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On the failure of cognitive ability to predict myside and one-sided thinking biases

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Two critical thinking skills—the tendency to avoid myside bias and to avoid one-sided thinking—were examined in three different experiments involving over 1200 participants and across two different paradigms. Robust indications of myside bias were observed in all three experiments. Participants gave higher evaluations to arguments that supported their opinions than those that refuted their prior positions. Likewise, substantial one-side bias was observed—participants were more likely to prefer a one-sided to a balanced argument. There was substantial variation in both types of bias, but we failed to find that participants of higher cognitive ability displayed less myside bias or less one-side bias. Although cognitive ability failed to associate with the magnitude of the myside bias, the strength and content of the prior opinion did predict the degree of myside bias shown. Our results indicate that cognitive ability—as defined by traditional psychometric indicators—turns out to be surprisingly independent of two of the most important critical thinking tendencies discussed in the literature.

Keywords: Myside bias; One-sided thinking; Cognitive ability.

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In the critical thinking literature, the ability to deal with evidence in an unbiased manner and the ability to take multiple perspectives when thinking about a problem are reasoning skills that are deemed of pre-eminent importance (Baron, 1991, 2000; Evans, 2002, 2007; Kuhn, 1999, 2001; Nickerson, 2004; Norris & Ennis, 1989; Paul, 1984, 1987; Perkins, 1995; Toplak & Stanovich, 2002; Wade & Tavris, 1993). Likewise, in many theoretical writings on wisdom such skills are also viewed as foundational (e.g., Baltes & Staudinger, 2000; Baron, 1985; Perkins, 2002; Perkins & Ritchhart, 2004; Staudinger, Dorner, & Mickler, 2005; Sternberg & Jordan, 2005). Nevertheless, research has demonstrated that people often fail to display both of these critical thinking tendencies. People display myside bias: they evaluate evidence, generate evidence, and test hypotheses in a manner biased towards their own opinions (Baron, 1991; Greenhoot, Semb, Colombo, & Schreiber, 2004; Klaczynski & Lavallee, 2005; Klaczynski & Robinson, 2000; Kuhn, 1991, 2005; Nickerson, 1998; Nussbaum & Kardash, 2005; Perkins, 1985; Perkins, Farady, & Bushey, 1991; Sá, Kelley, Ho, & Stanovich, 2005; Toplak & Stanovich, 2003). People also display a one-sided bias: they prefer arguments that are one-sided rather than arguments that reflect many different perspectives (Baron, 1991, 1995; Buehl, Alexander, Murphy, & Sperl, 2001; Kardash & Scholes, 1996; Kuhn, 1991, 2001; Kuhn & Weinstock, 2002).

Interestingly, measures of intelligence, often taken as the benchmark of good thinking, do not assess the avoidance of myside bias and one-side bias—the foundational skills in the critical thinking literature and in the rational thinking literature aimed at educational applications (Baron, 2000; Evans, 2005; Kuhn, 1993, 2005; Nussbaum & Sinatra, 2003; Perkins, 1995; Sternberg, 1997, 2001, 2003). Furthermore, we will argue here that there are theoretical reasons to believe that these classes of thinking skills—myside thinking and one-sided thinking—are likely to be unusually dissociated from measures of cognitive ability. Because intelligence is such a ubiquitous associate of cognitive performance, it is noteworthy to identify the types of cognitive tasks that tend to eliminate its predictive power.

Our argument depends strongly on differentiating the algorithmic from the intentional level of analysis, a distinction that has been made by numerous cognitive theorists although their terminology has varied (Anderson, 1990, 1991; Bermudez, 2001; Davies, 2000; Dennett, 1978, 1987; Horgan & Tienson, 1993; Levelt, 1995; Marr, 1982; Newell, 1982, 1990; Oaksford & Chater, 1995; Pylyshyn, 1984; A. Sloman, 1993; Sterelny, 1990, 2001). The algorithmic level is concerned with the computational processes and information-processing operations necessary to carry out a task. The cognitive psychologist works largely at this level by showing that human performance can be explained by positing certain

information-processing mechanisms in the brain (input-coding mechanisms, perceptual registration mechanisms, short- and long-term memory storage systems, etc.).

In contrast, at the intentional level (sometimes termed the rational level, see Anderson, 1990) issues of biological constitution and algorithmic processing sequence are set aside and predictions are made by attempting to provide a specification of the *goals* of the system's computations (*what* the system is attempting to compute and *why*) and its knowledge structure. The rational level of analysis is concerned with the goals of the system, beliefs relevant to those goals, and the choice of action that is rational given the system's goals and beliefs (Bratman, Israel, & Pollack, 1991; Dennett, 1987; Newell, 1982, 1990; Pollock, 1995).

Translating the algorithmic/intentional distinction into terms from the study of individual differences, Stanovich (2002, 2004; Stanovich & West, 1999, 2000) has emphasised the following operational mappings. Tests of cognitive ability such as intelligence tests primarily index individual differences at the algorithmic level, whereas tests of rational or critical thinking tend to index both the algorithmic and the intentional levels. For example, work in the psychology of individual differences has long recognised a distinction between cognitive capacities (intelligence) and thinking dispositions (e.g., Baron, 1985; Dole & Sinatra, 1998; Ennis, 1987; Moshman, 1994; Nickerson, 2004; Norris, 1992; Parker & Fischhoff, 2005; Perkins, 1995; Sinatra & Pintrich, 2003; Sternberg, 1997, 2003). Cognitive psychologists have focused on the type of algorithmic-level cognitive capacities that underlie traditional psychometric intelligence: perceptual speed, discrimination accuracy, working memory capacity, and the efficiency of the retrieval of information stored in long-term memory (Ackerman, Kyllonen, & Richards, 1999; Carpenter, Just, & Shell, 1990; Deary, 2000, 2001; Hunt, 1987, 1999; Kane & Engle, 2002; Lohman, 2000; Sternberg, 1977, 1985, 2000; Unsworth & Engle, 2005).

Another research tradition in psychology has focused on thinking dispositions and cognitive styles (e.g., Cacioppo, Petty, Feinstein, & Jarvis, 1996; Klaczynski, Gordon, & Fauth, 1997; Klaczynski & Lavallee, 2005; Kruglanski & Webster, 1996; Schommer-Aikins, 2004; Sinatra & Pintrich, 2003; Stanovich, 1999, 2002; Sternberg, 1997, 2003). Thinking dispositions, as studied in this literature, are largely intentional-level constructs. Many concern beliefs, belief structure and, importantly, attitudes towards forming and changing beliefs. Other cognitive styles concern a person's goals and goal hierarchy. Thinking disposition measures are telling us about the individual's goals and epistemic values—and they are indexing broad tendencies of pragmatic and epistemic self-regulation at the intentional level of analysis.

CONDITIONS FOR DISSOCIATION BETWEEN COGNITIVE ABILITY AND CRITICAL THINKING

The tasks on tests of cognitive capacities (intelligence tests or other aptitude measures) are often superficially similar to those on tests of critical thinking (in the educational literature, the term critical thinking is often used to cover tasks and mental operations that a cognitive scientist would term indicators of rational thought). An outsider to psychometrics or cognitive science might deem the classification of tasks into one category or the other somewhat arbitrary. In fact, it is far from arbitrary and actually reflects a distinction that is important from the standpoint of both the field of psychometrics and the field of cognitive science. Psychometricians have long distinguished typical performance situations from optimal (sometimes termed maximal) performance situations (Ackerman, 1994, 1996; Ackerman & Heggestad, 1997; Ackerman & Kanfer, 2004; Cronbach, 1949; Matthews, Zeidner, & Roberts, 2002). Typical performance situations are unconstrained in that no overt instructions to maximise performance are given, and the task interpretation is determined to some extent by the participant. In contrast, optimal performance situations are those where the task interpretation is determined externally (not left to the participant), and the participant is instructed to maximise performance and is told how to do so.

All tests of intelligence or cognitive aptitude are optimal performance assessments, whereas measures of critical or rational thinking are often assessed under typical performance conditions. Thus, tests of cognitive ability are constrained at the intentional level (an attempt is made to specify the task demands so explicitly that variation in intentional level thinking dispositions are minimally influential).[1] In contrast, tests of critical or rational thinking are not constrained at the intentional level (or at least are much less constrained). Tasks of the latter but not the former type allow high-level personal goals and their regulation to become implicated in performance, as well as tendencies to change beliefs in the face of contrary

[1]We do not wish to argue that tests of cognitive ability are entirely successful in this respect—that they entirely eliminate intentional-level factors—only that the constructors of the tests *attempt* to do so. Additionally, it is certainly the case that some higher-level strategic control is exercised on intelligence test items, but this tends to be a type of micro-level control rather than the activation of macro-strategies that are engaged by critical thinking tests. For example, on multiple-choice IQ-test items, the respondent is certainly engaging in a variety of control processes such as suppressing responses to identified distracter items. Nonetheless, if the test is properly designed, they are not engaging in the type of macro-level strategising that is common on critical thinking tests—for example, deciding how to construe the task or how to allocate effort across differing construals.

evidence (or tendencies to exhaustively or non-exhaustively think through problem possibilities).

