

## Analytical Thinking Predicts Less Teleological Reasoning and Religious Belief

Jeffrey C. Zemla (jzemla@brown.edu)

Samantha M. Steiner (samantha\_steiner@brown.edu)

Steven Sloman (steven\_sloman@brown.edu)

Cognitive, Linguistic, and Psychological Sciences, Brown University, 190 Thayer Street  
Providence, RI 02912 USA

### Abstract

Individual differences in reflectiveness have been found to predict belief in God. We hypothesize that this association may be due to a broader inclination for intuitive thinkers to endorse teleological explanations. In support of our hypothesis, we find that scientifically unfounded teleological explanations are more likely to be endorsed by intuitive compared to analytical thinkers, and that those who endorse teleological explanations are more likely to have religious beliefs.

**Keywords:** cognitive style; cognitive reflection test; religious belief; teleological explanations; causal reasoning

### Introduction

Religious beliefs have enormous impact on our lives. They affect our moral and political values, our personal relationships, and our life goals. While people are often aware of the overt influences of religion, there may be a deeper connection between religious belief and general cognition (Barrett, 2000). How does cognitive style affect religious belief, and what makes some people more inclined to believe in God than others?

Kelemen (2004) proposed that children are *intuitive theists* who have a natural predisposition to believe in God. The foundation of this claim rests on the finding that children are teleologically promiscuous: Children tend to generate and endorse explanations for phenomena that ascribe a purpose or intention to the effect that is being explained (Kelemen, 1999), even when these explanations are scientifically unsupported. As a result, many children may readily endorse explanations that appeal to God—the ultimate teleological explanation—and this belief may persist through adulthood.

However, childhood religious beliefs do not always indicate what a person will believe as an adult. The Pew Forum on Religion & Public Life (2009) found that roughly half of Americans have changed religious affiliations at least once since childhood. A majority of those who reported no religious affiliation during childhood now belong to a religious affiliation. Conversely, 16% of adult Americans report having no religious affiliation, though only 7% were raised without a religious affiliation. Together, these findings suggest that religious beliefs in the United States are fluid, with some embracing religion only later in life and others abandoning their childhood beliefs. Children may be intuitive theists, but this cannot explain why religious views change over the lifespan.

One of the most commonly cited reasons for becoming affiliated or unaffiliated with a religion is a change in one's belief in God (Pew Forum on Religion & Public Life, 2009). Many of those who left their childhood religion expressed the view that “modern science proves religion is a superstition” and that they “just don't believe in God” anymore. In contrast, many of those who embraced religion later in life indicated that they felt “called by God.”

Although it is common to think of belief in God as an unshakeable conviction, there have been many arguments both for and against the existence of God. Christian philosophers have presented teleological arguments in support of God's existence (Aquinas 1274/1938; Paley, 1802), while other scholars have presented scientific arguments against the existence of God (Darwin, 1859; Dawkins, 1986). How susceptible is faith to reasoned argument? If these arguments do affect religious belief, then individuals who are more strongly influenced by teleological arguments should be more likely to believe in God.

Recent research has suggested that individuals who adopt an analytical thinking style are less likely to have strong religious beliefs. For instance, those who neglect base-rates in a statistical problem in favor of qualitative, case-based reasoning were more likely to express a belief in God (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012). Likewise, participants who scored highly on the Cognitive Reflection Test (Frederick, 2005), used to measure the ability to deliberate and suppress intuitive yet incorrect responses to analytical problems, reported lower beliefs in God (Pennycook et al., 2012; Shenhav, Rand, & Greene, 2012). A variety of experimental manipulations support a causal role of analytical thinking in religious belief. Participants who were asked to describe a time when they used intuition to solve a problem were more likely to report a belief in God than those who described a situation that required careful reasoning to solve a problem (Shenhav et al., 2012). Even subtler manipulations, such as visual or linguistic priming of analytical thought, have shown an effect on reported religious beliefs (Gervais & Norenzayan, 2012).

Our hypothesis is that the relation between analytical thinking and religious belief is mediated by a willingness to endorse teleological explanations. Specifically, we hypothesize that intuitive thinkers will be more likely to endorse scientifically unfounded teleological explanations, in part because they are less likely to reflect on causal directionality. In other words, intuitive thinkers may endorse

teleological explanations because they confuse an effect with an intention to cause that effect (i.e., a teleological cause). In contrast, analytical thinkers may be more likely to reject teleological explanations that erroneously reverse cause and effect.

