



## Belief in Fake News is Associated with Delusionality, Dogmatism, Religious Fundamentalism, and Reduced Analytic Thinking



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Delusion-prone individuals may be more likely to accept even delusion-irrelevant implausible ideas because of their tendency to engage in less analytic and less actively open-minded thinking. Consistent with this suggestion, two online studies with over 900 participants demonstrated that although delusion-prone individuals were no more likely to believe true news headlines, they displayed an increased belief in “fake news” headlines, which often feature implausible content. Mediation analyses suggest that analytic cognitive style may partially explain these individuals’ increased willingness to believe fake news. Exploratory analyses showed that dogmatic individuals and religious fundamentalists were also more likely to believe false (but not true) news, and that these relationships may be fully explained by analytic cognitive style. Our findings suggest that existing interventions that increase analytic and actively open-minded thinking might be leveraged to help reduce belief in fake news.

### *General Audience Summary*

There has been a proliferation of fabricated news stories that are presented as being from legitimate sources on social media. The present studies made progress toward answering the questions of who is most likely to believe this “fake news” and why. Two studies with over 900 participants suggested that individuals who endorse delusion-like ideas (e.g., thinking that people can communicate telepathically), as well as dogmatic individuals and religious fundamentalists, are more likely to believe fake news. These studies also suggested that two related forms of thinking may protect against belief in fake news: The first, actively open-minded thinking, involves the search for alternative explanations and the use of evidence to revise beliefs. The second, analytic

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thinking, involves the disposition to initiate deliberate thought processes in order to reflect on intuitions and gut feelings. Reduced engagement in these forms of thinking predicts increased belief in fake news, and may help to explain belief in fake news among individuals who endorse delusion-like ideas, dogmatic individuals, and religious fundamentalists. These results suggest that existing interventions designed to increase actively open-minded and analytic thinking might be leveraged to combat belief in fake news.

*Keywords:* Fake news, Dogmatism, Dual-process theory, Religious fundamentalism, Actively open-minded thinking, Delusion-proneness

The formation of accurate beliefs guides many adaptive behaviors. One contributor to inaccurate beliefs is misinformation, including “fake news,” which consists of fabricated news stories that are presented as being from legitimate sources and promoted on social media to deceive the public for ideological or financial gain (Lazer et al., 2018). Indeed, a single prior exposure encourages later belief in fake news, even when headlines are contested by fact checkers or are inconsistent with the reader’s political ideology (Pennycook, Cannon, & Rand, 2018). Given that widespread dissemination of false information can have negative consequences at both the individual and societal levels, it is imperative to determine who may be susceptible to believing fake news and why.

Delusion-prone individuals, who endorse unusual ideas considered to be on a continuum with psychotic symptoms (see Rössler et al., 2015; Van Os, Hanssen, Bijl, & Ravelli, 2000), may be especially susceptible to believing fake news. These individuals are more likely to endorse conspiracy theories (Dagnall, Drinkwater, Parker, Denovan, & Parton, 2015), believe in paranormal phenomena (Pechey & Halligan, 2011), and give higher plausibility ratings to absurd explanations for ambiguous events (Bronstein & Cannon, 2017; Zawadzki et al., 2012). These observations suggest that endorsement of delusion-like beliefs is associated with increased vulnerability to believing many types of other implausible ideas. This vulnerability may make delusion-prone individuals especially likely to believe implausible ideas conveyed through misinformation, such as fake news. The present study therefore evaluates the hypothesis that delusion-prone individuals are particularly vulnerable to fake news, and that this vulnerability is due, at least in part, to deficits in traits (e.g., analytic thinking and actively open-minded reasoning) that may reduce the likelihood that a given individual will endorse other types of implausible beliefs (e.g., belief in conspiracy theories or paranormal phenomena).

Analytic reasoning processes are typically more effortful because they rely on working memory resources (Evans & Stanovich, 2013). Analytic reasoning may sometimes override default responses suggested by intuitive processes, which are thought to emerge autonomously from simple stimulus-response pairings (Evans, 2007; Evans & Stanovich, 2013). Through this override process, engagement in analytic reasoning may reduce gullibility, and may therefore decrease endorsement of many intuitive-but-implausible beliefs, including those advanced via fake news (Krueger, Vogrincic-Haselbacher, & Evans, 2019; Pennycook & Rand, 2018a, 2018b). In the general population,

use of this override process may vary due to individual differences in general cognitive ability and in willingness to engage in analytic thinking (i.e., in the degree to which individuals have an “analytic cognitive style”; Frederick, 2005; Pennycook, Koehler, & Fugelsang, 2015; Stanovich & West, 2000). Research suggesting that a more intuitive (non-analytic) cognitive style is associated with the endorsement of implausible ideas, including belief in delusion-related ideas (Freeman, Evans, & Lister, 2012; Freeman, Lister, & Evans, 2014), conspiracy theories (Barron et al., 2018; Swami, Voracek, Stieger, Tran, & Furnham, 2014), paranormal phenomena (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012), and pseudo-profound bullshit (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015; Pennycook & Rand, 2018b), is therefore consistent with the notion that reduced engagement in analytic reasoning might cause individuals to believe broadly in the implausible. This effect seems likely to generalize to delusion-prone individuals given that engagement in analytic reasoning mediates the relationship between delusion-like beliefs (magical/odd beliefs on the Schizotypal Personality Questionnaire; see Raine, 1991) and conspiracy theories (Barron et al., 2018).

