confirmation bias (Einhorn & Hogarth, 1978). In addition, bias decreased as a result of producing reasons that contradicted chosen answers. Furthermore, participants found it difficult to produce contradictory answers and assigned them less strength than supporting reasons known as the availability bias (Tversky & Kahneman 1974). Griffin and Tversky (1992) extended this research by finding that people focus on the strength or extremeness of the available evidence with insufficient regard for its weight or reliance. Their model predicted overconfidence when strength was high and weight was low, and underconfidence when strength was low and weight was high. Taken together, these findings lend support to the idea that confidence, at least in part, involves a tendency to retrieve and overweight supporting evidence.

The connection between heuristics and biases has been illustrated in a number of studies. Nelson and Narens (1980) found that people express stronger confidence in answers retrieved more quickly regardless of accuracy. Retrieval fluency has a clear conceptual link to the availability bias (Tversky, 1973). In addition, when retrieval fluency is increased through priming, overconfidence increases (Kelley & Lindsay, 1993). Shaw (1996) proposed that postevent questioning enhances retrieval fluency and subsequent confidence in answers.

Those who support ecological models of overconfidence argue that selected items are unrepresentative of the environment and therefore researchers, and not participants, exhibit bias (Gigerenzer, Hoffrage, & Kleinbolting, 1991). The argument is that in order for the test items to be representative of the environment, they must be randomly selected from a finite set. However, as Keren (1997) points out, there is substantial empirical evidence that overconfidence occurs even with items that have been randomly sampled.

A broad ecological approach considering organism, task, and the interaction, is not incompatible with the heuristic-bias connection. One way the environment may influence judgment and decision-making is time constraint. Sniezek, Paese, and Switzer (1990) found that overconfidence was greater for spontaneous, less contemplated choices suggesting that intentional and deliberate processing (careful consideration of options) might result in better calibration. Time pressure is a common stressor in many vocations and most likely is manifest in rushed judgments and decisions. In the case of overconfidence, a truncated information search likely results in the person left only with confirmatory evidence thereby susceptible to the confirmation bias.

The importance of taking the environment, especially task characteristics into consideration cannot be overemphasized. This approach, first advocated by Brunswik (1943), compels the researcher to consider the interplay of characteristics shared by both task and organism. According to Cognitive Continuum Theory (CCT; Hammond, 1996) the intuitive-analytic construct is conceptualized as falling on a continuum and both task and individual can be placed on these continua according to their relative degree of analytic and intuitive characteristics. CCT has received support from Dunwoody, Haarbauer, Mahan, Marino, and Tang (2000) in which an iconic information display induced an intuitive mode of information processing and a numeric display induced a more analytic mode. Stanovich (1999) provides a lucid description of potential effects of task representation (framing) on task construals (interpretation).

Whether the overconfidence task itself tends to favor one mode over the other, has yet to be empirically determined. The assumption for the present study is that the overconfidence task, like typical reasoning tasks, tends to favor analytical reasoning. This assumption is based on findings from two research areas that contain implications for the task. At the surface level, findings that an iconic display induces intuitive processing suggest that the numeric and verbal display of the overconfidence task might induce analytical processing (Dunwoody et al., 2000). At the semantic level, analytical processing might have preferential access to declarative knowledge. The overconfidence task consists of general knowledge questions and therefore accesses a person's declarative knowledge base. This task content facilitates decontextualized or impersonal reasoning. Decontextualized reasoning has been associated with analytic thinking dispositions (Stanovich, 1999). The overconfidence task probably favors decontextualized reasoning because the knowledge is factual and not personal in nature. A characteristic of the intuitive mode is the preference for using the self as a reference point when processing information (Epstein, 1990). Intuitively-oriented individuals may use themselves as an anchor and fail to adjust appropriately through some degree of decontextualization. This anchoring and adjustment bias (Tversky & Kahneman, 1974) might represent one of a family of biases which emerge when using the self as a reference point.

