2023

Reasoning about religion and the effects of belief bias

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REASONING ABOUT RELIGION AND THE EFFECTS OF BELIEF BIAS

BY

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A MASTER'S THESIS SUBMITTED TO THE GRADUATE FACULTY OF

RICHARD L. CONNOLLY COLLEGE OF LIBERAL ARTS AND SCIENCES

LONG ISLAND UNIVERSITY, BROOKLYN CAMPUS

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE DEGREE OF MASTER OF ARTS

MAJOR DEPARTMENT:

PSYCHOLOGY

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Date: December 2022

Abstract

The present study compares religious skeptics to believers, assessing both performance and response times on logical reasoning problems (syllogisms). Skepticism make fewer reasoning errors than did believers, while controlling for general cognitive ability, time spent on the problems, and various demographic variables. Comparison of response times indicated that skeptics also spent more time reasoning than did believers. This suggests that slower processing is an important component of analytic problem solving. Implications for using additional processing measures, such as response time, to investigate individual differences in cognitive style are discussed.

Keywords: Religiosity Dual-Process, Syllogisms, Deductive Reasoning, Judgment and Decision-Making

Belief bias during reasoning among religious believers and skeptics

A fundamental postulate of dual-process theories is that human thinking is influenced by two fundamentally different types of processing: (1) fast and frugal "intuitive" processes, and (2) slow and deliberative "analytic" processes. The interaction between intuitive and analytic processes has been used to explain decades of reasoning and decision-making research (for reviews, see Baron, 1994; Shafir & Tverksy, 1995; Stanovich & West, 2000). Recent evidence has suggested that dual-process theory can also be used to predict degrees of supernatural belief (Cheyne & Pennycook, 2013; Gervais & Norenzayan, 2012; Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012; Shenhav, Rand, & Greene, 2012). Specifically, those who are less likely to engage in analytic processing during problem solving, as indexed by the accuracy of their solutions, are more likely to hold a variety of religious beliefs (e.g., in the existence of God, heaven, hell, miracles, the soul, angels, and demons). However, it is unclear exactly why poor analytic think is linked to the tendency hold religious and supernatural beliefs.

Belief bias and dual-process theory.

Typically, syllogisms are used to measure analytic thinking in such studies. With a syllogism, a paradigm of logical processing, participants are provided with two premises and a conclusion, instructed to assume that the information in the premises is true and asked to judge the validity of the conclusion (i.e., whether it follows logically from the premises). Consider the following example:

All mammals can walk.
Whales are mammals.
Therefore, whales can walk.

The logical structure of this syllogism is valid (i.e., the conclusion follows logically from the premises). The conclusion, however, is unbelievable. Decades of research has reported that people often incorrectly respond on the basis of believability rather than validity (Markovits & Nantel, 1989; Oakhill, Johnson-Laird, & Garnham, 1989; Sá, West, & Stanovich, 1999). Within a dual-process framework (e.g., Evans, 2008; Evans & Frankish, 2009; Stanovich, 2009), belief biases are thought to occur due to an overreliance on fast, intuitive "Type 1" processes that rapidly evaluate believability and a failure to sufficiently engage the slow, deliberative, analytic "Type 2" processes involved in applying the rules of logic. Indeed, belief bias is often used in explaining the interplay between intuitive and analytic processing (e.g., De Neys, 2006b; Evans, 2008).

Dual-process theorists sometimes differentiate between cognitive ability and cognitive style (Stanovich, 2009; Stanovich & West, 1998, 2000, 2008; Stanovich, West, & Toplak, 2011); cognitive ability refers to a capacity for analytic processing, whereas cognitive style refers to a tendency or willingness to engage in analytic processing (Stanovich, 2009). Stanovich and colleagues have provided evidence that both cognitive style and ability are determinants of reasoning performance. With respect to syllogisms, for example, participants who are more willing to engage in Type 2 processing perform better (i.e., are more likely to reason according to logic), regardless of cognitive ability (Stanovich & West, 1998, 2000). The distinction between cognitive ability and cognitive style may have important implications for understanding the connection between poor analytic reasoning and maintain supernatural beliefs. Consistent with this idea, three recent studies have independently found that people who were more willing to engage in analytic thought reported having weaker religious and paranormal beliefs, even after controlling for cognitive ability (Gervais & Norenzayan, 2012; Pennycook et al., 2012; Shenhav