If an intuitive cognitive style does predispose delusion-prone individuals to believing implausible ideas in general, it may leave these individuals specifically prone to endorsing implausible beliefs advanced via fake news. This possibility is broadly consistent with the recently documented association between belief in fake news and reduced analytic thinking (Pennycook & Rand, 2018a). Given the theoretical connection between analytic thinking and working memory (Evans & Stanovich, 2013), this possibility is also consistent with research indicating that retracted misinformation (i.e., misinformation that is declared incorrect after dissemination) has a greater impact on beliefs in individuals with lower working memory capacities (Brydges, Gignac, & Ecker, 2018).

Reduced actively open-minded thinking (AOT; Baron, 1985) is a second (albeit conceptually related) trait that may increase belief in fake news by encouraging those who endorse delusion-like ideation to accept multiple other types of implausible ideas. AOT captures differences in the use of evidence (e.g., the opinions of others, information that disconfirms one’s beliefs) when forming and revising beliefs (Stanovich & West, 1997). It also captures the related tendency to actively search for alternatives (Campitelli & Gerrans, 2014). If individuals endorsing delusion-like ideation exhibit reduced AOT, they may be less likely to disconfirm implausible beliefs and replace them with

more viable alternatives. Broadly consistent with this possibility, reduced AOT is associated with belief in conspiracy theories (Swami et al., 2014) and paranormal phenomena (Svedholm & Lindeman, 2013).<sup>1</sup>

This study also examined whether dogmatic individuals and religious fundamentalists, who past research indicates may engage in less analytic and actively open-minded thinking, are more likely to fall for fake news. The possibility that more dogmatic individuals engage in less actively open-minded thinking stems from the overlapping nature of these constructs (see Stanovich & West, 1997). For example, one aspect of AOT is the disposition to search for alternative explanations (Campitelli & Gerrans, 2014). Both before and after judgments are made, dogmatic individuals generate less evidence against their judgments (Davies, 1998), which may impede this search. The evidence that dogmatic individuals engage in less analytic thinking is more empirical. Dogmatic individuals engage in less analytic reasoning during syllogism evaluation tasks that feature conflicting cues regarding syllogism validity (Martin, 2008). These individuals also produce fewer correct answers on the Cognitive Reflection Test (CRT; Frederick, 2005), which is comprised of items with intuitive-but-incorrect answers that must be overridden using analytic thinking to arrive at a correct response (Friedman & Jack, 2018).

Religious fundamentalists may also engage in less analytic and actively open-minded thinking. Categorical measures of religious belief suggest that individuals who believe in a personal God (vs. atheists) perform more poorly on the CRT (Pennycook, Ross, Koehler, & Fugelsang, 2016). Continuous measures of religious belief are also associated with poorer CRT performance (Bahçekapili & Yilmaz, 2017; Gervais & Norenzayan, 2012; Shenhav, Rand, & Greene, 2012) and with reduced AOT (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2014). Religious fundamentalism was chosen from the many aspects of religious belief as the focus of this study because religious fundamentalism is strongly correlated with dogmatism (Altemeyer, 2002). Given this strong correlation, the aforementioned evidence that dogmatism is related to both actively open-minded and analytic thinking provides additional support for the notion that religious fundamentalism is related to a reduced likelihood of exhibiting these cognitive styles.

In sum, this work was expected to identify three groups that may be particularly vulnerable to believing fake news (delusion-prone individuals, dogmatic individuals, and religious fundamentalists), and to suggest inter-related mechanisms that may contribute to this vulnerability (reduced analytic and actively open-minded thinking).

## Method

### Participants

Participants were recruited via Amazon's Mechanical Turk (MTurk) in two waves (Study 1:  $n=502$ , Study 2:  $n=446$ ; Demographics: SI Section S1). Only participants who were over 18 and who lived in the United States were recruited.

### Data Quality

Several steps were taken to ensure high data quality. Only MTurk workers with a history of providing good-quality responses (i.e., an acceptance ratio of >95%) were allowed to participate in this study. Studies employing MTurk workers who meet this criterion have obtained results comparable to those of studies conducted in the laboratory (Johnson & Borden, 2012). To prevent individuals from completing the same study multiple times or participating in more than one of the studies presented herein, only one response associated with a given MTurk ID (a unique identifier assigned to each MTurk worker) was accepted. Data from participants who did not complete the entire study were discarded prior to all analyses.