Consistent with this view is research in which analytically-oriented individuals tended towards deep processing (e.g., critical analysis) while those with an intuitive orientation tended towards elaborative (e.g., associationistic) processing (Schmeck, 1983). Schmeck (1983) concluded, however, that the holistic-analytic differences that emerged using the Deep and Elaborative Processing Subscales of the Inventory of Learning Processes (Schmeck et al., 1977) were subtle and suggested that deep and elaborative processing more likely reflect an integration of both analytic and holistic processing skills. This research alludes to the complexity of the relationship between the analytic and intuitive dimensions.

The distinction between systematic and heuristic processing is well-established and has taken many forms across psychology, including: verbal and nonverbal modes (Bucci, 1985; Pavio, 1986); declarative and procedural knowledge (Anderson, 1976; Winograd, 1975); tacit/implicit and explicit knowledge and memory systems (Broadbent, 1986; Schacter, 1987); extensional and heuristic processing (Tversky & Kahneman, 1983); propositional and narrative modes (Bruner, 1986); schematic and conceptual modes (Leventhal, 1984); and subconscious/automatic and conscious/deliberative modes (Brewin, 1989).

Additional evidence for the analytic and intuitive dimensions comes from construct validity of the intuitive-analytic continuum based on the convergence of three measures: Myers-Briggs Type Indicator (sensing, intuiting vs. judging, perceiving; Myers, 1985); Human Information Processing Survey (left and right hemispheric preference; Taggart, 1984); and Inventory of Learning Processes (holistic vs. serialist and deep vs. elaborative processing scales; Schmeck, Ribich, & Ramanaiah, 1977). Epstein's Cognitive-Experiential Self Theory (CEST) is a dual-process theory in which people are presumed to operate in two different, but parallel and interacting systems, rational and experiential (Epstein, 1990). According to CEST, the rational system is characterized as analytical, reason-oriented, processing that is intentional, effortful and slow, experienced consciously, and based on logical connections and context-general principles. In contrast, the experiential system can be characterized as intuitive, pleasure-pain oriented, processing that is automatic, effortless and rapid, experienced preconsciously, and based on associationistic connections and context-specific processing (Epstein, 1990).

Research on individual differences in reasoning supports the link between heuristic processing and biases. Individuals who reason more systematically or analytically, as defined by Need for Cognition (NFC; Cacioppo and Petty, 1982) fall prey to fewer biases. Epstein, Pacini, Denes-Raj, and Heier (1996) found that intuitively-oriented individuals produced fewer logical responses to vignettes, believed their heuristic responses were logical, advocated less effective coping strategies, and expressed unrealistic expectations of future success. Epstein et al. (1996) found that rationally-oriented individuals were less likely to express naïve optimism, although Klaczynski and Fauth (1996) found that analytically-oriented young adults tended to be more overoptimistic about future life events than those less analytically-oriented. Klaczynski, Gordon, and Fauth (1997) found intuitive-orientation was positively and analytic-orientation negatively associated with violations of the law of large numbers, persuasion, and failures of evidence evaluation. In addition, Epstein, Donovan, & Denes-Raj (1999) found that those aware of the conjunction rule violated it anyway. Epstein and Pacini (1999) modified judgment tasks taken from Kahneman & Tversky (1982) to investigate the use of heuristics. Participants responded to vignettes from three perspectives, indicating how they believed most people would have behaved, how they themselves would have behaved, and how a logical person would have behaved. In all studies, most responded that they and others would not behave like that of a logical person. An analysis of the responses indicated that the way people believed that they and others would behave was consistent with an intuitively-based system. This research suggests two things: 1) people are aware of two modes of thinking, and 2) they sometimes knowingly choose to behave in a way they consider less than rational.