It is clearly the case that some critical thinking tasks should be related to cognitive ability because they strongly tap computational capacity at the algorithmic level (Bara, Bucciarelli, & Johnson-Laird, 1995; Copeland & Radvansky, 2004; Gilhooly, 2004; Hambrick & Engle, 2003; Handley, Capon, Beveridge, Dennis, & Evans, 2004; Rips & Conrad, 1983; Stanovich & West, 1997, 1998; Sternberg, 1977; Verschueren, Schaeken, & D'Ydewalle, 2005). For example, the moderately strong correlation between a basic thinking skill such as analogical reasoning and cognitive ability is theoretically expected. Although tasks such as syllogistic reasoning with validity/knowledge conflicts (Evans, Barston, & Pollard, 1983; Evans & Curtis-Holmes, 2005; Evans & Feeney, 2004; Goel & Dolan, 2003) do loosen constraints on intentional-level functioning, they still implicate algorithmic-level computational capacity to a large extent (Gilinsky & Judd, 1994; Handley et al., 2004; Kokis, Macpherson, Toplak, West, & Stanovich, 2002; Newstead, Handley, Harley, Wright, & Farrelly, 2004; Sá, West, & Stanovich, 1999; Simoneau & Markovits, 2003; Stanovich & West, 1998; Torrens, Thompson, & Cramer, 1999).

It would not be surprising to see syllogistic reasoning with validity/knowledge conflicts on a critical thinking test because such tests do not constrain intentional-level thinking dispositions. Such items would not be included on intelligence tests, however, because on intelligence tests there would be no epistemic ambiguity created in the first place. It is the efficiency of computational abilities under optimal (not typical) conditions that is the focus of IQ tests. Variation in intentional-level thinking dispositions would contaminate this algorithmic-level assessment.

Other tasks in the literature have even less intentional-level constraint than syllogisms with validity/knowledge conflicts, however. For example, Klaczynski and colleagues (Klaczynski, 1997; Klaczynski & Gordon, 1996; Klaczynski et al., 1997; Klaczynski & Lavallee, 2005; Klaczynski & Robinson, 2000) had participants evaluate flawed hypothetical experiments and evidence-based arguments that led to either opinion-consistent or opinion-inconsistent conclusions. The lack of explicit instructions to detach prior opinion from experiment evaluation in the Klaczynski (1997) paradigm probably left intentional-level functioning relatively unconstrained and decreased the association between myside bias and algorithmic-level functioning. However even this paradigm, because it is run within subjects, contains cues that might help participants interpret what the experimenter might deem optimal performance (see Fischhoff, Slovic, & Lichtenstein, 1979; Kahneman, 2000; Kahneman & Frederick, 2002, 2005; Kahneman & Tversky, 1996; LeBoeuf & Shafir, 2003).

A between-subjects design, in not containing cues to the variable of interest, might even further reduce the relationship between myside bias and individual difference variables. This was found in a paradigm that Stanovich and West (2007) introduced to study so-called natural myside bias. Natural myside bias is the tendency to evaluate propositions from within one's own perspective when given no instructions to avoid doing so and when there are no implicit cues (such as within-subjects conditions) to avoid doing so. Stanovich and West (2007) defined the participant's perspective as their previously existing status on four variables: their sex, whether they smoked, their alcohol consumption, and the strength of their religious beliefs. Participants then evaluated a proposition relevant to each of these demographic factors. For example, for the demographic variable sex, the proposition was: "The gap in salary between men and women generally disappears when they are employed in the same position". Myside bias was defined between subjects as the mean difference in the evaluation of the proposition between groups with differing prior status on the variable. Statistically, whether an individual difference variable (such as cognitive ability for example) is related to the magnitude of the myside bias in this paradigm is indicated by whether the individual difference variable interacts with the between-subjects status variable. Thus, in this paradigm, the participant is completely unaware that myside bias is being assessed—hence the term natural myside bias. It is assumed that the ecology of this paradigm is more like that which exists when we observe myside bias in the real world.

For three of the four prior-status variables (smoking, alcohol consumption, and religious beliefs), Stanovich and West (2007) found no evidence of an association between myside bias and cognitive ability. One prior status variable (sex) displayed a marginal interaction between status and cognitive ability. Thus, cognitive ability was relatively dissociated from myside bias in this paradigm. However, this conclusion was based on tests of only four propositions in four different domains.

In the series of experiments reported here, we attempted to examine the association between cognitive ability and two of the most important critical thinking skills, and we examined the association in the context of experimental paradigms that were relatively unconstrained at the intentional level. In Experiment 1 we expanded the Stanovich and West (2007) paradigm by examining natural myside bias in 15 different propositions spread over seven different prior status domains. In Experiment 2 we used a different informal reasoning task with relatively unconstrained processing demands to study not only myside bias but also one-sided bias. In Experiment 3 we examined associations between thinking dispositions (in addition to cognitive ability) and myside and one-sided bias.

EXPERIMENT 1

Method

Participants. The participants were 449 undergraduate students (112 males and 337 females) recruited through an introductory psychology subject pool at a medium-sized state university. Their mean age was 18.7 years ($SD = 1.2$). The majority of these students were freshmen (281 students) or sophomores (112 students), and almost 89% of them identified themselves as White (398 White; 26 African American; 7 Asian American; 18 Other).

Prior demographic status. The demographics form filled out by the students included seven questions about their status on seven likely sources of natural myside bias (e.g., "I currently am a nonsmoker/smoker."). The questions, which are listed in the left-hand column of Table 1, concerned their sex, alcohol consumption, whether or not they smoked, the strength of their religious belief, in-state versus out-of-state residency, their presidential voting preference, and their favourite soft drink. These seven questions were used to dichotomise the sample.

The gender question dichotomised the sample into 112 males and 337 females. The alcohol consumption question dichotomised the sample into 62 nondrinkers and 387 drinkers. The third dichotomisation was smoker ($n = 49$) versus nonsmoker ($n = 400$). A dichotomisation of whether they believed God certainly existed ($n = 257$) versus whether their belief in God was less than certain ($n = 192$) was formed by assigning those who reported that they were "certain that God exists" (Table 1) to the God certain group and the remaining students to the God not certain group. The fifth dichotomisation divided the sample into 293 in-state students and 156 out-of-state students. A total of 246 students would have voted for George Bush on the day they were tested, versus a total of 203 who would have voted for John Kerry (the actual elections had taken place on 2 November 2004, while these data were collected throughout the autumn of 2005). The seventh dichotomisation divided the sample into 135 who identified Coke Classic, Diet Coke, or Caffeine Free Diet Coke as their favourite soft drink and 313 who identified something else.

Myside bias propositions. Subsequent to filling out the demographic form and some reasoning problems that were not part of the present investigation, participants were asked to indicate the extent to which they agreed or disagreed with each of 15 different statements (e.g., "Secondhand smoke is a health hazard for nonsmokers."). The statements are listed in the right-hand column of Table 1, and are grouped with their corresponding prior status variable. Participants responded using the following 6-point

TABLE 1
Prior demographic status questions and corresponding myside bias propositions

Prior demographic status question	*Corresponding myside bias proposition*
1. Sex: (1) Male (2) Female	1. The gap in salary between men and women generally disappears when they are employed in the same position.[a] 2. There is bias in favour of males in admissions to medical school, law school, and graduate school.[b]
2. During the last month, how many times have you consumed alcohol?	3. Students who drink alcohol while in college are more likely to become alcoholic in later life.[a] 4. Consumption of alcohol by young adults is associated with health problems later in life.[a]
3. I currently am a (check one): (1) nonsmoker (2) smoker	5. Secondhand smoke is a health hazard for nonsmokers.[a] 6. The majority of nonsmokers find it very unpleasant to be near a smoking person in a public place.[a]
4. My feelings concerning the existence of God are: (1) I am certain that God exists, (2) I am pretty sure that God exists (3) I think that there probably is a God (4) I am not sure whether God exists or not (5) I think that there probably is not a God (6) I am pretty sure that God does not exist (7) I am certain that God does not exist.	7. Religious people are generally more honest than nonreligious people.[a] 8. The divorce rate is much higher for nonreligious people.[a]
5. What is your university residency status? (1) In-state (2) Out-of-state	9. The tuition that JMU charges out-of-state students is too high relative to what it charges in-state students.[b]

(*continued*)

TABLE 1
(*Continued*)

Prior demographic status question	*Corresponding myside bias proposition*
6. If the election were held today, I would vote for (1) George W. Bush (2) John F. Kerry	10. The United States is safer from terrorist attack because of the invasion of Iraq.[a] 11. Our use of fossil fuels as an energy source is resulting in dangerous global warming.[b] 12. Most people in Iraq welcomed the invasion by the United States in 2003.[a] 13. I think that the President was correct to invade Iraq in 2003.[a] 14. Since November 2000, unemployment in the United States has risen.[b]
7. Which carbonated soft drink(s) is your favourite? (1) Coke Classic, Diet Coke, or Caffeine Free Diet Coke (2) Some other soft drink (3) I do not have a favourite soft drink	15. Coke Classic, Diet Coke, or Caffeine Free Diet Coke are the most popular soft drinks in America because they taste the best.[a]

Participants responded to the Myside Bias Propositions using the following 6-point scale: Strongly Agree (6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1).