### Measures

Participants completed a number of different measures. A news evaluation task measured belief in fake and real news. During this task, participants encountered 12 fake and 12 real news headlines, in random order. Headlines were presented in a format often used on social media (accompanied by a photo and brief description). Example stimuli can be found in Figure 1. The fake news headlines used in this study were either taken from claims judged false by Snopes.com (a popular fact-checking website) or described widely circulated fake news stories from the 2016 US presidential election. Real news headlines were taken from credible mainstream media sources. Real and fake news stimuli included an equal number of pro-Democrat and pro-Republican news headlines. The political leaning of news headlines was evaluated via a large pretest (Pennycook & Rand, 2018b). Participants were instructed to rate the accuracy of each headline based on the degree to which they believed the headline described something that actually happened. Accuracy ratings were made on a four-point scale (1 = *Not at all accurate*, 4 = *Very accurate*). Belief in fake news was calculated using the average of these judgments across all fake stories, while belief in real news was calculated using the average across all real stories. Real news stories were selected to be contemporaneous with the fake news stories.

The Peters et al. Delusion Inventory (PDI; Peters, Joseph, Day, & Garety, 2004; example item: "Do you ever feel as if there is a conspiracy against you?") measured delusion-like ideation. Each of the 21 items in this inventory asks participants whether or not they have had one delusion-like experience. If they endorse the experience, they are asked to rate how distressing (1 = *Not distressing at all*, 5 = *Very distressing*), preoccupying (1 = *Hardly ever think about it*, 5 = *Think about it all the time*) and convincing (1 = *Don't believe it's true*, 5 = *Believe it's absolutely true*) it is on three separate five-point scales. The sum of

<sup>1</sup> Two additional traits (individual differences in the illusory truth and post-diction effects) were also examined in this study. However, because individual differences in these effects were not related to belief in fake news, this portion of the present study is not discussed in detail in this manuscript (but, see SI Section S14).



**Figure 1.** Example fake news stimuli. Left: Pro-Democrat fake news. Right: Pro-Republican fake news.

the number of experiences endorsed and all ratings describing aspects of those experiences (the PDI Total Score) was used to quantify delusion-like ideation.

Cognitive style was measured in two ways. The first was a shortened version of the actively open-minded thinking scale (Stanovich & West, 2007; example item: “A person should always consider new possibilities”; for the shortened scale, see SI Section S2). Participants indicated their agreement with each of the eight items comprising this measure using a six-point scale (1 = *Strongly disagree*, 6 = *Strongly agree*). AOT scores were computed as the sum of these ratings (after items were reverse scored as appropriate). Higher scores on this measure reflect greater use of evidence when forming and revising beliefs (Stanovich & West, 1997), and greater consideration of alternatives (Campitelli & Gerrans, 2014).

The second was the Cognitive Reflection Test (CRT; Frederick, 2005; example item: “How many cubic feet of dirt are there in a hole that is three feet deep by three feet wide by three feet long?”). The Cognitive Reflection Test measures analytic thinking by presenting participants with several problems that have intuitive-but-incorrect responses that must be overridden to arrive at the correct answer. The version of the CRT employed here consisted of seven items: three reworded items from the original CRT (via Shenhav et al., 2012) and the four-item non-numeric CRT (Thomson & Oppenheimer, 2016). Previous research has shown that this seven-item version of the CRT has acceptable reliability (Pennycook & Rand, 2018a). Scores on the CRT represent the number of correct answers given by participants. Higher scores reflect greater cognitive ability and/or a more analytic cognitive style.

Dogmatism was measured using the DOG scale (Altemeyer, 2002; example item: “The things I believe in are so completely true, I could never doubt them”). Participants indicated their agreement with each of the 20 items comprising this measure on a nine-point scale (1 = *Strongly disagree*, 9 = *Strongly agree*). Dogmatism scores were computed as the sum of these ratings (after items were reverse scored as appropriate). Higher scores indicated greater dogmatism (relatively unchangeable,

unjustified certainty; Altemeyer, 2002). The DOG scale was selected to measure dogmatism because its validity has been demonstrated across multiple studies (Altemeyer, 2002; Crowson, DeBacker, & Davis, 2008) and because it was designed to capture dogmatism in a manner not specific to any political philosophy (Altemeyer, 2002).

Religious fundamentalism was measured using an established religious fundamentalism scale (Altemeyer & Hunsberger, 1992; example item: “The basic cause of evil in this world is Satan, who is still constantly and ferociously fighting against God”). Participants indicated their agreement with each of the 20 items comprising this measure on a nine-point scale (1 = *Strongly disagree*, 9 = *Strongly agree*). Religious fundamentalism scores were computed as the sum of these ratings (after items were reverse scored as appropriate); higher scores indicated greater fundamentalism. For details on the measurement of the illusory truth and postdiction effects, see SI Section S14.