## Experiment 1

In Experiment 1, we seek to establish a correlation between teleological reasoning and analytical thinking, as well as replicate two previous findings that show a connection between religious belief and teleological reasoning (Heywood & Bering, 2013; Banerjee & Bloom, 2014), and between religious belief and analytical thinking (Pennycook et al., 2012; Shenhav et al., 2012; Gervais & Norenzayan, 2012).

### Methods

**Participants.** 65 participants (40 male, 25 female, ages 19-66, median age 29) completed the experiment via Amazon Mechanical Turk. All participants were located in the United States.

**Materials and Procedure.** The experiment consisted of four sections in order: an abbreviated numeracy scale, a set of true/false teleological explanations, an extended cognitive reflection test (CRT), and a religious questionnaire<sup>1</sup>.

First, participants completed an abbreviated numeracy scale (Weller et al., 2013). The six-item scale measures a participant's ability to evaluate numerical problems involving percentages, probabilities, and basic mathematical operations. Some evidence suggests that the CRT may be essentially a measure of numeracy (Weller et al., 2013). We included a numeracy scale in order to rule out the possibility that CRT is measuring numeracy alone.

Second, participants completed a test of teleological reasoning consisting of 40 single-sentence explanations that suggest an intentional cause, taken from Kelemen, Rottman, & Seston (2013). Participants read each explanation and judged whether it was true or false. Twenty of the explanations were *test* stimuli. These explanations were scientifically unsupported teleological explanations, such as "*Bees frequent flowers in order to aid pollination.*" Although it is true that bees frequent flowers and that they do aid pollination, they do not visit flowers *in order to* aid pollination. That is, the bee's role in pollinating flowers is not intentional.

The remaining twenty explanations were *control* stimuli, half teleological and half causal (non-teleological). Additionally, half of each type were true and half false. For example, two of the control stimuli include "*Houses have doorbells in order to make dogs bark,*" (false teleological) and "*A lightbulb shines because electricity passes through its filaments,*" (true causal). The control stimuli were used

to ensure participants had no trouble reasoning about teleological and causal explanations in general. The order of the control and test stimuli were pseudo-randomized.

Third, participants completed the CRT, designed to measure the degree to which one engages in analytical as opposed to intuitive thinking. The original scale (Frederick, 2005) is made up of three questions in which the intuitive response is incorrect. Participants who engage in reflective thinking (analytical reasoning) may override the tendency to respond with their first instinct, and instead arrive at the correct answer. For instance, one question reads, "If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?" The intuitive response is 100 minutes, whereas the correct analytical response is 5 minutes. Several variants of the CRT have been proposed that include more than three items. We employed a six-item version that includes the original three questions plus three new questions (Toplak, West, & Stanovich, 2014)<sup>2</sup>.

Finally, participants completed a religious questionnaire identical to that used in Shenhav et al. (2012). Participants reported their belief in God on a 7-point Likert scale from "Confident atheist" to "Confident believer" (midpoint "Agnostic/undecided"). Additional Likert questions probed the participant's familial religiosity during childhood, belief in an immortal soul, change in religious belief since childhood, and whether they had a belief that convinced them of God's existence (yes/no).

### Results

Following Kelemen et al. (2013), seven participants were excluded from analysis for answering fewer than 80% of the teleological reasoning control questions correct, leaving a total of 58 participants remaining. Although performance on these control stimuli was not related to any of the primary measures of interest (CRT or religious belief, both  $p > .14$ ), there was a significant positive correlation between performance on the control questions and numeracy ( $r = .26, p = .048$ ). The control questions were not used in subsequent analyses. Pairwise correlations from Experiment 1 are reported in Table 1.

**CRT and Religious Belief.** Participants were assigned a CRT score based on the number of correct (analytical) responses (0-6). We found a significant negative correlation between CRT and belief in God ( $r = -.37, p = .004$ ). Participants who performed well on the CRT (more analytical responses) reported less of a belief in God than those who scored poorly on the CRT, even though CRT performance does not predict religious beliefs during childhood ( $r = -.11, p = .41$ ).