[a]Lower values on Prior Demographic Status Question are predicted to be associated with stronger agreement with Corresponding Myside Bias Proposition. [b]Higher values on Prior Demographic Status Question are predicted to be associated with stronger agreement with Corresponding Myside Bias Proposition.

scale: Strongly Agree (scored as 6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1).

Cognitive ability measure. Students were asked to indicate their verbal, mathematical, and total SAT scores on the demographics form. The mean reported verbal SAT score of the students was 578 ($SD = 67$), the mean reported mathematical SAT score was 579 ($SD = 67$), and mean total SAT score was 1156 ($SD = 110$). The institution-wide averages for this university were 565, 575, and 1140, respectively in 2006. Several studies have indicated that the correlation between self-reported SATs and verified SAT scores is in the range of .80 to .90 (Cassady, 2001; Kuncel, Crede, & Thomas, 2005). An indication of the validity of the self-reported scores is that they correlated with a third variable to the same extent as verified scores. Stanovich and West (1998) found that the correlation between a vocabulary test and self-reported SAT total scores (.49) was quite similar to the .51 correlation between the vocabulary test and verified total SAT scores in a previous investigation using the same vocabulary measure (West & Stanovich, 1991). The total SAT score is used as an index of cognitive ability in the analyses reported here because it loads highly on psychometric *g* (Frey & Detterman, 2004; Unsworth & Engle, 2007).

In its current iteration the SAT is a 3-hour-and-55-minute exam that is widely used for university admissions testing in the United States. In 2006 a writing section (60 minutes) was added to pre-existing verbal (also referred to as "critical reading"; 75 minutes) and mathematics (75 minutes) test sections (there is also a 25-minute unscored section). The verbal section of the SAT test assesses "knowledge of meaning of words . . . and the ability to understand how the different parts of a sentence fit logically together" (http://www.collegeboard.com). The mathematical section contains "varied items chiefly requiring quantitative reasoning and inductive ability" (Carroll, 1993, p. 705).

For the purposes of the analyses described below, the 218 students with SAT scores below the median (1150) were assigned to the low-SAT group, and the 231 remaining students were assigned to the high-SAT group.

Results

Table 2 illustrates that each of the 15 propositions displayed some degree of myside bias (all effects were in the expected direction) and that 13 of the 15 propositions displayed statistically significant myside bias. For example, regarding proposition #2, the 337 females were significantly more favourable towards the proposition ("There is bias in favour of males in admissions to medical school, law school, and graduate school") ($M = 3.47$) than were the 112 males ($M = 3.02$), $t(447) = -3.27$, $p < .001$. Each of the

TABLE 2
Mean myside bias proposition scores as a function of prior demographic status

	Status 1		*Status 2*			
Prior demographic status	*M*	*SD*	*M*	*SD*	*t(447)*	*Cohen's* d
Sex for Proposition 1 Status 1:Male ($n = 112$) Status 2:Female ($n = 337$)	3.18	1.20	2.96	1.21	1.63	0.18
Sex for Proposition 2 Status 1:Male ($n = 112$) Status 2:Female ($n = 337$)	3.02	1.21	3.47	1.28	−3.27*	0.36
Drinking for Proposition 3 Status 1:Nondrinker ($n = 62$) Status 2:Drinker ($n = 387$)	4.26	1.23	2.94	1.29	7.50*	1.03
Drinking for Proposition 4 Status 1:Nondrinker ($n = 62$) Status 2:Drinker ($n = 387$)	4.97	0.94	3.74	1.22	7.59*	1.04
Smoking for Proposition 5 Status 1:Nonsmoker ($n = 400$) Status 2:Smoker ($n = 49$)	5.04	1.18	4.35	1.49	3.74*	0.57
Smoking for Proposition 6 Status 1:Nonsmoker ($n = 400$) Status 2:Smoker ($n = 49$)	5.03	1.00	4.74	1.05	1.79	0.29
Belief in God for Proposition 7 Status 1:Certain ($n = 257$) Status 2:Not Certain ($n = 192$)	3.23	1.34	2.39	1.35	6.53*	0.69
Belief in God for Proposition 8 Status 1:Certain ($n = 257$) Status 2:Not Certain ($n = 192$)	4.00	1.26	3.60	1.25	3.36*	0.32
Residency Status for Proposition 9 Status 1:In-State ($n = 293$) Status 2:Out-of-State ($n = 156$)	4.81	1.28	3.47	1.36	−10.18*	1.01
Vote for Proposition 10 Status 1: George W. Bush ($n = 246$) Status 2: John F. Kerry ($n = 203$)	3.24	1.28	1.83	1.07	12.50*	1.23
Vote for Proposition 11 Status 1: George W. Bush ($n = 246$) Status 2: John F. Kerry ($n = 203$)	4.07	1.25	4.60	1.09	−4.68*	0.46
Vote for Proposition 12 Status 1: George W. Bush ($n = 246$) Status 2: John F. Kerry ($n = 203$)	2.90	1.37	2.00	1.16	7.46*	0.73
Vote for Proposition 13 Status 1: George W. Bush ($n = 246$) Status 2: John F. Kerry ($n = 203$)	4.34	1.20	1.99	1.16	21.00*	2.00

(*continued*)

TABLE 2
(*Continued*)

Prior demographic status	*Status 1*		*Status 2*		*t(447)*	*Cohen's* d
	M	*SD*	*M*	*SD*		
Vote for Proposition 14 Status 1: George W. Bush ($n = 246$) Status 2: John F. Kerry ($n = 203$)	3.63	1.06	4.25	1.03	−6.21*	0.60
Soft Drink for Proposition 15 Status 1: Coke ($n = 135$) Status 2: Other ($n = 313$)	3.73	1.49	2.32	1.25	10.31*	1.06

*$p < .001$.

seven prior status variables generated at least one statistically significant myside bias. The magnitude of the effect sizes (Cohen's *d*) ranged from .18 to 2.00 and averaged a healthy .77. Note that our paradigm does not allow one to pinpoint bias in individuals or in one particular group but instead gives a between-subjects indication that a particular magnitude of bias is present *somewhere*. It indicates that people with a particular stance or group status evaluate propositions differently from those having the opposite group status.

The next series of analyses examined whether the magnitude of the myside bias effect was moderated by cognitive ability. This was done by examining, in an ANOVA context, whether the degree of myside bias on each of the propositions interacted with SAT scores (see Table 3). In each analysis, SAT (low, high) and a prior status variable (sex, drinking, smoking, belief in God, residency, voting, beverage) were examined in a 2×2 factorial ANOVA. As expected given the results in Table 2, the main effect for the prior status variable was significant ($p < .01$ to $p < .001$) in 13 of 15 cases. The main effect of SAT reached significance for only one proposition. However, the critical statistic in these analyses is the test of significance for the interaction because it indicates whether the degree of myside bias was related to cognitive ability. Here the results were unambiguous. None of interactions reached statistical significance. Thus, these analyses provided no evidence at all that myside bias effects are smaller for students of higher cognitive ability.

A more powerful, fully continuous analysis also converged with this conclusion. The significance of the interactions was tested in 15 regression analyses in which SAT was used as a continuous variable rather than as a dichotomous variable (as in the ANOVA). The status variable by SAT interaction failed to reach significance in each of these analyses, thus converging with the ANOVA outcomes.