The internal consistency of all questionnaire measures was assessed using McDonald’s (1999) Omega Total. All measures had good, very good, or excellent internal consistency (see SI Section S3). Descriptive statistics for all measures can be found in Table 1. To discourage responses to any measure that were motivated by social desirability, the survey alternated between items from the measures of dogmatism, actively open-minded thinking, religious fundamentalism, and delusion-like ideation.

**Table 1**  
Descriptive Statistics: Means (SDs)

	Study 1	Study 2
Belief in fake news	1.79 (0.46)	1.85 (0.49)
Belief in real news	2.78 (0.47)	2.82 (0.46)
Actively open-minded thinking	34.09 (7.18)	34.02 (7.51)
Analytic thinking	3.65 (2.11)	4.12 (2.03)
Delusion-like ideation	51.52 (37.76)	41.39 (38.47)
Dogmatism	78.43 (27.12)	81.06 (26.45)
Religious fundamentalism	71.59 (40.17)	72.57 (41.91)

**Table 2**  
Zero-Order Correlations Between Variables

	2	3	4	5	6	7	8	9
1. Belief in fake news	.05	-.66*	.72*	-.32*	-.19*	.24*	.28*	.26*
2. Belief in real news	–	.65*	.68*	.14	.12	.06	-.15	-.07
3. News sensitivity		–	-.04	.34*	.25*	-.14*	-.32*	-.23*
4. News bias			–	-.15*	-.08	.23*	.10	.14
5. A.O. thinking				–	.33*	-.40*	-.69*	-.67*
6. Analytic thinking					–	-.31*	-.21*	-.37*
7. Delusion-like ideation						–	.25*	.46*
8. Dogmatism							–	.61*
9. Religious Fundamentalism								–

*Note.* Non-parametric correlations (Spearman's rho) were reported because variable distributions were non-normal. Only correlations with  $p$ -values less than .001 are reported as significant and marked by an asterisk. A.O. thinking = Actively open-minded thinking. Zero-order correlations for variables in Studies 1 and 2 can be seen in supplementary material (Tables S6/S7).

## Procedure

In Study 1, participants completed the Cognitive Reflection Test along with several additional individual difference measures (AOT scale, DOG scale, RF scale, and PDI). Half of the participants completed the Cognitive Reflection Test before these additional individual difference measures. The other half of the participants completed these additional individual difference measures first. Participants also completed the news-evaluation task, which either preceded or followed all other individual difference measures (i.e., the order of these two sets of stimuli was counterbalanced).

In Study 2, participants began by completing the first phase of the illusory truth task (in which they rated the interestingness of several facts; see SI Section S14). They then completed the CRT, news-evaluation task, postdiction task (see SI Section S14), and several additional individual difference measures (AOT scale, DOG scale, RF scale, and PDI), in random order. Finally, they completed the second phase of the illusory truth task (in which they rated the accuracy of several facts). Participants were given as much time as they needed to complete each study. For additional details regarding the order of measure administration, see SI Section S4.

## Analyses

Although we completed preregistrations (which can be found in SI Section S5) for each of the two recruitment waves, in the main text we combine the data from both waves and—based on the advice of a referee—many of our analyses deviated substantially from our preregistered plans. However, given that analyzing the individual study waves separately gives extremely similar results (see SI Sections S6–8 and S10), we feel confident in the replicability of our findings.

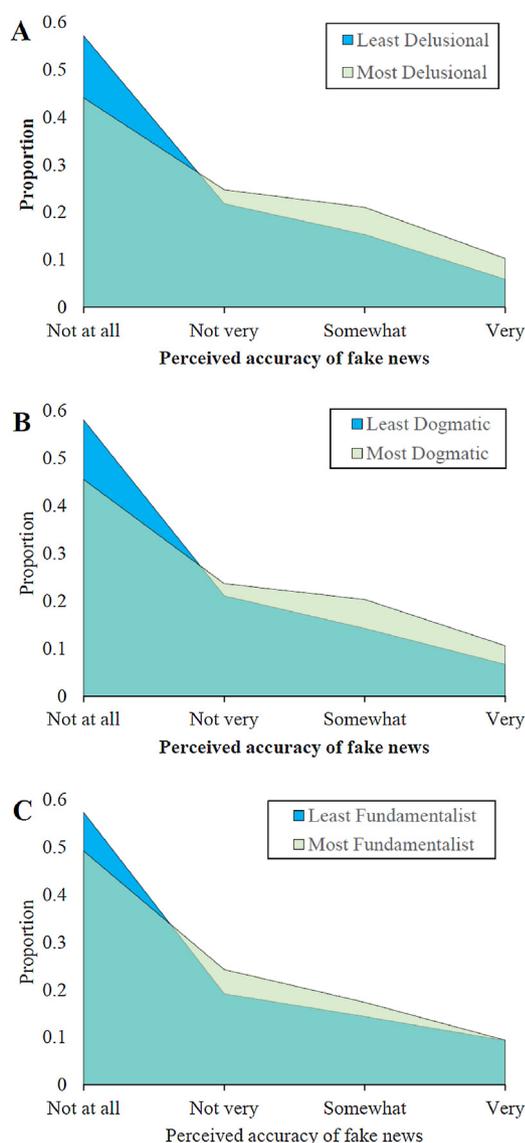
In accordance with our preregistered plans, outliers were detected using the method of Hubert and Van der Veen (2008), as implemented in R's *RobustBase* package, because this method is robust to skewed data. Identified outliers were winsorized (see Fuller, 1991). To compare results with and without outliers (which are qualitatively similar), see SI Sections S6–7. For further information about outlier processing, see SI Section S9.