<sup>1</sup> The full experimental stimuli used in both experiments are available at <http://research.clps.brown.edu/SlomanLab/cogsci2016/>

<sup>2</sup> Toplak, West, & Stanovich, (2014) propose a seven-item version of the CRT, but due to an error we excluded the sixth item.

Table 1: Correlations between variables measured in Experiment 1. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Variable	Belief in God	Teleo. reasoning	CRT	Numeracy	Familial religiosity	Age	Gender
Belief in God	—						
Teleological reasoning	.24	—					
CRT	-.37**	-.32*	—				
Numeracy	-.14	-.29*	.55***	—			
Familial religiosity	.33*	-.05	-.11	-.03	—		
Age	.20	-.04	-.04	-.31*	.13	—	
Gender (1=M, 2=F)	.29*	-.02	-.22	-.38**	.22	.22	—
Education	.15	-.28*	.17	-.01	-.01	.28*	.23

**Numeracy and Religious Belief.** Performance on the six-item numeracy scale did not predict belief in God ( $r = -.14$ ,  $p = .3$ ). This suggests that the predictive ability of the cognitive reflection test is not due to differences in numerical ability.

**Religious Belief and Teleological Belief.** To construct a teleological reasoning score for each participant, we counted the number of teleological test questions that were endorsed (0-20). We found that participants who reported a strong belief in God were more likely to endorse teleological explanations, a marginally significant result ( $r = .24$ ,  $p = .067$ ). However, a post-hoc analysis controlling for familial religiosity indicated a significant partial correlation between teleological reasoning and belief in God ( $r = .27$ ,  $p = .037$ ). This suggests that the effect of teleological reasoning on religious belief may be moderated by religious upbringing.

**CRT and Teleological Beliefs.** Our original hypothesis was that those who engage in analytical reasoning are less likely to endorse false teleological explanations. Indeed, we found that participants who scored highly on the CRT were less likely to endorse teleological explanations ( $r = -.32$ ,  $p = .016$ ). We also found that numeracy predicts endorsement of teleological explanations ( $r = -.29$ ,  $p = .029$ ). However, given that the teleological explanations contained no numerical information, it is unlikely that numeracy has direct influence on teleological reasoning.

## Discussion

Experiment 1 replicates several findings from prior literature. Specifically, we find that both analytical thinking and teleological reasoning predict belief in God. We also demonstrate a novel effect: analytical style predicts willingness to endorse teleological explanations. Given these preliminary results, we conducted a follow-up study to examine these effects with a larger sample size. In addition, we propose and test a mechanism by which analytical style influences teleological reasoning.

## Experiment 2

Experiment 1 found that participants who engaged in analytical thinking were less likely to endorse scientifically unwarranted teleological explanations. It is hard to imagine how to explain this result and others (e.g., Kelemen & Rosset, 2009) without assuming that teleological explanations have an intuitive appeal that can be overridden by more deliberative processes. In Experiment 2, we test a mechanistic account of why this might be. Specifically, we propose that intuitive thinkers are more likely to neglect causal directionality, leading them to endorse teleological explanations in which the intention to bring about an effect is itself a cause. We test whether participants who attend to causal relations are less likely to endorse teleological explanations.

We suggest this mechanism may lead high CRT to be unwilling to endorse teleological explanations. For example, consider the explanation “Bees frequent flowers in order to aid pollination.” An individual who is aware of causal directionality may correctly reason that a bee’s flower visit is a *cause* of pollination, but that the reverse is not true: the desire to pollinate a flower is not a *cause* of the bee’s visit. That is, bees do not visit flowers *in order to* pollinate them. This ability to identify causal directionality is crucial to successfully evaluate teleological explanations. If intuitive thinkers are more likely to neglect causal directionality, they should be more likely to endorse some false teleological explanations.

## Methods

**Participants.** 188 participants (99 male, 87 female, 1 other, 1 unknown, ages 18-66, median age 26) completed the experiment. 135 participants (72%) were recruited via Amazon Mechanical Turk, while 53 participants (28%) were recruited from the Brown University undergraduate subject pool for course credit. All participants were located in the United States.

**Materials and Procedure.** Participants completed four tasks: the six-item CRT (identical to Experiment 1), an abbreviated teleological reasoning test, a causal reasoning test, and a religious questionnaire<sup>1</sup>. Questions were inter-

mixed and pseudo-randomized except for those from the religious questionnaire, which were presented last.