et al., 2012). These studies form part of a growing literature that links more analytic, open-minded, or "rational" reasoning with nonbelief in supernatural phenomena. Stanovich and colleagues, for example, foreshadowed this more recent work in previous studies by including a paranormal belief scale (Stanovich & West, 1998) and a superstitious-thinking scale (Macpherson & Stanovich, 2007) in a composite selfreported analytic-versus-intuitive thinking disposition scale, which in turn was correlated with reasoning performance on a wide variety of tasks (including syllogisms). More directly, work by Aarnio, Lindeman, et al. have used self-report thinking disposition measures to support the claim that believers in the paranormal have less reflective and more intuitive thinking dispositions (Aarnio & Lindeman, 2005, 2007; Lindeman & Aarnio, 2006, 2007; Svedholm & Lindeman, 2012). More generally, within the domain of religious belief, atheists have been found to be more intellectual, rational, and skeptical relative to theists (e.g., Beit-Hallahmi, 2007). It should be noted, however, that the more recent work by Gervais and Norenzayan, Pennycook et al., and Shenhav et al. is distinct from these past studies in three important ways: (1) Performance-based measures of reasoning style, as opposed to self-report, were used to predict supernatural belief directly; (2) numerous control variables, including cognitive ability, were included to rule out possible third-variable interpretations (Pennycook et al., 2012; Shenhav et al., 2012); and (3) experimental manipulations were used to verify a causal path between analytic thinking and religious belief (Gervais & Norenzayan, 2012; Shenhav et al., 2012).

However, these recent studies are far from definitive. Specifically, in measuring cognitive style, both Gervais and Norenzayan (2012) and Shenhav et al. (2012) relied on a single type of reasoning problem, the Cognitive Reflection Test (CRT; Frederick, 2005), and Pennycook et al. (2012) employed just two tasks, the CRT and base-rate problems. As both CRT and base-rate

problems involve mathematical or probabilistic reasoning, it is necessary to examine the relation between cognitive style and religious belief in other, nonmathematical domains of reasoning.

Perhaps more importantly, the previous work has also focused exclusively on reasoning performance (i.e., accuracy). Dual-process theorists have been criticized for overreliance on response output as opposed to measures intended to more directly assess cognitive processing (e.g., Gigerenzer & Regier, 1996). The primary criticism is that differences in accuracy can be explained by factors outside of cognitive style. While this issue has been partially addressed by measuring and controlling for cognitive ability (e.g., Pennycook et al., 2012), other factors could contribute to observed differences in accuracy. For example, some participants may have a "mindware gap," such that they lack the necessary knowledge to successfully solve the problem (i.e., even if they do engage in Type 2 processing; Stanovich, 2009). Mindware gaps are individual differences in domain-specific skills that are separate from general factors such as intelligence and working memory capacity (Stanovich, 2009). Alternatively, people who do well on logic–belief conflict tasks may simply be more generally reflective in their approach to problems, taking more time to assess alternative responses. In the present work, we therefore assessed response times (RTs) as a first step toward more directly probing differences in underlying processes during reasoning and associating these with both analytic performance and religious belief status. While RT is also presumably influenced by many factors, a selective increase in RT while reasoning has been taken as a sign of the use of Type 2 processes, because slower responding is generally expected under higher levels of deliberation (e.g., De Neys, 2006a; Evans, 2008).

In the present study four different types of syllogisms are used, combine the variables validity and believability. The syllogisms are either:

valid–believable (VB),
valid–unbelievable (VU),
invalid–believable (IB),
invalid–unbelievable (IU).