In all mediation analyses, measures of actively open-minded and analytic thinking were entered into the same mediation model (PROCESS Model 4; Preacher & Hays, 2008). This method was expected to provide insight into whether these variables could each explain unique variance in the relationship between belief in fake news and delusion-like ideation, dogmatism, and religious fundamentalism. For each mediation model, 5000 bootstrapped samples and bias-corrected 95% confidence intervals were generated. All variables were standardized before entry into mediation models.

## Results

Zero-order correlations between all measures can be found in Table 2 (for the combined dataset) and SI Section S10 (for individual data collection waves). Delusion-like ideation, dogmatism, and religious fundamentalism were all positively correlated with belief in fake news (see Figure 2), but uncorrelated (delusion-like ideation and religious fundamentalism) or negatively correlated (dogmatism) with belief in real news. Delusion-like ideation, dogmatism, religious fundamentalism, and belief in fake news were all negatively correlated with analytic and actively open-minded thinking, whereas belief in real news was positively correlated with analytic and actively open-minded thinking.

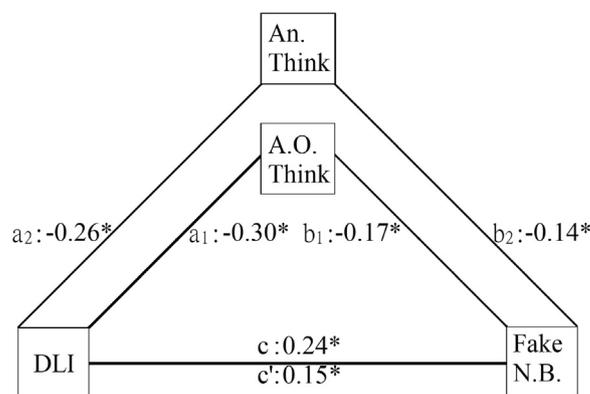
As a result, delusion-like ideation, dogmatism, and religious fundamentalism were negatively correlated with news sensitivity or “media truth discernment” (calculated as the difference between standardized real and fake news accuracy ratings, i.e., hits minus false alarms), whereas both cognitive style measures were positively correlated with media truth discernment. Furthermore, delusion-like ideation, dogmatism, and religious fundamentalism were associated with increased belief in all news, regardless of reality status (that is, these variables were associated with bias in news accuracy ratings, calculated as the sum of standardized fake and real news accuracy ratings, i.e., hits plus false alarms), whereas actively open-minded thinking, but not analytic thinking, was associated with a bias toward perceiving all news as inaccurate.



**Figure 2.** Distribution of the perceived accuracy of fake news as a function of delusion-proneness, dogmatism, and religious fundamentalism. Dark blue = lowest quintile, light blue = highest quintile. The y-axis of each graph is the proportion of all respondents who, on average, gave the response indicated on the x-axis.

### Mediation Analyses

Mediation analyses were conducted to examine whether the relationship between belief in fake news and delusion-like ideation, dogmatism, and religious fundamentalism could be partially explained by analytic and actively open-minded thinking. As anticipated, the total effect of delusion-like ideation on belief in fake news was significant, ( $\beta = 0.24$ ,  $p < .001$ , 95% CI [0.18 0.30]). Delusion-like ideation predicted actively open-minded ( $\beta = -0.30$ ,  $p < .001$ , 95% CI [-0.36 -0.24]) and analytic thinking ( $\beta = -0.26$ ,  $p < .001$ , 95% CI [-0.32 -0.20]). When delusion-like ideation, analytic thinking, and actively open-minded thinking were entered simultaneously into the regression model, actively open-minded ( $\beta = -0.17$ ,  $p < .001$ , 95% CI [-0.24 -0.11]) and analytic thinking ( $\beta = -0.14$ ,  $p < .001$ , 95% CI [-0.20 -0.08]) predicted belief in fake news.



**Figure 3.** The mediation model used to test the hypothesis that actively open-minded and analytic thinking are simultaneous mediators of the relationship between delusion-like ideation and belief in fake news. Numbers represent standardized coefficients. Paths are labeled according to the conventions of Baron and Kenny (1986). Path  $c$  = total effect. Path  $c'$  = direct effect. Paths  $a$  and  $b$  together depict the indirect effect of delusion-like ideation on belief in fake news. *DLI* = Delusion-like ideation. *An. Think* = Analytic thinking. *A.O. Think* = Actively open-minded thinking. *Fake N.B.* = Belief in fake news. \* $p < .05$ .