To avoid redundancy, we tested an abbreviated version of the teleological reasoning test used in Experiment 1. We used only five test items and three control items. The test items chosen were the most discriminative in Experiment 1, teleological explanations whose responses were highly dependent on CRT score. The three control items all had a high proportion of correct responses in Experiment 1.

The causal reasoning test included six conditional probability problems, including two from Tversky and Kahneman (1977) and four novel problems with the same structure. Each question presented participants with a scenario and asked them to choose the most likely of three options. One question, borrowed from Tversky and Kahneman (1977), read:

*Which of the following is more probable?*

- (a) That a girl has blue eyes if her mother has blue eyes
- (b) That a mother has blue eyes if her daughter has blue eyes
- (c) Equally likely

The correct answer to this, and to all of our conditional probability problems was (c): Equally likely. Kahneman and Tversky (1977) found that people often exhibit a bias when answering these problems, with a significant portion of participants responding (a) and very few responding (b). This result has been explained as a causal bias due to the strong forward causal relation from a mother's eye color to a daughter's eye color. Though people correctly reason that a daughter's eye color cannot influence her mother's eye color, they fail to identify that this does not influence the relative conditional probabilities of (a) and (b).

Participants with strong causal reasoning skills may be more likely to fall prey to this bias. Conversely, those who neglect causal directionality may be less likely to exhibit this bias and instead arrive at the correct answer. Thus, we hypothesize that participants who engage in deliberate analytical thinking will be better at causal reasoning, and less likely to arrive at the correct answers. As such, we expect participants who score high on the CRT to be *less likely* to answer the causal reasoning questions correctly.

In addition, we included three causal reasoning control questions. These questions were of a similar format to the causal reasoning test questions, except that the conditional probabilities were unbalanced so that the correct answer was not "Equally likely." For instance, one question asked:

*Which of the following events is more probable?*

- (a) That a woman has held a leading part in a musical given that she can sing
- (b) That a woman can sing given that she has held a leading part in a musical
- (c) Equally likely

The correct answer is (b) as all leads in a musical can sing, though not everyone who can sing has held the lead in a musical. These causal reasoning control questions were used to measure a participant's ability to reason through conditional probability questions more generally.

Finally, we used a religious questionnaire identical to that of Experiment 1, with two additional questions to gauge the participant's belief in God's agency: "To what extent do you believe that a God or Supreme being actively influences events in the world over the course of a day, and over the course of a century?"

## Results

Eleven participants were excluded from the analyses for failure to answer all three control teleological questions correctly. The teleological control questions were not analyzed further.

**CRT, Teleological Reasoning, and Belief in God.** We replicated many of the effects found in Experiment 1. Participants who scored high on the CRT were less likely to endorse teleological explanations ( $r = -.32, p < .001$ , see Figure 1) and less likely to report a belief in God ( $r = -.29, p < .001$ ). We also found a robust correlation between teleological reasoning and belief in God ( $r = .27, p < .001$ , see Figure 2). Note that undergraduate students were less likely to answer the CRT questions correctly ( $p = .04$ ) but more likely to express a belief in God ( $p = .07$ ) compared to Mechanical Turk participants.

Our primary hypothesis was that analytical style leads to decreased religious belief because analytical reasoning affects our ability to evaluate teleological arguments. We tested this hypothesis using a mediation analysis, and find that teleological reasoning does mediate the relation between CRT performance and belief in God, Sobel's  $z = -2.24, p = .025$ . This shows that teleological reasoning accounts for a significant portion of the shared variance between CRT and belief in God. However because our design is entirely correlational, we cannot rule out alternative hypotheses. It may be, for instance, that religious beliefs influence teleological reasoning.

**Causal Reasoning.** Participants were assigned a causal reasoning score based on the number of correctly answered causal reasoning test questions (0-6). We did not find support for our hypothesis that intuitive thinkers are less likely to exhibit a causal reasoning bias. Causal reasoning scores did not correlate significantly with CRT scores, teleological reasoning scores, or belief in God (all  $p > .17$ ).

Table 2. Correlations between variables measured in Experiment 2. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ . Shaded cells indicate effects that are significant ( $p < .05$ ) in both Experiments 1 and 2.