TABLE 3
ANOVA (Prior Status Variable × SAT) and mean proposition scores as a function of status variable and SAT

Source	*F(1, 445)*		*Mean (number in cell)*	
Sex Prop 1	2.82		Male	Female
SAT	<1	SAT Low	3.29 (35)	2.87 (183)
Sex × SAT	1.71	SAT High	3.13 (77)	3.08 (154)
Sex Prop 2	7.46**		Male	Female
SAT	<1	SAT Low	3.20 (35)	3.48 (183)
Sex × SAT	<1	SAT High	2.94 (77)	3.45 (154)
Drinking Prop 3	56.28***		Nondrinker	Drinker
SAT	2.20	SAT Low	4.00 (31)	2.94 (187)
Drinking × SAT	2.14	SAT High	4.52 (31)	2.95 (200)
Drinking Prop 4	57.33***		Nondrinker	Drinker
SAT	<1	SAT Low	4.84 (31)	3.79 (187)
Drinking × SAT	1.19	SAT High	5.10 (31)	3.69 (200)
Smoking Prop 5	12.58***		Nonsmoker	Smoker
SAT	1.57	SAT Low	5.17 (199)	4.47 (19)
Smoking × SAT	<1	SAT High	4.91 (201)	4.27 (30)
Smoking Prop 6	1.80		Nonsmoker	Smoker
SAT	4.76*	SAT Low	5.08 (199)	5.11 (19)
Smoking × SAT	2.26	SAT High	4.98 (201)	4.53 (30)
Belief in God Prop 7	39.58***		Certain	Not Certain
SAT	<1	SAT Low	3.28 (141)	2.47 (77)
Belief in God × SAT	<1	SAT High	3.16 (116)	2.34 (115)
Belief in God Prop 8	11.76***		Certain	Not Certain
SAT	<1	SAT Low	4.01 (141)	3.51 (77)
Belief in God × SAT	<1	SAT High	3.99 (116)	3.66 (115)
Residency Prop 9	104.75***		In-State	Out-State
SAT	<1	SAT Low	3.58 (143)	5.00 (75)
Residency × SAT	<1	SAT High	3.37 (150)	4.64 (81)
Vote for Prop 10	155.71***		Bush	Kerry
SAT	<1	SAT Low	3.13 (126)	1.84 (92)
Vote for × SAT	<1	SAT High	3.34 (120)	1.82 (111)
Vote for Prop 11	21.43***		Bush	Kerry
SAT	<1	SAT Low	4.02 (126)	4.58 (92)
Vote for × SAT	<1	SAT High	4.13 (120)	4.16 (111)
Vote for Prop 12	55.20***		Bush	Kerry
SAT	<1	SAT Low	2.86 (126)	1.37 (92)
Vote for × SAT	<1	SAT High	2.98 (120)	1.98 (111)
Vote for Prop 13	440.93***		Bush	Kerry
SAT	1.44	SAT Low	4.25 (126)	1.95 (92)
Vote for × SAT	<1	SAT High	4.43 (120)	2.03 (111)

(*continued*)

TABLE 3
(*Continued*)

Source	*F(1, 445)*		*Mean (number in cell)*	
Vote for Prop 14	38.88***		Bush	Kerry
SAT	<1	SAT Low	3.69 (126)	4.29 (92)
Vote for × SAT	<1	SAT High	3.58 (120)	4.22 (111)
Soft Drink Prop 15	52.85***		Coke	Other
SAT	<1	SAT Low	3.74 (72)	2.41 (146)
Soft Drink × SAT	<1	SAT High	3.71 (63)	2.24 (167)

*$p < .05$, **$p < .01$, ***$p < .001$.

EXPERIMENT 2

The natural myside bias observed in the paradigm used in Experiment 1 demonstrated complete dissociation from cognitive ability across a wide variety of domains and propositions. In Experiment 2 we examined performance in another informal reasoning paradigm that is relatively unconstraining of intentional-level functioning. In addition to investigating myside bias in this paradigm, we also examine one-sided thinking—the tendency to prefer arguments that are one-sided rather than arguments that reflect many different perspectives (Baron, 1991, 1995; Kuhn, 1991, 2001; Kuhn & Weinstock, 2002).

Our paradigm was a modification of that used by Baron (1995) in which he had participants evaluate the thinking of hypothetical other students on the issue of abortion. Participants evaluated paragraphs that were transcriptions of the arguments hypothetical students made while thinking about the issue. Participants graded the paragraphs on an A+ to F scale. A myside bias was demonstrated—participants gave higher grades to thinking that coincided with their own opinion on the issue. Additionally, a one-sided bias was demonstrated—participants gave higher grades to paragraphs that were one-sided in their arguments (all arguments on one side of the issue) than paragraphs that were two-sided (i.e., containing arguments on both sides of the issue). Amazingly, participants even preferred one-sided arguments that went against their position. That is, they gave higher grades to one-sided paragraphs that argued against their position than they did to paragraphs containing arguments on both sides of the issue. In Experiment 2 we examine whether cognitive ability was associated with the myside bias and the one-sided bias displayed in this paradigm.

Method

Participants. The participants were 439 undergraduate students (128 males and 311 females) recruited through an introductory psychology

subject pool at a medium-sized state university. Their mean age was 18.5 years ($SD = 1.1$). The majority of these students were freshmen (275 students) or sophomores (122 students), and 89% of them identified themselves as White (389 White; 17 African American; 19 Asian American; 14 Other).

Thinking evaluation task. Each participant was asked to evaluate the quality of the reasoning used by four students who, the participants were told, had been asked to speak out loud as they reasoned about the issue of abortion. Each student's reasoning statements were actually constructions that consisted of a set of four statements selected from a list of eight anti-abortion and eight pro-choice statements. Eleven of these were statements or slight modifications of statements reported in Baron (1995, Experiment 1), and the remaining five statements were generated by the authors. A variety of conjunctive adverbs and transitional expressions (e.g., but; also; however; in addition; additionally; I also think that; it could be said that; it is also the case that) were used within a student's set of the statements to increase the set's coherence and naturalness. The contrastives "on the other hand" and "despite that, however" were used to indicate places where students showed they were aware that their subsequent statements would contrast with their preceding statements.

The participants were randomly assigned to one of two groups. The first group evaluated the quality of the reasoning of four students who each made one of the following sets of statements: set 1: four anti-abortion reasoning statements (acronym: 4anti/0pro); set 2: two pro-choice followed by two anti-abortion reasoning statements (2pro/2anti); set 3: four pro-choice reasoning statements (0anti/4pro); and set 4: two anti-abortion followed by two pro-choice reasoning statements (2anti/2pro). For the second group of participants, the sets of statements were as follows: set 1: four pro-choice reasoning statements (0anti/4pro); set 2: two anti-abortion followed by two pro-choice reasoning statements (2anti/2pro); set 3: four anti-abortion reasoning statements (4anti/0pro); and set 4: two pro-choice followed by two anti-abortion reasoning statements (2pro/2anti). Thus each participant evaluated the reasoning of two students whose reasoning statements represented only one side of the abortion issue (one consistently anti-abortion, and one consistently pro-choice) and two students whose reasoning statements represented two sides of the abortion issue.

Each of the 16 reasoning statements was used once in each participant's evaluations, and, across the two participant groups, each reasoning statement occurred once in a one-sided (either 4anti/0pro or 0anti/4pro) and once in a two-sided (either 2pro/2anti or 2anti/2pro) set of reasoning statements. Within each participant group, the order of the sets and

statements was fixed. The directions read by the participants were as follows:

> In the following task, you will be asked to evaluate the thinking of some students. These students were asked to speak out loud as they reasoned about a particular issue. They were asked to reason like a good reasoner would when trying to arrive at an opinion about the issue. Your task will be to evaluate how good their thinking was.
> The controversial issue they were asked to reason about was the issue of abortion. Below you see several student responses. You are to rate how good their reasoning was by using the following grade scale:
>
> A+ A A− B+ B B− C+ C C− D+ D D− F
>
> Please remember that you are to evaluate the thinking and not the verbal expression. The transcripts have been edited to eliminate obviously ungrammatical sentences.

A grade of A+ was scored as 13, a grade of A was scored 12, and so on down to a grade of F, which was given a score of 1.

The following is an example of a one-sided set of reasoning statements supporting the anti-abortion view:

> Well, some women get pregnant irresponsibly, and the fetus shouldn't have to be destroyed because of her mistake. Also, aborting a fetus is preventing someone from having a life, and this is wrong. None of us would have wanted to have been aborted ourselves. I worry about abortion because there is no clear place to draw the line between late abortions of fetuses that could survive on their own and the killing of unwanted infants. Also, condoning abortion is likely to reduce respect for human life in general, leading to decreased effort to preserve human life in other cases.

The following is an example of a one-sided set of reasoning statements supporting the pro-choice view:

> The fetus is not hurt by an early abortion because it has no future plans, no knowledge of life, no pain, and no fear of death. Also, contraceptive methods are all subject to failure, and it would be terrible for a woman to be forced to have a child when she does not want one. In addition, women should not have to bear a child when it is the result of the forcible or criminal acts of men. Also, many women who get pregnant by mistake are adolescents and others who are not ready to care for children. The possibility of abortion allows many of them to continue their education and have children when they are mature enough to raise them well.

The following is an example of a two-sided set of reasoning statements:

> Families must be limited in today's world. If we are going to limit births, it is better to limit the births of unwanted children than limit the births of children

who are wanted. Abortion is one means of preventing unwanted children from being born, when it is too late to limit them by other means. Also, women should be able to decide whether they want to go through something that affects them as much as pregnancy and childbirth do. On the other hand, I do believe that killing human beings is wrong and abortion is killing a human, even though the human is only a fetus. Also, abortion is never absolutely necessary as a means of birth control. There are lots of alternatives.

Position on the abortion issue. On another measure, participants responded to a questionnaire item, embedded in a series of other items, that probed the participant's position on the issue of abortion: "I believe that abortion should be legal in this country." Participants indicated the extent of their agreement with this proposition using the following response format: Strongly Agree (scored as 6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1). The mean agreement score was 3.75 ($S.D. = 1.79$). A total of 61.0% of the participants indicated some degree of agreement with the statement and 39.0% of the participants indicated some degree of disagreement with the statement. The former group was labelled pro-choice and the latter group anti-abortion.