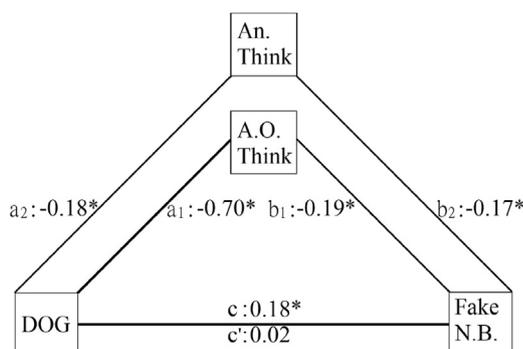
These results suggested that delusion-like ideation might exert indirect effects on belief in fake news via actively open-minded and analytic thinking. Critically, when these indirect effects were taken into account, the remaining (direct) effect of delusion-like ideation on belief in fake news ( $\beta = .15$ ,  $p < .001$ , 95% CI [0.09 0.21]) was less strong than the total effect. The significance of this decrease in strength was confirmed by 95% CIs for the completely standardized indirect effects of delusion-like ideation on belief in fake news (through actively open-minded thinking: [0.03 0.07]; through analytic thinking: [0.02 0.06]) that did not overlap with zero. The full mediation model described through these regression results is depicted in Figure 3. A summary of all statistics for the regression models in this mediation analysis can be found in Table 3.

The total effect of dogmatism on belief in fake news was also significant,  $\beta = 0.18$ ,  $p = .001$ , 95% CI [.12 .25]. Dogmatism predicted actively open-minded ( $\beta = -0.70$ ,  $p < .001$ , 95% CI [-0.75 -0.65]) and analytic thinking ( $\beta = -0.18$ ,  $p < .001$ , 95% CI [-0.24 -0.12]). When dogmatism, analytic thinking, and actively open-minded thinking were entered simultaneously into the regression model, actively open-minded ( $\beta = -0.19$ ,  $p < .001$ , 95% CI [-0.28 -0.11]) and analytic thinking ( $\beta = -0.17$ ,  $p < .001$ , 95% CI [-0.23 -0.11]) predicted belief in fake news. These results suggested that dogmatism might exert indirect effects on belief in fake news via actively open-minded and analytic thinking. Critically, when these indirect effects were taken into account, the remaining (direct) effect of dogmatism on belief in fake news ( $\beta = 0.02$ ,  $p = .679$ , 95% CI [-0.07 0.10]) was less strong than the total effect. The significance of this decrease in strength was confirmed by 95% CIs for the completely standardized indirect effects of dogmatism on belief in fake news (through actively open-minded thinking: [0.08 0.20]; through analytic thinking: [0.02 0.05]) that did not overlap with zero. The full mediation model described through these regression results is depicted in Figure 4. A summary of

**Table 3**  
The Relationship Between Belief in Fake News and Delusion-like Ideation is Mediated by Cognitive Style

Criterion variable	Predictor(s)	Standard error	$\beta$ [95% CI]	$t$	$F$	$R^2$
Analytic thinking	Delusion-like ideation	0.03	-0.26 [-0.32 -0.20]	8.49	72.09	.07
Actively open-minded thinking	Delusion-like ideation	0.03	-0.30 [-0.36 -0.20]	9.79	95.89	.09
Belief in fake news	Delusion-like ideation	0.03	0.24 [0.18 0.30]	7.68	58.92	.06
Belief in fake news	Analytic thinking	0.03	-0.14 [-0.20 -0.08]	4.28	41.05	.12
	Actively open-minded thinking	0.03	-0.17 [-0.24 -0.11]	5.14		
	Delusion-like ideation	0.03	0.15 [-0.09 -0.21]	4.67		

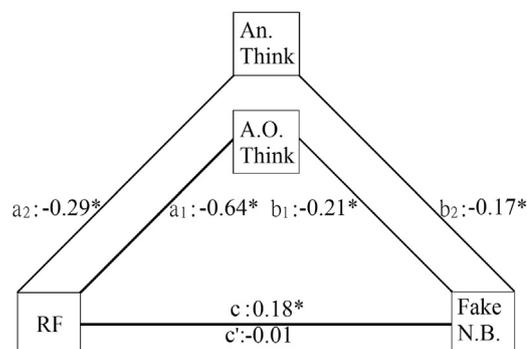
Note. The indirect effect through analytic thinking was significant, coefficient = 0.04, 95% CI = [0.02 0.06], as was the indirect through actively open-minded thinking, coefficient = 0.05, 95% CI = [0.03 0.07]. The indirect effects through these variables explained 37% of the total effect of delusion-like ideation on belief in fake news. Horizontal lines separate individual regression models.