Additional evidence comes from research on the ratio bias effect. People judge low probability events as having a lower subjective probability when represented by equivalent ratios of smaller numbers (eg. 1 in 10) versus larger numbers (eg. 10 in 100). For example, if participants are given an opportunity to win money by drawing a red jellybean from either a small bowl that contains 1 in 10 red jellybeans or from a large bowl that always contains 100 jellybeans with the percentage of red jellybeans varying from 5% to 10%; most choose from the large bowl. Participants will admit that they know it is irrational, but they still *feel* that they have a better chance of drawing a red jellybean when there are more of them (Epstein & Pacini, 1999). These results suggest that intuitive reasoning will result in more overconfidence than analytical reasoning.

Method

Participants. Two hundred seventeen University of Georgia undergraduates (169 women and 48 men, mean age 19 years, SD = 1.21) participated in the study in exchange for partial course credit.

Materials. The Rational-Experiential Inventory (REI; Epstein et al., 1996) is a 31-item personality inventory designed to measure analytical and intuitive processing modes. The analytic and intuitive modes correspond to the rational and experiential systems respectively. The REI contains a shortened-version (19 items) of the original 45-item Need for Cognition (NFC) scale (Cacioppo & Petty, 1982) and a 12-item Faith in

Intuition (FI) scale constructed by Epstein et al., 1996. Reliability for FI (Cronbach's ∀ = .77) and NFC (Cronbach's ∀ = .87) are considered moderate to high and acceptable for non-clinical research (Rosenthal & Rosnow, 1991). The NFC and FI items were randomly mixed and the item order remained constant across participants. Fourteen of the 19 NFC items were reverse-worded. Participants responded on a 5 point Likert-type scale ranging from 1 (completely false) to 5 (completely true).

The NFC scale is a reliable and valid measure (Cacioppo & Petty, 1982) for assessing an individual's desire to engage in and enjoy intellectual activities such as deep thinking. NFC is "the tendency for individuals to gain intrinsic rewards from thinking per se in a variety of situations" (Cacioppo & Petty, 1982). A sample item is *I would prefer complex to simple problems.* The 12-item FI scale (Epstein et al., 1996) measures the tendency to engage in and have confidence in one's intuition. A sample item is, *My initial impressions of people are almost always right*.

One hundred fifty general knowledge questions were randomly drawn from a set developed by Nelson and Narens, 1980. The stimuli consisted of binary choice questions, as is standard in overconfidence research. A sample question is *What is the last name of the man who invented dynamite?* After answering each question, participants indicated their degree of confidence in their answer by selecting one of seven confidence intervals: 50-52%, 53-60%, 61-70%, 71-80%, 81-90%, 91-97%, and 98-100%. The questions were randomly selected and presented from a pool of 299 for each participant.

Procedure. Participants were tested in groups of up to three people separated by partitions in a quiet room. One half the participants completed the paper and pencil REI before the computerized calibration task and one half afterwards. The calibration task was performed on personal computers and responses were inputted by use of the mouse and keyboard. Data was automatically coded and scored by a Delphi software program. The sessions lasted approximately thirty minutes.

Results

Table 1 contains the correlations between confidence, accuracy, bias, calibration, resolution, need for cognition and faith in intuition. As expected, there was a significant positive correlation between bias and calibration indicating that those who were biased were also poorly calibrated. In addition, a significant negative correlation between bias and resolution and between calibration and resolution indicates that those who were poorly calibrated and who were biased, also tended to show poor resolution. The significant relationships between accuracy and the these three indices are also consistent in that accuracy was significantly associated with good resolution and inversely associated with bias and poor calibration. Consistent with previous research, greater confidence is associated with greater accuracy, however, confidence is also significantly related to bias and poor calibration. The first relationship is revealed in the calibration curve (see Figure 1) in which the calibration curve increases monotonically across confidence and accuracy measures, however, the dip of the curve below the identity line reveals the bias and lack of calibration indicated by the correlation coefficients.