Measurement of myside and one-side bias. Each participant graded four paragraphs: two two-sided paragraphs and two one-sided paragraphs (one on each side of the abortion issue). Each participant received four scores: the rating (numerically transformed grade) they gave their 4anti/0pro paragraph, the rating they gave their 0anti/4pro paragraph, the rating they gave their 2anti/2pro paragraph, and the rating they gave their 2pro/2anti paragraph.

Each participant's myside bias was indexed by a difference score whose calculation depended on their prior opinion. For the anti-abortion group, the myside bias score was derived by subtracting their 0anti/4pro score from their 4anti/0pro score. For the pro-choice group, the myside bias score was derived by subtracting their 4anti/0pro score from their 0anti/4pro score. Positive difference scores indicate myside bias, and the higher the score, the more the myside bias. A score of zero indicates complete unbiasedness in argument evaluation. A negative score would indicate an otherside bias.

Each participant's one-side bias score was derived by adding their 4anti/0pro score to their 0anti/4pro score and subtracting from that the sum of the two 2/2 scores. A positive score on this metric (onebias1) indicates one-side bias—the two one-sided paragraphs (one in favour of the participant's opinion and one against) would be rated superior to the two balanced paragraphs. A negative score on the metric indicates a two-sided bias. A score of zero would indicate no preference for either type of argument.

A second one-side bias index (onebias2) was calculated in which the average of the two 2/2 scores was subtracted from the score on the one-sided paragraph that went against the participant's prior opinion (0anti/4pro if the participant was anti-abortion and 4anti/0pro if the participant was pro-choice).

Cognitive ability measure. Students were asked to indicate their verbal, mathematical, and total SAT scores on the demographics form. The mean reported verbal SAT score of the students was 585 ($SD = 70$), the mean reported mathematical SAT score was 588 ($SD = 68$), and mean total SAT score was 1174 ($SD = 109$). These self-reported scores closely match the averages for this institution (582, 587, and 1169, respectively).

Results

Table 4 presents the means of the four paragraph ratings for the anti-abortion group and for the pro-choice group. The means indicate that myside bias is present in the ratings of both groups. The anti-abortion group rated the 4anti/0pro paragraph higher than the 0anti/4pro paragraph (10.22 vs 7.80) and the pro-choice group rated the 0anti/4pro paragraph higher than the 4anti/0pro paragraph (9.66 vs 8.91). Likewise, there are indications of a one-sided bias in Table 4. Not surprisingly, the one-sided paragraph in favour the participant's prior opinion received the highest rating for both groups. However, replicating Baron's (1995) finding regarding a bias for one-sided thinking, our results indicated that the one-sided paragraph *opposing* the participant's opinion was rated as highly as the two paragraphs containing balanced arguments. Indeed, for the pro-choice group, the mean for the 4anti/0pro paragraph (8.91) was higher than the mean for either of the two balanced paragraphs (8.38 and 8.87).

Collapsed across the two groups, the mean myside bias score was 1.40 ($SD = 3.98$), and this score was significantly different from zero, $t(438) = 7.40$, $p < .001$. Myside bias scores were greater than zero for 245 participants, 68 participants had a myside bias score of zero, and 126 participants displayed an otherside bias. Collapsed across the two

TABLE 4
Mean paragraph ratings for anti-abortion and pro-choice groups in Experiment 2

	4anti/0pro	*2anti/2pro*	*2pro/2anti*	*0anti/4pro*
Anti-abortion ($n = 171$)	10.22	7.45	7.87	7.80
Pro-choice ($n = 268$)	8.91	8.38	8.87	9.66

groups, the mean one-side bias score was 1.86 ($SD = 5.75$), and this score was significantly different from zero, $t(438) = 6.77$, $p < .001$. One-side bias scores were greater than zero for 250 participants, 43 participants had a one-side bias score of zero, and 146 participants displayed a two-sided bias.

The key purpose of Experiment 2 was to examine whether the degree of myside bias and one-side bias was related to cognitive ability. The results here were quite clear cut. SAT total scores displayed a nonsignificant $-.03$ correlation with the degree of myside bias and a correlation of .09 with the degree of one-side bias (onebias1), which just missed significance on a two-tailed test but in any case was in the unexpected direction. An identical .09 correlation was obtained with the second one-side bias index (onebias2). The degree of myside bias and one-side bias (onebias1) was uncorrelated ($r = .01$).

One obvious potential qualification on the finding that myside bias was unrelated to cognitive ability is apparent from a perusal of Table 4—the anti-abortion group displayed more myside bias. The mean myside bias for the anti-abortion group was 2.42 ($SD = 4.26$), compared to a mean myside bias for the pro-choice group of 0.75 ($SD = 3.64$), a difference that was statistically significant, $t(437) = 4.37$, $p < .001$. Thus the correlation between SAT total score and myside bias was computed separately for the anti-abortion and pro-choice groups. Neither correlation attained statistical significance ($r = -.09$ and .04, respectively).

A more refined analysis revealed further how myside bias was related to the content and the strength of the prior opinion but not to cognitive ability. Figure 1 presents a scatter diagram of the degree of myside bias plotted against the prior opinion on the abortion statement (“I believe that abortion should be legal in this country”). The tilted U-shaped cubic function illustrates several things about how myside bias relates to the nature of prior belief on this issue. The curve bows upward on both ends, indicating that those with more extreme opinions displayed more myside bias. The curve is not symmetrical, however, which reflects the fact that the anti-abortion group displayed more myside bias at every degree of strength of opinion. Indeed, as Table 5 indicates, the group who slightly agreed with the proposition had a mean myside bias score of less than zero.

We conducted a regression analysis to examine the effects of opinion content (pro versus anti) and strength (slightly, moderately, strongly agree or disagree) on the degree of myside bias and whether cognitive ability could account for any variance after valence and strength had been partialled out. The content variable coded an anti-abortion opinion (of any strength) as 1 and a pro-choice opinion (of any strength) as 0. The strength variable coded

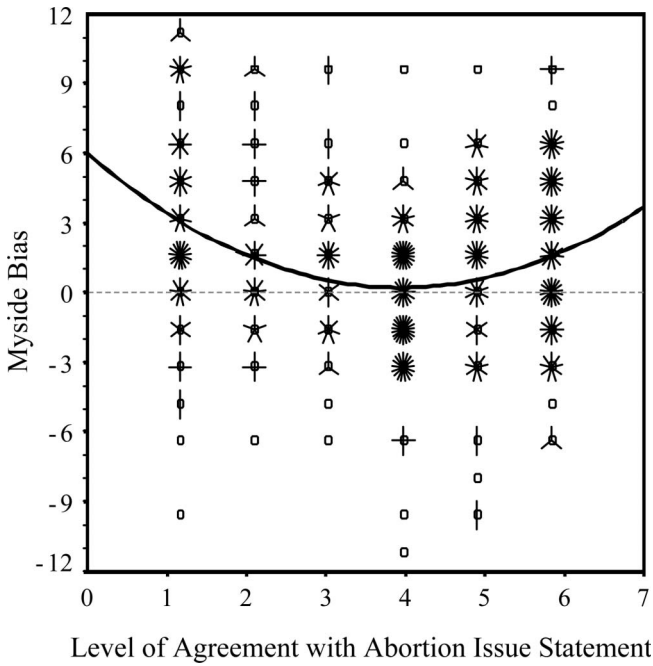

Figure 1. Scatterplot of myside bias as a function of level of agreement with the abortion statement in Experiment 2. Sunflowers indicate multiple participants at each point.

TABLE 5
Mean myside bias on the abortion issue as a function of level of agreement with the abortion issue statement* in Experiment 2

	Mean (SD)
Strongly Disagree ($n = 82$)	3.24 (4.70)
Moderately Disagree ($n = 43$)	2.02 (4.00)
Slightly Disagree ($n = 46$)	1.33 (3.37)
Slightly Agree ($n = 97$)	−0.52 (3.11)
Moderately Agree ($n = 72$)	1.06 (3.79)
Strongly Agree ($n = 99$)	1.78 (3.68)

*"I believe that abortion should be legal in this country".

a "slightly" response (regardless of content) as 1, a "moderately" response as 2, and a "strongly" response as 3. In a simultaneous regression analysis, the beta weights of the content variable and the strength variable were both significant ($p < .001$ in both cases). The beta weight for the SAT total was not significant, $F(1, 437) = 0.38$, *ns*.

EXPERIMENT 3

Experiment 2 converged with the results of Experiment 1 regarding the dissociation between myside bias and cognitive ability. Neither experiment demonstrated any connection between cognitive ability and the degree of myside bias. Both reasoning paradigms were relatively unconstrained in that no strong debiasing instructions were given. However, unlike the task in Experiment 1, the argument evaluation paradigm of Experiment 2 did measure myside bias by using a within-subjects manipulation that might have contained cues that the experiment demanded unbiased reasoning. Whether or not this occurred, it was not sufficient to create a correlation with cognitive ability.