Belief bias effects occur when there is a decrease in accuracy for conflict problems (IB and VU) relative to nonconflict (VB and IU) (see Klauer, Musch, & Naumer, 2000, for a review). It is predicted that accuracy for conflict problems (i.e., avoiding belief bias) would be negatively correlated with religious belief, even when controlling for cognitive ability; also, it is predicted that performance on nonconflict problems would not be related to cognitive style, ability, or (by extension) religious belief, as the intuitive belief-based response would be consistent with logical considerations (Stanovich & West, 2000). Furthermore, under the hypothesis that Type 2 processing is slower than Type 1 processing, participants who engage in more Type 2 processing should spend more time reasoning. Although some recent studies have used RT analyses to investigate the processes that underlie deductive reasoning (e.g., De Neys, 2006a; De Neys & Glumicic, 2008; Evans & Curtis-Holmes, 2005; Thompson, Prowse Turner, & Pennycook, 2011), none have used RT to assess individual differences in cognitive style. Here, it is predicted that those with faster RTs would have decreased accuracy on syllogisms and be more likely to hold specific religious beliefs.

Method

Participants. A group of 156 psychology undergraduate students (96 female, 60 male; average age = 19.5 years, sd = 3.9 yrs.) participated in a session lasting approximately 30 min. Participation was voluntary, and participants received course credit.

Measures. All measures were presented on a computer monitor using E-Prime version 1.2. Reaction Time (RT) was measured from the outset of the problem presentation, and included reading time.

Syllogistic reasoning task: Eight syllogisms were taken from the work of Markovitz and Nantel (1989), and participants were asked to decide whether the conclusions followed logically from their premises. Participants selected "yes" or "no" by pressing a button on the keyboard. The participants were given standard instructions explaining the concept of logical validity and emphasizing that they should select "yes" if and only if the conclusion logically followed from the premises. Four of the problems had conclusions that did follow logically from the premises (i.e., were valid), and four did not; in addition, four had believable conclusions and four had unbelievable conclusions, yielding four different problem types that were each presented twice.

Belief rating task: Following the syllogisms, participants were asked to rate the believability of each of the conclusion statements from each of the eight syllogisms. Rating the believability of an obviously true or false statement likely does not require much more than cursory analytic processing. Thus, the RT for the belief rating task was taken as a proxy measure of individual differences in reading time, which was then treated as a control variable.

WordSum: WordSum test used here as a control for cognitive ability. It is a brief vocabulary test that correlates well with full-scale measures of intelligence (e.g., r = .40 with the fullscale

WAIS-R, .60 after a correction for attenuation; Huang & Hauser, 1998). Participants were presented with ten target words in capital letters and asked to choose the one of the provided options that most closely matching the meaning of the target word.

Religiosity: The Religious Belief (Rb) scale assesses five conventional religious beliefs held in varying degrees by religious people: heaven, hell, miracles, afterlife, and the existence of angels and demons. Each of the items rated on a Likert type scale and then calculated across items. Higher scores reflected higher belief. The scale had good distributional properties and acceptable internal consistency, Cronbach's alpha = .91.

Demographics: Participants completed a demographics questionnaire at the beginning of the semester as part of a participant pool prescreen. From this, we obtained information on socioeconomic status (SES), ethnicity, year in university, and university faculty to act as additional control variables (none of which had been examined as potential mediators in previous research). For SES, participants indicated, on a scale from 1 to 8, which social class they most strongly identified with (1 = working class,8= upper class). As the majority of participants listed their ethnicity as either White/Caucasian (47.3 %) or Asian (31.9 %), the remaining ethnic groups were coded as "other."

Results

Correlations among the major variables are presented in Table 1. As expected, religious belief was strongly negatively correlated with accuracy for conflict syllogisms but not nonconflict syllogisms, and the difference between the two correlations was significant by a Williams test, $t(85) = 2.73$, $p = .008$. Religious belief was also negatively correlated with overall mean RTs for both syllogisms and WordSum, indicating that skeptics also spent more time on

both tasks. Furthermore, overall RT for syllogisms was positively correlated with accuracy for conflict syllogisms, consistent with the hypothesis that increased reasoning time reflects increased Type 2 processing (De Neys, 2006a; Evans & Curtis-Holmes, 2005). Finally, belief rating RT was positively correlated with RTs for syllogisms and WordSum, as would be expected given stable differences in response tempo across the tasks.