**Figure 4.** The mediation model used to test the hypothesis that actively open-minded and analytic thinking are simultaneous mediators of the relationship between dogmatism and belief in fake news. Numbers represent standardized coefficients. Paths are labeled according to the conventions of Baron and Kenny (1986). Path  $c$  = total effect. Path  $c'$  = direct effect. Paths  $a$  and  $b$  together depict the indirect effect of dogmatism on belief in fake news. *DOG* = Dogmatism. *An. Think* = Analytic thinking. *A.O. Think* = Actively open-minded thinking. *Fake N.B.* = Belief in fake news. \* $p < .05$ .

all statistics for the regression models in this mediation analysis can be found in SI Table S8.

The total effect of religious fundamentalism on belief in fake news was also significant,  $\beta = 0.18$ ,  $p < .001$ , 95% CI [.11 .24]. Religious fundamentalism predicted actively open-minded ( $\beta = -0.64$ ,  $p < .001$ , 95% CI [-0.69 -0.59]) and analytic thinking ( $\beta = -0.29$ ,  $p < .001$ , 95% CI [-0.35 -0.22]). When religious fundamentalism, analytic thinking, and actively open-minded thinking were entered simultaneously into the regression model, actively open-minded ( $\beta = -0.21$ ,  $p < .001$ , 95% CI [-0.29 -0.13]) and analytic thinking ( $\beta = -0.17$ ,  $p < .001$ , 95% CI [-0.23 -0.11]) predicted belief in fake news. These results suggested that religious fundamentalism might exert indirect effects on belief in fake news via actively open-minded and analytic thinking. Critically, when these indirect effects were taken into account, the remaining (direct) effect of religious fundamentalism on belief in fake news ( $\beta = 0.01$ ,  $p = .852$ , 95% CI [-0.09 0.07]) was less strong than the total effect. The significance of this decrease in strength was confirmed by 95% CIs for the completely standardized indirect effects of religious fundamentalism on belief in fake news (through actively open-minded thinking: [0.08 0.18]; through analytic thinking: [0.03 0.07]) that did not overlap with zero.



**Figure 5.** The mediation model used to test the hypothesis that actively open-minded and analytic thinking are simultaneous mediators of the relationship between religious fundamentalism and belief in fake news. Numbers represent standardized coefficients. Paths are labeled according to the conventions of Baron and Kenny (1986). Path  $c$  = total effect. Path  $c'$  = direct effect. Paths  $a$  and  $b$  together depict the indirect effect of religious fundamentalism on belief in fake news. *RF* = Religious fundamentalism. *An. Think* = Analytic thinking. *A.O. Think* = Actively open-minded thinking. *Fake N.B.* = Belief in fake news. \* $p < .05$ .

The full mediation model described through these regression results is depicted in Figure 5. A summary of all statistics for the regression models in this mediation analysis can be found in SI Table S9.

The results for belief in real news can be seen in SI Section S12. These results suggest that the mediation pathways presented above are specific to belief in fake news. At zero-order, belief in real news (unlike belief in fake news) did not correlate with delusion-like ideation. The indirect effect of delusion-like ideation on belief in real news via actively open-minded thinking competed with the direct effect of delusion-like ideation on belief in real news. Analytic thinking was not a significant mediator of the relationship between delusion-like ideation and belief in real news. This pattern contrasts with the complementary mediation effect of these cognitive styles that was observed for fake news. Although belief in real news (like belief in fake news) was correlated with dogmatism and religious fundamentalism at zero-order, the ability of actively open-minded and analytic thinking to explain the relationship between dogmatism/religious fundamentalism and news accuracy judgments appears to be specific to contexts in which fake news is being evaluated.

## Discussion

These studies established that delusion-prone individuals, dogmatic individuals, and religious fundamentalists are more likely to believe fake news. Mediation analyses suggested that these relationships may be partially or fully explained by reduced engagement in actively open-minded and analytic thinking, which may broadly discourage implausible beliefs.

These results build upon prior work relating analytic thinking to reduced belief in fake news (Pennycook & Rand, 2018a, 2018b) by suggesting that reductions in analytic thinking and a related concept, actively open-minded thinking (see Campitelli & Labollita, 2010), may increase belief in fake news across multiple groups of people. It follows from this suggestion that interventions designed to increase analytic thinking (Ward & Garety, 2017) or actively open-minded thinking (Gürçay-Morris, 2016) may help keep delusion-prone and dogmatic individuals, as well as religious fundamentalists, from falling for fake news. Because these interventions target specific mechanisms putatively contributing to belief in fake news, they may be more successful than previous interventions, such as explicit “warning” labels, which have sometimes inadvertently encouraged belief in un-warned fake news (see Pennycook & Rand, 2017). Future research should therefore examine these potential interventions’ efficacy.