In addition to converging with the results of Experiment 1, the findings of Experiment 2 contained two important implications for our developing view of the relation between intelligence and critical thinking abilities. First, it was demonstrated that another important critical thinking pitfall—the tendency to value one-sided thinking—was also independent of cognitive ability. Thus, these two experiments have demonstrated that two of the most important critical thinking tendencies, the tendency to avoid myside thinking and the tendency to avoid one-sided thinking, are—at least in these unconstrained paradigms—relatively independent of algorithmic-level computational capacity. Second, Experiment 2 did reveal that the magnitude of the myside bias displayed was predictable from some factors. However, those factors were specific to the opinion—that is, the strength and content of the opinion itself—and were not general individual difference characteristics such as cognitive ability.

Abortion, however, is a highly charged issue. It is possible that the strength and content effects we have observed were specific to that particular issue. More importantly, it would be important to examine whether the dissociation between myside bias and cognitive ability in this paradigm was specific to the abortion issue or whether it would generalise to another source of diverse opinion. In Experiment 3, in addition to examining whether the patterns of association on the abortion issue are replicated, we examined another issue—the legal age for drinking—that these students participants should, in the aggregate, care about somewhat but that is not so emotionally charged as is the abortion issue.

Two additional features were incorporated into Experiment 3. First, we added a formal reasoning task in which participants were explicitly instructed to avoid the bias of prior belief—that is, a constrained reasoning task as described in the Introduction. It was expected that the constrained task would display higher correlations with cognitive ability than did the unconstrained tasks and that the myside bias on the unconstrained task would show little relation to belief bias in a constrained processing situation.

Second, in Experiment 3 we examined additional individual difference variables—specifically, measures of two thinking dispositions: need for cognition (Cacioppo et al., 1996) and actively open-minded thinking (Stanovich & West, 1997, 2007).

Method

Participants. The participants were 420 undergraduate students (102 males and 318 females) recruited through an introductory psychology subject pool at a medium-sized state university. Their mean age was 18.9 years ($SD = 2.2$). The majority of these students were freshmen (252 students) or sophomores (112 students), and 90% of them identified themselves as White (375 White; 20 African American; 15 Asian American; 7 Other).

Thinking evaluation tasks. The abortion issue task was a replication of the thinking evaluation task used in Experiment 2.

The drinking issue thinking evaluation task used the same design and procedures as the preceding task; however, the controversial issue concerned the legal drinking age. Each participant was asked to evaluate the quality of the reasoning used by four students who, the participants were told, had been asked to speak out loud as they reasoned about the issue of lowering the legal drinking age from 21 to 18 years. Each student's reasoning statements were actually constructions that consisted of a set of four statements selected from a list of eight anti-drinking and eight pro-drinking statements.

The participants were randomly assigned to one of two groups. The first group evaluated the quality of the reasoning of four students who each made one of the following sets of statements: set 1: four anti-drinking reasoning statements (acronym: 4anti/0pro); set 2: two pro-drinking followed by two anti-drinking reasoning statements (2pro/2anti); set 3: four pro-drinking reasoning statements (0anti/4pro); and set 4: two anti-drinking followed by two pro-drinking reasoning statements (2anti/2pro). For the second group of participants, the sets of statements were as follows: set 1: four pro-drinking reasoning statements (0anti/4pro); set 2: two anti-drinking followed by two pro-drinking reasoning statements (2anti/2pro); set 3: four anti-drinking reasoning statements (4anti/0pro); and set 4: two pro-drinking followed by two anti-drinking reasoning statements (2pro/2anti). Thus, each participant evaluated the reasoning of two students whose reasoning statements represented only one side of the drinking issue (one consistently anti-drinking, one consistently pro-drinking) and two students whose reasoning statements represented two sides of the drinking issue.

Each of the 16 reasoning statements was used once in each participant's evaluations and, across the two participant groups, each reasoning statement occurred once in a one-sided (either 4anti/0pro or 0anti/4pro) and once in a two-sided (either 2pro/2anti or 2anti/2pro) set of reasoning statements. Within each participant group, the order of the sets and statements was fixed. Except for the change to the drinking issue, the directions participants read matched those used in Experiment 2. They responded on the same A+ to F scale.

The following is an example of a two-sided set of reasoning statements for the alcohol issue:

> Alcohol makes people feel friendlier and facilitates social interactions, and 18-year-olds should not be deprived of these benefits. Lowering the legal age for drinking alcohol to 18 will mean that younger people will now be allowed to work at some alcohol-serving establishments. This will give younger people more employment opportunities. Despite that, I also think however, by lowering the legal drinking age to 18, we will be exposing more people to the possibility of becoming alcoholics. Also, 18-year-olds simply are not mentally mature enough to handle a psychoactive drug as powerful as alcohol.

Positions on abortion and drinking issues. On a separate measure, participants responded to a questionnaire item, embedded in a series of other items, that probed the participant's position on the issue of abortion: "I believe that abortion should be legal in this country." Participants indicated the extent of their agreement with this proposition using the following response format: Strongly Agree (scored as 6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1). The mean agreement score was 3.84 ($SD = 1.86$). A total of 55.7% of the participants indicated some degree of agreement with the statement and 44.3% of the participants indicated some degree of disagreement with the statement. The former group was labelled pro-choice and the latter group anti-abortion.

The questionnaire also included an embedded item that probed the participant's position on the drinking issue: "Eighteen-year-olds should have the legal right to drink alcoholic beverages." Participants indicated the extent of their agreement with this proposition using the preceding response format. The mean agreement score was 3.77 ($SD = 1.65$). A total of 63.3% of the participants indicated some degree of agreement with the statement and 36.7% of the participants indicated some degree of disagreement with the statement. The former group was labelled pro-drinking and the latter group anti-drinking.

Measurement of myside and one-side bias. For each issue (abortion and alcohol), each participant graded four paragraphs: two two-sided

paragraphs and two one-sided paragraphs. Each participant received four scores for each issue: the rating (numerically transformed grade) they gave their 4anti/0pro paragraph, the rating they gave their 0anti/4pro paragraph, the rating they gave their 2anti/2pro paragraph, and the rating they gave their 2pro/2anti paragraph.

Each participant's myside bias for each issue was indexed by a difference score, calculation of which depended on their prior opinion. The abortion issue scores were calculated as in Experiment 2 and the alcohol issue scores were calculated analogously. Specifically, for the anti-drinking group, the myside bias score was derived by subtracting their 0anti/4pro score from their 4anti/0pro score. For the pro-drinking group, the myside bias score was derived by subtracting their 4anti/0pro score from their 0anti/4pro score. Positive difference scores indicate myside bias.

Each participant's one-side bias score was derived by adding their 4anti/0pro score to their 0anti/4pro score and subtracting from that the sum of the two 2/2 scores. A positive score on this metric indicates one-side bias—the two one-sided paragraphs (one in favour of the participant's opinion and one against) would be rated superior to the two balanced paragraphs. A negative score on the metric indicates a two-sided bias. A second one-side bias index was calculated in which the average of the two 2/2 scores was subtracted from the score on the one-sided paragraph that went against the participant's prior opinion. However, as in Experiment 2, this index produced results highly similar to those of the other one-sided index and thus will not be discussed further.

Syllogistic reasoning task. A total of 32 syllogistic reasoning problems, largely drawn from Markovits and Nantel (1989), were completed by the participants. Twelve of the problems were worded such that the validity judgement was in conflict with the believability of the conclusion (for example, All flowers have petals; Roses have petals; therefore, Roses are flowers—which is invalid). Twelve of the problems were worded such that the validity judgement was congruent with the believability of the conclusion (for example, All fish can swim; Tuna are fish; therefore, Tuna can swim—which is valid). Eight of the problems involved imaginary content (for example, All opprobines run on electricity; Jamtops run on electricity; therefore, Jamtops are opprobines—which is invalid). These syllogisms were thus neutral as regards conflict between validity and believability. The item types were intermixed.

Participants were instructed as follows:

> In the following problems, you will be given two premises *which you must assume are true*. A conclusion from the premises then follows. You must decide whether the conclusion *follows logically* from the premises or not. You

> must *suppose that the premises are all true* and limit yourself only to the information contained in the premises. This is very important. Decide if the conclusion follows logically from the premises, assuming the premises are true, and circle your response.

After each item, the participants indicated their responses by circling one of the two alternatives: (a) Follows Logically, (b) Does Not Follow Logically. Our analyses here will focus on the inconsistent items—those that mirror most closely the critical thinking skill of being able to put aside one's prior knowledge and reason from new premises. Scores on the inconsistent syllogisms ranged from 0 to 12 ($M = 7.12$, $SD = 3.40$).

Cognitive ability measure. Students were asked to indicate their verbal, mathematical, and total SAT scores on the demographics form. The mean reported verbal SAT score of the students was 589 ($SD = 67$), the mean reported mathematical SAT score was 588 ($SD = 67$), and mean total SAT score was 1177 ($SD = 103$).