Of particular interest is the relationship between analytic and intuitive thinking styles captured by the Need for Cognition and Faith in Intuition and the other confidence-accuracy indices, bias in particular. As can be seen in Table 1, those with an analytical thinking style were more likely to be confident and more likely to be accurate than those with less of an analytic thinking style. Those with an intuitive thinking style also tended to be confident, but were not significantly more accurate than those with less of an intuitive thinking style. Moreover, Intuitives were significantly more overconfident than those without an intuitive thinking style, lending tentative support to the hypothesis that intuitive thinking is positively associated with bias.

Table 1

Correlations Between Rational Experiential Inventory (REI) Subscales and Primary Calibration Variables

	NFC	FI	Confidence	Accuracy	Bias	Calibration	Resolution
NFC	--						
FI	.227**	--					
Confidence	.207**	.255**	--				
Accuracy	.186**	.065	.540**	--			
Bias	-.012	.159*	.329**	-.614**	--		
Calibration	.037	.077	.244**	-.475**	.767**	--	
Resolution	.088	.013	.096	.623**	-.606**	-.470**	--

* $p < .05$. ** $p < .01$ (all p-values are two-tailed).

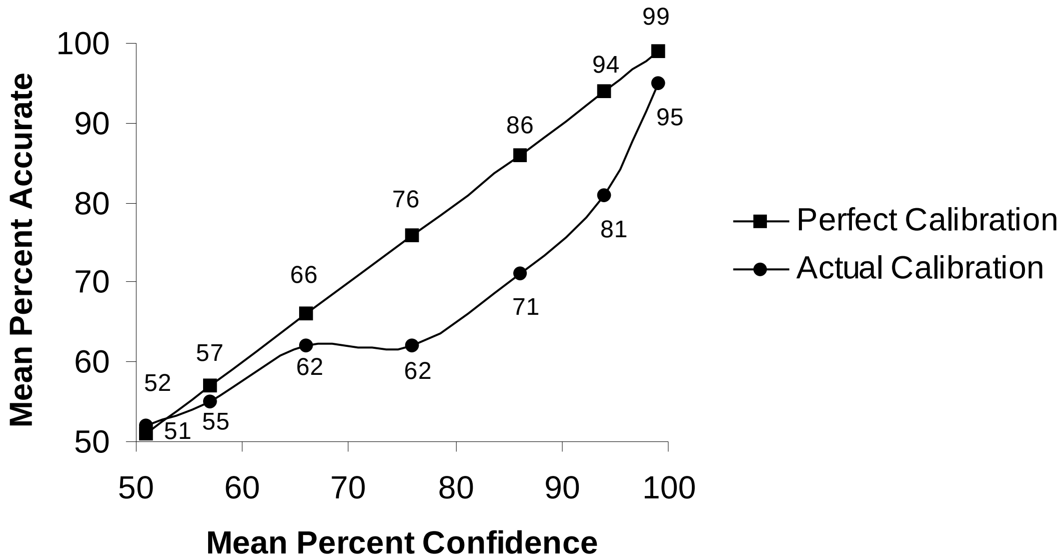

Figure 1. Calibration curve for sample (N = 217) with mean confidence on the abscissa and mean percentage of correct responses on the ordinate for each of the seven confidence intervals respectively.

Finally, the significant positive association between the two thinking styles is curious in light of past research. Epstein et al. (1996) found a slight negative correlation between NFC and FI. The significant relationship between NFC and FI in this sample suggests that some of the participants considered themselves both high in need for cognition and having faith in their intuition. This relationship might be interpreted as "real," in that people can have both a high need for cognition and faith in their intuition. In contrast, this relationship may be interpreted as a form of response bias in which participants rated themselves high on both dimensions as a function of the inventory questions. The FI scale in particular contained only positively-worded items and the wording might have promoted high self rankings because the questions are presented such that it would be deemed desirable to have more of that quality. This possibility beckons future researchers to incorporate a measure of Social Desirability and non-self-report measures of heuristic processing. The association between NFC and FI might be weakening the relationship found between intuition and bias. In order to assess the pure connection between intuition and bias, a multiple regression analysis was conducted to determine unique variance in bias explained by intuitive thinking style.