Variable	Belief in God	Teleo. reasoning	CRT	Familial religiosity	Causal reason. (test)	Causal reason. (control)	Age	Gender
Belief in God	—							
Teleological reasoning	.27***	—						
CRT	-.29***	-.32***	—					
Familial religiosity	.45***	.05	-.07	—				
Causal reasoning (test)	-.10	-.08	-.01	-.13	—			
Causal reasoning (control)	-.03	-.16*	.26***	.15	-.30***	—		
Age	.11	-.12	.10	.09	-.03	.07	—	
Gender (1=M, 2=F)	.10	.08	-.31***	.03	-.11	.07	.05	—
Education	-.06	-.18*	.27***	.05	-.14	.19**	.26***	-.09

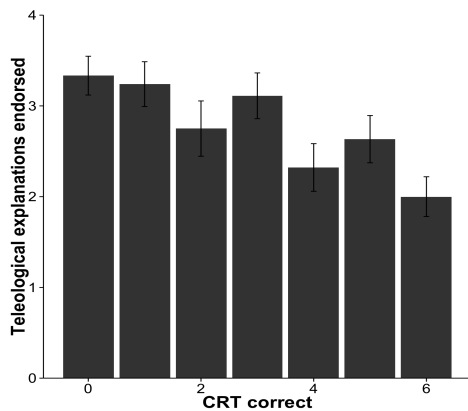


Figure 1. Performance on the CRT negatively predicts willingness to endorse teleological explanations.

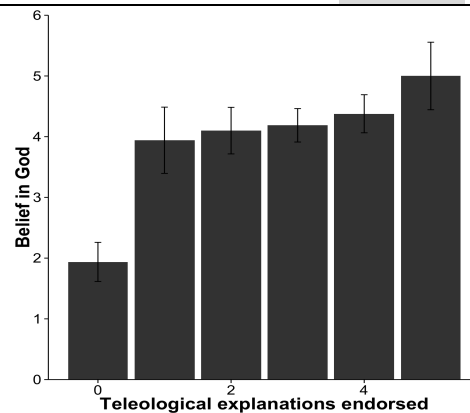


Figure 2. Participants who endorse teleological explanations are more likely to report a belief in God.

We assessed participants' performance on the causal reasoning control questions to ensure that this was not due to a failure to understand conditional probability problems more generally. Performance on these control questions, where the correct answer is consistent with a causal bias, was significantly positively correlated with both CRT scores ( $r = .26, p < .001$ ) and negatively correlated with teleological reasoning ( $r = -.16, p = .039$ ). That is, participants who were better at these control conditional probability problems were more likely to engage in analytical thinking and were less likely to endorse teleological explanations, as expected.

Performance on the causal reasoning control questions was *negatively* correlated with performance on the test questions ( $r = -.30, p < .001$ ). This is consistent with our initial hypothesis: some participants are lured by the forward causal option, leading them to get the control questions correct but the test questions wrong; other participants are not influenced by the causal lure and instead prefer the "Equally likely" option, leading them to get the test questions correct but the control questions wrong. What is surprising is that this behavior is *not* accounted for by analytical style.

## Discussion

Our results lend support to our initial hypothesis that teleological reasoning is a mediating factor that affects the relationship between analytical thinking and religious belief. However we cannot rule out the alternative possibility that religious participants were more likely to endorse teleological explanations *because* of their religious beliefs. This may be a reasonable position for some explanations. For instance, a religious thinker who believes in intelligent design may endorse the teleological explanation that "lemurs have adapted in order to avoid extinction." However it seems less likely that those same religious beliefs would cause a participant to endorse non-evolutionary teleological arguments, such as "hurricanes circulate seawater to gather energy," or teleological arguments that appear to superficially endorse evolution, such as "the fittest animals survive so that species can grow stronger."

We found no strong support for our mechanistic hypothesis that intuitive thinkers endorse teleological explanations due to a failure to distinguish between cause and effect, but we did uncover a novel and strange effect: Performance on standard conditional probability questions predicted susceptibility to causal bias on conditional probability problems used by Kahneman and

Tversky (1977). Although we predicted this result, our proposed mediating variable (CRT performance) failed to account for it.