Thinking dispositions measures. *Actively Open-minded Thinking (AOT) Scale*: The items on this scale were intermixed with the need for cognition items (described below) and with other scales not part of the present investigation. The actively open-minded thinking scale was composed for 41 items drawn from a variety of sources: 10 items from a flexible thinking scale developed by Stanovich and West (1997); 8 items from the Openness-Values facet of the Revised NEO Personality Inventory (Costa & McCrae, 1992); 9 items measuring dogmatism (Paulhus & Reid, 1991; Robinson, Shaver, & Wrightsman, 1991; Troldahl, & Powell, 1965); 3 items from the categorical thinking subscale of Epstein and Meier's (1989) constructive thinking inventory; 9 items from the belief identification scale developed by Sá et al. (1999); 2 items from a counterfactual thinking scale developed by Stanovich and West (1997). All items were scored in the direction that higher scores represented a greater tendency toward openminded thinking. Examples of items are ''People should always take into consideration evidence that goes against their beliefs'', ''Certain beliefs are just too important to abandon no matter how good a case can be made against them'' (reverse scored), ''no one can talk me out of something I know is right'' (reverse scored). The response format for each item in the questionnaire was: Strongly Agree (6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1). The score on the scale was obtained by summing the responses to the 41 items (Mean = 168.5, $SD = 18.3$). The reliability (Cronbach's alpha) of the actively open-minded thinking scale was .84.

Need for Cognition Scale: The 18-item need for cognition scale published by Cacioppo et al. (1996) was employed in this study. Sample items include:

"The notion of thinking abstractly is appealing to me" and "I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought." The response format for each item in the questionnaire was: Strongly Agree (6), Moderately Agree (5), Slightly Agree (4), Slightly Disagree (3), Moderately Disagree (2), and Strongly Disagree (1). The mean score was 66.8 ($SD = 11.9$). The reliability (Cronbach's alpha) of the need for cognition scale was .87.

After completing the demographic information sheet, participants completed, in order, the thinking evaluations task on the abortion issue, the thinking evaluation task on the drinking issue, the thinking dispositions measures, and the syllogistic reasoning task.

Results

Table 6 presents the means of the four paragraph ratings for the anti-abortion group and for the pro-choice group. The means indicate that myside bias is present in the ratings of both groups. The anti-abortion group rated the 4anti/0pro paragraph higher than the 0anti/4pro paragraph (10.42 vs 7.15) and the pro-choice group rated the 0anti/4pro paragraph higher than the 4anti/0pro paragraph (10.12 vs 8.40). Likewise, there are indications of a one-sided bias in Table 6. The mean of the one-sided arguments was higher than the mean of the two-sided arguments for both groups.

Collapsed across the two groups, the mean myside bias score was 2.31 ($SD = 4.20$), and this score was significantly different from zero, $t(419) = 11.26$, $p < .001$. Collapsed across the two groups, the mean one-side bias score was 1.82 ($SD = 5.05$), and this score was significantly different from zero, $t(419) = 7.38$, $p < .001$.

Table 7 presents the means of the four paragraph ratings for the anti-alcohol group and for the pro-alcohol group. The anti-alcohol group rated the 4anti/0pro paragraph higher than the 0anti/4pro paragraph (9.62 vs 7.92). Although the pro-choice group rated the 0anti/4pro paragraph higher than the 4anti/0pro paragraph, the means were quite close (9.19 vs 9.05). There were also indications of a one-sided bias in Table 7. The means of the

TABLE 6
Mean paragraph ratings for anti-abortion and pro-choice groups in Experiment 3

	4anti/0pro	*2anti/2pro*	*2pro/2anti*	*0anti/4pro*
Anti-abortion ($n = 160$)	10.42	7.20	8.10	7.15
Pro-choice ($n = 260$)	8.40	8.35	8.63	10.12

one-sided arguments was higher than the mean of the two-sided arguments for both groups.

Collapsed across the two groups, the mean myside bias score was 0.72 ($SD = 4.10$), and this score was significantly different from zero, $t(419) = 3.58$, $p < .001$. Collapsed across the two groups, the mean one-side bias score was 2.61 ($SD = 5.09$), and this score was significantly different from zero, $t(419) = 10.52$, $p < .001$.

The purpose of Experiment 3 was to examine whether the degree of myside bias and one-side bias was related to cognitive ability. Table 8 presents a correlation matrix including all of the key variables in the study. First, it is apparent that there is at least a modest degree of domain generality in myside bias and one-side bias. The degree of myside bias on the abortion issue was significantly correlated with the degree of myside bias on the alcohol issue ($r = .21$, $p < .001$), and the degree of one-side bias on the abortion issue was significantly correlated with the degree of one-side bias

TABLE 7
Mean paragraph ratings for anti-alcohol and pro-alcohol groups in Experiment 3

	4anti/0pro	*2anti/2pro*	*2pro/2anti*	*0anti/4pro*
Anti-alcohol ($n = 154$)	9.62	7.55	7.55	7.92
Pro-alcohol ($n = 266$)	9.05	8.02	7.51	9.19

TABLE 8
Intercorrelations among key variables in Experiment 3

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Abortion Myside							
2. Abortion One-Side	−.046						
3. Alcohol Myside	.213***	−.016					
4. Alcohol One-Side	−.082	.380***	−.074				
5. Syllogisms	−.070	.097*	−.056	.034			
6. SAT	−.042	.084	−.076	.051	.462***		
7. AOT	−.165***	−.033	−.127**	−.024	.225***	.217***	
8. Need for Cognition	.008	.049	−.100*	−.008	.205***	.187***	0.394***

$N = 420$.
AOT = activity open-minded thinking measure.
*$p < .05$, **$p < .01$, ***$p < .001$.

on the alcohol issue ($r = .38$, $p < .001$). However, the degree of myside bias was uncorrelated with SAT scores for both issues (correlations of $-.04$ and $-.08$ for the abortion and alcohol issues, respectively). Likewise, the degree of one-side bias was uncorrelated with SAT scores for both issues (correlations of .08 and .05 for the abortion and alcohol issues, respectively). Myside bias was also uncorrelated with number of inconsistent syllogisms answered correctly.

The degree of myside bias displayed a weak tendency to correlate with the thinking dispositions. Myside bias on the abortion issue displayed a significant correlation of $-.17$ ($p < .001$) with the actively open-minded thinking scale but not with the need for cognition scale ($r = .01$). For the alcohol issue, myside bias displayed small but significant correlations with both the actively open-minded thinking ($-.13$, $p < .01$) and the need for cognition scale ($r = -.10$, $p < .05$). The degree of one-side bias on both the abortion and alcohol issues failed to correlate with either of the thinking dispositions.

In contrast to the unconstrained thinking evaluation tasks, which displayed very weak relationships with individual difference variables, performance on the inconsistent syllogisms (a constrained reasoning task) displayed fairly robust and consistent correlations with both cognitive ability and thinking dispositions. The number of inconsistent syllogisms answered correctly displayed significant correlations with SAT total ($r = .46$, $p < .001$), actively open-minded thinking ($r = .22$, $p < .001$), and need for cognition ($r = .21$, $p < .001$). The .46 correlation validates the SAT scores. Each of the thinking dispositions remained a significant predictor after SAT total was partialled out (and of course the converse was also true). As in Experiment 2, we examined how myside bias varied with the strength and content of the prior opinion on each of the issues. Replicating Experiment 2, the mean myside bias for the anti-abortion group (3.27, $SD = 4.68$) was larger than the mean myside bias displayed by the pro-choice group of (1.71, $SD = 3.76$), and the difference was statistically significant, $t(418) = 3.75$, $p < .001$. Table 9 illustrates how myside bias was related to the opinion on the abortion statement (“I believe that abortion should be legal in this country”). The table shows a replication of the tilted U-shaped function of Experiment 2. Myside bias increases with the strength of opinion for both groups, but the anti-abortion group tended to display more myside bias.

Table 10 displays an analogous table of means across the responses to the alcohol issue (“Eighteen-year-olds should have the legal right to drink alcoholic beverages”). Here again, although bias increased with strength of opinion for both groups, those opposed to the issue displayed more bias at each level of opinion strength. Indeed, those who slightly agreed with the proposition actually displayed an otherside bias (mean $= -1.15$).

TABLE 9
Mean myside bias on the abortion issue as a function of level of agreement with the abortion issue statement[¶] in Experiment 3

	Mean (SD)
Strongly Disagree ($n = 86$)	4.86 (4.68)
Moderately Disagree ($n = 33$)	2.15 (4.44)
Slightly Disagree ($n = 41$)	0.83 (3.50)
Slightly Agree ($n = 74$)	0.82 (3.61)
Moderately Agree ($n = 75$)	1.07 (3.31)
Strongly Agree ($n = 111$)	2.74 (3.92)

[¶]"I believe that abortion should be legal in this country".