A regression analysis using the Enter method contained NFC and FI entered simultaneously as the predictors and bias as the criterion. Of the two predictors, only FI was a significant predictor of bias accounting for 3% of unique variance in bias, $R^2 = .025$, $p < .05$. This suggests that an intuitive rather than analytical thinking style contributes to overconfidence.

Discussion

The purpose of the present study was to test the hypotheses that heuristic processing is associated with overconfidence. The findings lend support to this hypothesized relationship. These results are consistent with previous research which revealed a connection between heuristic reasoning and reasoning biases (Cacioppo and Petty, 1982; Epstein et al., 1996; Klaczynski et al., 1997; Tversky and Kahneman, 1974).

The current findings extend the literature by revealing a direct connection between overconfidence and heuristic processing that had heretofore only been implied via naïve optimism (Klaczynski and Gordon, 1996). This is important in that other reasoning biases linked to heuristic processing were qualitatively distinct from overconfidence. For example, intuitively-oriented participants based judgments on sample sizes that were too small, on spurious correlations, and on experiments in which they failed to detect serious flaws (Klaczynski et al., 1997). However, these findings are not surprising given that these tasks rely on analytical skills. It has yet to be determined empirically whether the overconfidence task also draws upon analytical skills. The current findings that analytically-oriented individuals were less overconfident than those with an intuitive-orientation suggest that this may be the case.

One problematic issue that has plagued this area of research is the inconsistency in terminology leading to conceptual confusion. For example, is experiential, heuristic, mnemonic, and intuitive reasoning the same construct; and if so, is this construct a thinking disposition, cognitive style, or preferred mode of processing information? Another concern is the assumption that "tendency to engage in" is analogous to tendency to "have confidence in." Need for cognition assesses the former and Faith in Intuition the latter, so interpretation should be made cautiously. How strong and stable must the tendency be before deemed a personality trait? However, the construct validity of the REI used in this study was established through correlations that emerged between behavioral and self-report responses (Epstein et al., 1996).

It should be noted that "preference for" does not necessarily lead to "engagement in;" in other words, motivation is not the sole determinant of behavior. The organism-environment exchange is dynamic and task and other environmental conditions might inhibit such tendencies. Future studies need to consider feature relevant to the task and the individual simultaneously. For example, is likely that an interaction will emerge between individuals and task on the intuitive-analytic dimension depending on the task. The interaction between the rational and experiential systems is also an important consideration. Is it the case that everyone starts out in the more "primitive" intuitive mode and "rational" switch modes because they can and/or prefer to? Is this mode switching a choice, considering the experiential system is preconscious. Also, if task features induce one mode over the other as previous research indicates, then are Intuitives and Analytics differentially susceptible to task features and in their mental flexibility for mode switching? Epstein (1999) posits that the rational-experiential systems interact, however, the experiential system tends to exert greater influence on the rational system and that this unconscious processing biases conscious processing. While challenging, these assumptions need to be subject to empirical inquiry in order to ferret out the nuances and factors relevant to the interaction.

An important distinction between the rational-experiential systems is speed of processing. Future studies might reveal that intuitively-oriented people complete intuitive or neutral tasks more quickly than analytically-oriented individuals. In addition, incorporating task features inherent to naturalistic decision making, eg. time pressure, will increase the ecological validity of an otherwise highly construed task.

In addition to naturalistic decision making tasks, insights might be gleaned from developmental studies of overconfidence. Surprisingly little research has been conducted on probability estimation and cognitive development. Some researchers have looked at age differences in overconfidence (Crawford and Stankov, 1996), but children have yet to be studied in this reasoning task. Children's assessment of their own knowledge could provide critical insight into this process. Individual differences in learning styles has received some attention in educational psychology and the overlap between this work and a variety of age-appropriate reasoning tasks could provide valuable insights into a process that remains elusive. Hopefully the current work contributes one of many pieces of the overconfidence puzzle.

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