The present studies also build upon prior research examining gullibility and implausible beliefs. Analytic reasoning has been argued to reduce gullibility (Krueger et al., 2019); a conjecture that is consistent with the negative correlation between engagement in analytic reasoning and belief in fake news observed here. The present studies also interface with prior research through their suggestion that increased engagement in analytic reasoning may improve the ability to discriminate real from fake news. Through this suggestion, the present research joins prior work (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015; Pennycook & Rand, 2018b) in suggesting that analytic reasoning may promote the ability to discern statements constructed without concern for truth from more meaningful statements. Finally, the present studies interface with prior research through their suggestion that reduced engagement in analytic reasoning may promote the endorsement of multiple types of implausible beliefs. It follows from this suggestion that reduced engagement in analytic thinking may explain the associations between implausible ideas identified in previous research (e.g., between conspiracy theories and rejection of well-supported science; Lewandowsky, Oberauer, & Gignac, 2013).

Beyond these relationships with prior work, the present studies provide directions for future research on fake news. Such research might begin by investigating *why* belief in fake news is reliably associated with reduced engagement in analytic reasoning. Research on dual-process reasoning may provide insight into the underlying cause of this association. This research suggests that failures of conflict detection may pre-empt deliberative reasoning processes (Pennycook, Fugelsang, & Koehler, 2015). It follows from this suggestion that engagement in analytic reasoning may be correlated with belief in fake news because both depend on the ability to detect conflicts during reasoning.

Consistent with this possibility, research indicates that weakened conflict detection may explain the association between reduced analytic thinking, actively open-minded thinking (Pennycook, Fugelsang, & Koehler, 2015), and religious beliefs (Pennycook et al., 2014).

Future research might also build upon the present studies’ mediation analyses. In the present studies, the effect of delusion-like ideation on belief in fake news remained significant when indirect effects through analytic and actively open-minded thinking were simultaneously considered. Given that the direct effect of delusion-like ideation on belief in fake news was positive, this result suggests that additional indirect effects that might increase belief in fake news were missing from our mediation model (see Zhao, Lynch & Chen, 2010). Given that the content of fake news is often implausible (Pennycook & Rand, 2018a), the search for these missing indirect effects might begin with cognitive biases thought to increase or maintain delusion-prone individuals’ belief in the implausible. Two such biases are the bias toward reduced data gathering (Dudley, Taylor, Wickham, & Hutton, 2015) and the bias toward discounting evidence against one’s beliefs (Bronstein & Cannon, 2017). Reduced data gathering may increase delusion-prone individuals’ belief in fake news by reducing the chances that they encounter information that may contradict its content. This effect of reduced data gathering may be amplified by the fact that delusion-prone individuals may begin their information search by focusing on less reliable sources of information (Glöckner & Moritz, 2008). Even when information that may contradict fake news content is encountered by delusion-prone individuals, these individuals’ bias against disconfirmatory evidence may prevent this information from being fully considered.

The present studies’ implications for past and future research should be considered in the context of several limitations. One such limitation is that cross-sectional mediation analyses, like the ones conducted in the present studies, are biased estimators of causal processes that likely unfold over time (Maxwell & Cole, 2007). This limitation qualifies the present studies’ support for the hypothesis that reduced engagement in analytic and actively open-minded thinking might explain the relationship between belief in fake news and delusion-like ideation. Future research could address this limitation by examining whether reduced engagement in analytic reasoning predicts both belief in fake news and the endorsement of delusion-like ideation in a longitudinal dataset or by experimentally manipulating engagement in analytic reasoning. A second limitation of the present studies is that the small amount of variance explained in our regression models may prompt concerns that these models’ significance is entirely due to the large samples we recruited, which were required for the present studies to achieve adequate statistical power (see Fritz & MacKinnon, 2007). This limitation is mitigated somewhat by the pre-registration of our key analyses and the consistency of our results with prior research (e.g., Barron et al., 2018).

These limitations notwithstanding, the present studies suggest that delusion-prone and dogmatic individuals, as well as religious fundamentalists, are more likely than others to believe fake news, and that this may be in part because they

exhibit reduced analytic and actively open-minded thinking. This suggestion points to potential interventions that may keep individuals from falling for fake news and lays the groundwork for future fake news research. Pursuit of these avenues for future work may help address societal concerns associated with belief in fake news (e.g., its potential to inspire violence, Hsu, 2017).

### Conflict of Interest Statement

The authors declare that they have no conflict of interest.

### Author Contributions

Tyrone D. Cannon and David G. Rand developed the study concept. All authors contributed to study design. Testing and data collection were performed by Gordon Pennycook, Michael V. Bronstein, and Adam Bear. Michael V. Bronstein, Gordon Pennycook, and Adam Bear performed data analysis and interpretation under the supervision of Tyrone D. Cannon and David G. Rand. Michael V. Bronstein drafted the manuscript, all other authors provided critical revisions. All authors approved the final version of the manuscript for submission.

### Appendix A. Supplementary Data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.jarmac.2018.09.005>.

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