TABLE 10
Mean myside bias on the alcohol issue as a function of level of agreement with the alcohol issue statement[§] in Experiment 3

	Mean (SD)
Strongly Disagree ($n = 61$)	3.16 (4.61)
Moderately Disagree ($n = 51$)	0.90 (3.31)
Slightly Disagree ($n = 42$)	0.55 (3.78)
Slightly Agree ($n = 104$)	−1.15 (3.80)
Moderately Agree ($n = 92$)	0.50 (3.30)
Strongly Agree ($n = 70$)	1.61 (4.46)

[§]"Eighteen-year-olds should have the legal right to drink alcoholic beverages".

For both issues we conducted a regression analysis to examine the effects of opinion content (pro versus anti) and strength (slightly, moderately, strongly agree or disagree) on the degree of myside bias and whether cognitive ability could account for any variance after content and strength had been partialled out. In the first analysis, the content variable coded an anti-abortion opinion (of any strength) as 1 and a pro-choice opinion (of any strength) as 0. The strength variable coded a "slightly" response (regardless of content) as 1, a "moderately" response as 2, and a "strongly" response as 3. In a simultaneous regression analysis, the beta weights of the content variable and the strength variable were both significant ($p < .001$ in both cases). The beta weight for the SAT total was not significant, $F(1, 418) = 1.14$, *ns*.

In the second analysis the content variable coded an anti-alcohol opinion (of any strength) as 1 and a pro-alcohol opinion (of any strength) as 0. Strength was coded as in the previous analysis. In a simultaneous regression analysis, the beta weights of the content variable and the strength variable were both significant ($p < .001$ in both cases). The beta weight for the SAT total was not significant, $F(1, 418) = 0.67$, *ns*.

In summary, Experiment 3 replicated the results of Experiment 2 regarding the abortion issue. More importantly, Experiment 3 demonstrated an analogous pattern of results in the context of the alcohol issue. Specifically, the myside and one-side bias in the responses to that issue were unrelated to cognitive ability but were related to the strength and content of the prior opinion. These results contrasted with those from the syllogistic reasoning measure—a reasoning task with more intentional-level constraint. There, both cognitive ability and thinking dispositions correlated with reasoning performance.

GENERAL DISCUSSION

Across the three experiments reported here, robust indications of myside and one-side bias were demonstrated. In Experiment 1, a between-subjects demonstration of myside bias, some degree of myside bias was shown on each of 15 different propositions distributed across seven different domains of potential bias. Of the 15 myside bias effects, 13 were significant. Experiments 2 and 3 demonstrated robust indications of myside bias across two different opinion domains using a within-subjects design. These latter two experiments also showed statistically significant one-side bias effects across two different issue domains. It should be noted that this one-sided bias was observed despite the use of contrastives (e.g., "on the other hand") that pragmatically implied the authors of the two-sided statements were well aware of the contrasting nature of their subsequent statements. That is, it should have been clear to the participants that a student's two-sided statements represented an attempt at presenting both sides of an issue rather than merely a failure to monitor their own consistency.

The focus of our experiments, however, was on the individual difference correlates of myside bias and one-sided thinking. Across three different experiments involving two different paradigms and a variety of different prior beliefs, we found very little evidence that cognitive ability was related to myside bias. Using the paradigm introduced by Baron (1995) and across two different prior beliefs, we also found that another important critical thinking skill—the tendency to avoid one-sided thinking—was also independent of cognitive ability. On the face of it, the failure to find that cognitive ability predicted the degree of myside bias in these experiments seems incredibly surprising. Ever since Spearman (1904) first discovered positive manifold, intelligence indicators have correlated with a plethora of cognitive abilities and thinking skills that are almost too large to enumerate (e.g., Ackerman et al., 1999; Carroll, 1993; Deary, 2000, 2001; Deary, Whiteman, Starr, Whalley, & Fox, 2004; Lubinski, 2000, 2004; Lubinski & Humphreys, 1997).

We conjecture that the reason for this unusual dissociation from cognitive ability is that the myside and one-sided measures in these experiments were derived from paradigms that had features which were relatively less constraining of intentional-level functioning. For example, in the syllogistic reasoning task examined in Experiment 3, the participant was instructed to focus on validity and avoid being influenced by knowledge. Cognitive ability was related to performance on this task. In contrast, our version of the Baron (1995) paradigm used in that same experiment did not specifically instruct the participant to avoid myside or one-side bias. The natural myside bias paradigm of Experiment 1 measured bias between subjects and had few cues at all that bias was the focus of the experiment.

Although not associated with cognitive ability, there were indications in Experiment 3 that the degree of myside bias could, at least to some extent, be predicted by other factors. First, myside bias on the abortion issue displayed a significant correlation with myside bias on the alcohol issue (likewise, the one-side bias displayed across the two issues was significantly correlated). Second, the strength and content of the prior opinion predicted the degree of myside bias on both the abortion and the alcohol issue (multiple R of .336 and .328, respectively, both $ps < .001$). Finally, the degree of myside bias on both issues (but not the degree of one-side bias) displayed significant, albeit small, correlations with a measure of actively open-minded thinking. In short, there was enough reliable variance in myside bias to display correlations with variables other than cognitive ability.

Nevertheless, although actively open-minded thinking correlated with the degree of myside bias, the magnitude of this association was quite low. We would have thought measures of intentional-level functioning such as actively open-minded thinking and need for cognition would have been more potent predictors in these unconstrained reasoning tasks. In fact, simultaneous regressions indicated that the characteristics of the opinion itself (content and strength) were more potent predictors than any of the individual difference factors. For the abortion issue, once content and strength were entered as predictors of myside bias, the three individual difference factors (SAT total, actively open-minded thinking, and need for cognition) accounted for 2.7% additional variance. In contrast, after SAT total and the two thinking dispositions were entered into the equation, content and strength accounted for almost four times more additional variance (10.6% unique variance). A similar pattern held for the alcohol issue (1.8% unique variance versus 10.5% unique variance).

Another way to think of this is that the results suggest it might not be *people* who are characterised by more or less myside bias, but *beliefs* that differ in the degree of myside bias they engender—that differ in how strongly they are structured to repel contradictory ideas (Toplak & Stanovich, 2003).

It is possible that this tendency for opinion content factors to explain more variance in myside bias than individual difference factors might be understood by using some concepts from dual-process theory (Evans, 1984, 2003, 2006, 2007; Evans & Over, 1996, 2004; Kahneman & Frederick, 2002, 2005; Over, 2002; Reyna, Lloyd, & Brainerd, 2003; Sloman, 1996, 2002; Stanovich, 1999, 2004).

Consider that general individual difference characteristics that are posited to permeate large areas of cognitive functioning (e.g., intelligence, thinking dispositions such as need for cognition) are rather poor predictors of the degree of myside bias. Cognitive ability measures such as the SAT are indices of the computational power of the analytic system in dual-process theories (System 2; see Evans, 2003, 2006; Stanovich, 1999; Stanovich & West, 2000, 2003). Likewise, thinking dispositions such as actively open-minded thinking and need for cognition reflect the intentional-level processes of epistemic regulation associated with System 2. In contrast to cognitive ability and thinking dispositions, the prior belief that determined the magnitude of the myside bias in all of these experiments reflects not computational power or a generic mechanism of epistemic regulation, but instead reflects an interlocking knowledge structure. As a knowledge structure, it of course is available for an access "call" by serial production systems operating in System 2. But, importantly, well-instantiated knowledge structures are also subject to call from System 1.

We are suggesting that in unconstrained myside bias paradigms, bias is largely a function of the knowledge and beliefs subject to automatic triggering from System 1 and is little moderated by decontextualising operations carried out by System 2. This is why myside bias is so little related to System 2 processing indices such as cognitive ability (algorithmic-level functioning) or thinking dispositions (intentional-level functioning). The degree of bias shown is a function of the knowledge structures subject to automatic call and not individual differences in System 2 functioning. In contrast to natural myside bias situations, in tasks constrained at the intentional level—when people are explicitly cued to detach from their current perspective—individual differences in their decoupling abilities (indexed by general intelligence indices) come to the fore and predict the degree of myside bias displayed.[2] Thus, we speculate that natural myside bias has a different processing logic than does processing under explicit

[2]Interestingly, the correlation between SAT and the inconsistent syllogisms (.46) was higher than the correlation between SAT and the neutral syllogisms (.34). The latter correlation was in turn higher than the correlation between SAT and the consistent syllogisms (.26). Decoupling for the purpose of System 1 override is most necessary in the case of the inconsistent syllogisms and totally unnecessary in the case of consistent syllogisms. These results are very congruent with those of Handley et al. (2004).

instructions to detach from one's current perspective. Importantly, the critical thinking literature emphasises the former—the tendency to *spontaneously* adopt the perspectives of others and to avoid imposing one's prior belief on new evidence. Thus, the tasks studied here—rather than the belief bias and syllogistic reasoning paradigms traditionally studied by cognitive psychologists—are better indicators of the canonical reasoning skills discussed in the critical thinking literature. Our results thus indicate that intelligence—as defined by traditional psychometric indicators—turns out to be surprisingly independent of critical thinking tendencies. Cognitive ability measures such as the SAT thus miss entirely an important quality of good thinking.

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