Importantly, however, the RT for the belief rating task did not correlate with religious belief, and the correlation between religious belief and syllogism RT remained robust when controlling for belief rating RT ($rp = -.23$, $p = .028$) or WordSum RT ($rp = -.22$, $p = .035$). Hence, it appears that the correlations between religious belief and RTs for cognitive measures are unlikely to have arisen due to differences in reading time or nonspecific individual differences in response tempo.

WordSum performance was also correlated significantly negatively with religious belief and positively with performance for conflict problems. Thus, to assess the independent relation between analytic cognitive style and religious belief, a regression analysis was conducted predicting religious belief from syllogism performance (i.e., accuracy for conflict syllogisms), controlling for demographic variables, RT for the belief-rating task, mean RT for WordSum and syllogisms ("WS/Syll RT"),2 and WordSum performance (see the supplementary materials for the full regression).3 As is clear from Table 2, syllogism performance continued to make a significant independent contribution to the prediction of Rb. Participants with a more analytic cognitive style, as indexed by performance on conflict syllogisms while controlling for cognitive ability, were less likely to endorse religious beliefs, independent of sex, socioeconomic status, ethnicity, year in university, university faculty, reading ability, and time spent on reasoning

Table 1 Pearson product–moment correlations among major variables

	Performance			RT		
	Conflict	Nonconflict	WS	Syllogism	WS	Belief Rating
Rb	–.46	–.03	–.34	–.24	–.23	–.07
Conflict		–.04	.30	.27	.01	.20
Nonconflict			.19	–.10	–.10	–.03
WS				.17	.16	.15
Syllogism RT					.48	.50
WS RT						.32

Rb religious beliefs; WS WordSum; Conflict accuracy for conflict syllogisms, Nonconflict accuracy for nonconflict syllogisms. Coefficients in bold are significant at $p < .05$. $N = 91$

Table 2. Final step of hierarchical multiple regression analysis predicting religious beliefs with accuracy for conflict syllogisms (Conflict Acc.)

	B	SE	B	t	p	r	rp
Intercept	460.71	105.75	4.36				
Sex	19.47	26.24	0.08	0.74	.460	.24	.09
SES	-5.33	7.93	-0.07	-0.67	.503	-.16	-.08
Caucasian	-12.24	29.12	-.06	-0.42	.676	-.23	-.05
Asian	25.54	30.77	0.11	0.83	.409	.13	.10
Un. Yr.	-.835	.975	-0.08	-0.86	.395	-.12	-.10
Un. Faculty	-7.97	22.31	-0.04	-0.36	.722	.01	-.04
Belief rating	0.02	<0.01	0.19	1.65	.103	-.07	.19
WS/Syll RT	**-0.01**	**<0.01**	**-0.26**	**-2.23**	**.029**	**.026**	**-.25**
WS Acc	-112.19	69.03	-0.17	-1.63	.108	-.33	-.18
NonConflict	-23.89	61.18	-0.04	-0.39	.697	-.05	-.05
Conflict Acc	-91.53	28.10	-0.34	-3.26	.002	-.44	-.35

Controlling for sex, socioeconomic status (SES), ethnicity (Caucasian, Asian), year in university, university faculty (1 = arts,2= science/ engineering/mathematics), belief rating response time (RT), mean RTs for syllogisms and WordSum (WS/Syll RT), WordSum accuracy (WS Acc.), and nonconflict syllogism accuracy (Nonconflict Acc.). N = 88

tasks. RTs for syllogisms and WordSum also remained significant in the final step of the regression, providing further support for the proposed relation between religious belief and RT.

Discussion

The present work extends recent research by demonstrating a negative relation between analytic thinking and religious belief (Cheyne & Pennycook, 2013; Gervais & Norenzayan, 2012; Pennycook et al., 2012; Shenhav et al., 2012). Specifically, those better able to overcome belief bias during deductive reasoning tended also to be religiously skeptical. In addition, the RTs on syllogisms suggest that more skeptical participants also spent more time than did religious participants when reasoning on challenging tasks. Both accuracy and RT also predicted religious belief independently of one another and of several variables potentially offering alternative explanations. This work has ruled out sex, ethnicity, socioeconomic status, income, year in university, university faculty, education (in a nonuniversity sample), political ideology, age, religious engagement, various personality variables, and cognitive ability (using multiple measures) as potential mediators of the negative relation between reasoning performance and religious belief. Together, these findings suggest (a) that people who are less religious are more willing to engage in analytic "Type 2" reasoning, and that one of the potential cognitive mechanisms that underlies this relation is response slowing.