One possibility is that performance on the causal reasoning test questions is influenced by two factors. On the one hand, participants must think analytically. On the other hand, participants must ignore causal directionality. If these two factors are in opposition to each other, it could explain why we observed a null effect for the correlation between causal reasoning test questions and CRT performance.

## General Discussion

In two experiments, we replicated previous findings that show religious beliefs are negatively correlated with analytical thinking, but positively correlated with willingness to endorse teleological explanations. In addition, we found that analytical thinking is negatively correlated with willingness to endorse teleological explanations, and that teleological reasoning mediates the relationship between analytical style and belief in God. However, our proposed mechanistic account of why intuitive thinkers endorse teleological explanations was not supported.

One limitation of the present studies is their reliance on correlational data. Future research should attempt to manipulate individual factors, such as teleological reasoning and analytical style, to clarify the causal direction of these effects. Unraveling this complex set of relations will further our understanding of reflectiveness and the sources of religious belief.

## Acknowledgments

This publication was made possible through the support of a grant from The Varieties of Understanding Project at Fordham University and The John Templeton Foundation. The opinions expressed in this publication are those of the author(s) and do not necessarily reflect the views of The Varieties of Understanding Project, Fordham University, or The John Templeton Foundation. We would like to thank Amitai Shenhav for helpful discussion and Deborah Kelemen for sharing her experimental stimuli used for the teleological reasoning task. We would also like to thank Daniela Lopez and Cristina Ballarini for their excellent research assistance.

## References

Aquinas, T. (1274/1938). *Summa theologica* (Vol. 66, pp. II-II). impressa per Andream de Torresanis.  
Banerjee, K., & Bloom, P. (2014). Why did this happen to me? Religious believers' and non-believers' teleological reasoning about life events. *Cognition*, 133(1), 277-303.  
Barrett, J. L. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, 4(1), 29-34.

Darwin, C. (1859). *The origin of species by means of natural selection: or, the preservation of favored races in the struggle for life*. W. F. Bynum (Ed.). AL Burt.  
Dawkins, R. (1986). *The blind watchmaker: Why the evidence of evolution reveals a universe without design*. WW Norton & Company.  
Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic perspectives*, 19(4), 25-42.  
Gervais, W. M., & Norenzayan, A. (2012). Analytic thinking promotes religious disbelief. *Science*, 336(6080), 493-496.  
Heywood, B. T., & Bering, J. M. (2014). "Meant to be": How religious beliefs and cultural religiosity affect the implicit bias to think teleologically. *Religion, Brain & Behavior*, 4(3), 183-201.  
Kelemen, D. (1999). The scope of teleological thinking in preschool children. *Cognition*, 70(3), 241-272.  
Kelemen, D. (2004). Are children "intuitive theists"? Reasoning about purpose and design in nature. *Psychological Science*, 15(5), 295-301.  
Kelemen, D., & Rosset, E. (2009). The human function compunction: Teleological explanation in adults. *Cognition*, 111(1), 138-143.  
Kelemen, D., Rottman, J., & Seston, R. (2013). Professional physical scientists display tenacious teleological tendencies: Purpose-based reasoning as a cognitive default. *Journal of Experimental Psychology: General*, 142(4), 1074-1083.  
Paley, W. (1802). *Natural Theology; Or Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature* by William Paley, Ed. FC and J. Rivington.  
Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, 123(3), 335-346.  
Pew Forum on Religion & Public Life. "Faith in flux: Changes in religious affiliation in the U.S." Pew Research Center, Washington, D.C. (April, 2009). <http://www.pewforum.org/files/2009/04/fullreport.pdf>.  
Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: cognitive style influences belief in God. *Journal of Experimental Psychology: General*, 141(3), 1-6.  
Toplak, M. E., West, R. F., & Stanovich, K. E. (2014). Assessing miserly information processing: An expansion of the Cognitive Reflection Test. *Thinking & Reasoning*, 20(2), 147-168.  
Tversky, A., & Kahneman, D. (1977). *Causal Schemata in Judgments Under Uncertainty*. Eugene, Oregon: Defense Technical Information Center.  
Weller, J. A., Dieckmann, N. F., Tusler, M., Mertz, C. K., Burns, W. J. and Peters, E. (2013). Development and Testing of an Abbreviated Numeracy Scale: A Rasch Analysis Approach. *Journal of Behavioral Decision Making*, 26, 198-212.