While much research in reasoning has employed RT as a measure of Type 2 engagement (e.g., De Neys, 2006a; De Neys & Glumicic, 2008; Thompson et al., 2011), the use of RT to assess individual differences in reasoning is, to our knowledge, novel. Using RT as a complementary measure to reasoning performance strikes us as an interesting strategy to more directly investigate differences in cognitive style. As numerous factors will surely influence RT,

such as general processing speed or reading ability, differences in cognitive style would likely need to be fairly substantial to be indexed by differences in RT. Of course, given the highly variable nature of RT, it is also important to have strong a priori reasons to assume that increases in RT reflect actual differences in analytic processing. Here, for example, we asked participants to assess logical validity, a task that surely elicits some degree 1 of analytic reasoning. This presumption was validated by the finding that those who took longer on the syllogisms were also less prone to belief bias. Thus, we suggest that at least part of the variation in RTs for syllogisms was a result of differences in the willingness to engage analytic reasoning, and therefore, the negative correlation between religious belief and syllogism RT provides further evidence for the hypothesized negative relation between analyticity and religiosity.

The negative correlation between syllogism RT and religious belief is an intriguing, but preliminary, piece of evidence for the possible role of "response slowing" as a component of analytic cognitive style that promotes overriding intuitive "first impressions." It is noteworthy, however, that this extra processing time was insufficient to fully explain the analytic performance association with religious belief. This suggests that religious skeptics are perhaps both more reflective and more effective during reasoning. Skeptics, in other words, appear to be both more analytical in their disposition and better able to perform the mental operations necessary to correctly solve logic problems. This makes sense because having an analytic disposition would likely have an attenuated effect on religious belief if the ability to successfully represent and manipulate representations via Type 2 processing were lacking.

An unexpected result was the finding that RT on the WordSum vocabulary test was also negatively correlated with religious belief. While one could argue that the WordSum task also potentially requires some level of analytic processing that could be affected by individual

differences, this result should be treated with caution. Nonetheless, it should be noted that the WS task does involve considering and selecting from a set of options, and the mean RT for the WordSum items was only 1 s less than that for syllogisms (see the supplementary materials). It is possible that some of the presented options may have "felt" right, and hence required some reflective capacity to hold off decision pending consideration of other options—a characteristic of analytic tasks, such as the Cognitive Reflection Test (Frederick, 2005), that have previously been associated with religious beliefs (Gervais & Norenzayan, 2012; Pennycook et al., 2012; Shenhav et al., 2012). Alternatively, it may be that response slowing may happen chronically among those with an analytic cognitive style as a strategy to insulate reasoning from intuitive outputs, regardless of whether the influence of intuitive outputs is actually detected. Of course, it is also entirely possible that neither of these explanations is accurate, because individual differences in some other variable, such as reading ability, underlie the apparent relation between RT and religious belief. We note, however, that religiosity did not correlate with RTs on the belief-rating task. Clearly, more research will be necessary to elaborate the potentially complex relation between RT and cognitive style. As this study is the first to use RT in this way, it is important to treat our results with caution. Nonetheless, on the basis of the foregoing discussion, we suggest that increases in RT are generally reflective of increased Type 2 processing, given a task for which (a) analytic processing is required and (b) variability in the relative engagement of analytic processing during task performance is expected, because of individual differences (as was the case here), task-specific cues, such as response conflict (e.g., De Neys & Glumicic, 2008), or metacognitive "feelings of rightness" (Thompson et al., 2011). Taking this approach allowed us to provide further evidence for the potential relation between cognitive style and religious belief. We suggest, on this basis, that using RT as a measure complementary to

accuracy in order to index differences in the willingness to engage analytic processing is an intriguing and potentially fruitful direction for future research.

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