The Origins of Religious Disbelief: A Dual Inheritance Approach

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Abstract

Widespread religious disbelief represents a key testing ground for theories of religion. We evaluated the predictions of three prominent theoretical approaches – secularization, cognitive byproduct, and dual inheritance – in a nationally representative (USA, $N = 1417$) dataset with preregistered analyses, and found considerable support for the dual inheritance perspective. Of key predictors of religious disbelief, witnessing fewer credible cultural cues of religious commitment was the most potent, $\beta = 0.28$, followed distantly by reflective cognitive style, $\beta = 0.13$, and less advanced mentalizing, $\beta = 0.05$. Low cultural exposure predicted about 90% higher odds of atheism than did peak cognitive reflection, and cognitive reflection only predicted disbelief among those relatively low in cultural exposure to religion. This highlights the utility of considering both evolved intuitions and transmitted culture, and emphasizes the dual roles of content- and context-biased social learning in the cultural transmission of disbelief.

Keywords: atheism; religion; culture; evolution; dual inheritance theory

4964 words

Introduction

Evolutionary approaches to religion have proliferated in recent years, and different theories make starkly different predictions about the existence, nature, and origins of religious disbelief. Atheists – merely people who do not believe in the existence of a God or gods – constitute a large and perhaps growing proportion of earth's human population. A prominent estimate from about a decade ago (Zuckerman, 2007) posits the existence of 500-700 million atheists globally. This estimate is in all likelihood a drastic underestimate (Gervais & Najle, 2018). People routinely overreport their religious practices (Hadaway et al., 1993), and indirect measurement of atheism in the USA reveals a potentially large gulf between some indirect (~26%) and direct (~3%) estimates of atheist prevalence (Gervais & Najle, 2018). Combining direct estimates and inferences drawn from the few available indirect estimates, we suspect that upwards of 2 billion people on earth may in fact be atheists. Many evolutionary theories of religion posit a universal or near-universal implicit theism (Barrett, 2004, 2010; Bering, 2010; Boyer, 2008), and may thus be fundamentally incompatible with global atheism that is simultaneously prevalent and deliberately concealed. Here we test predictions on atheism from three prominent theoretical frameworks (outlined in Table 1): secularization, cognitive byproduct, and an emerging dual inheritance model of religion (Norenzayan et al., 2016; Norenzayan & Gervais, 2013). This project situates the study of religious disbelief firmly within established theoretical frameworks for studying the evolution of human behavior and contributes to broader discussions of the role of transmitted versus evoked culture in core aspects of human nature (Laland & Brown, 2011).

Prominent Theoretical Approaches

Three of the most prominent current approaches to religion and disbelief are **secularization** theories, the **cognitive byproduct** approach made popular by evolutionary psychology and the cognitive science of religion, and a **dual inheritance** approach.

Secularization

Secularization theories emerging from sociology of religion (Inglehart & Norris, 2004; Marx, 1843; Schnabel, 2020) and social psychology (Inzlicht et al., 2011; Kay et al., 2008) posit that religions serve some sort of societal or intrapsychic function, be it for bringing groups together or assuaging existential concerns. As strong secular institutions emerge in some places (Inglehart & Norris, 2004), or in situations in which people feel secure and in which secular institutions can quench a thirst for control and order (Kay et al., 2008) religious motivations wane. These approaches predict that religion should be nearly universal, but that atheism might emerge when 1) people largely feel existentially secure, or when 2) secular institutions are

strong and effective.

Cognitive Byproduct

Cognitive byproduct accounts, emerging from both evolutionary psychology and the cognitive science of religion, view the capacity for religious cognition as a byproduct of adaptations that emerged for other functions (Barrett, 2004; Boyer, 2008). This includes a putative *Hyepractive Agency Detection Device* – oft posited, never substantiated[i] – as well as more general mental adaptations for mind perception and social life. The cognitive byproduct approach predicts near-universal theistic belief. Atheism – if indeed it is a genuine phenomenon rather than a self-report illusion that only goes "skin deep" as some have claimed (Bering, 2010) – would emerge only in special environments and conditions. For example, in this view atheism could result from subtle individual differences in the cognitive adaptations that underpin the representation of supernatural agents, such as mind perception and advanced mentalizing. Alternatively, a common refrain in the cognitive science of religion is that atheism requires effortful cognitive reflection. Prominent scholars of this tradition claim, for example, that atheism "require[s]... cognitive effort" (Barrett, 2010) and that "disbelief is generally the result of deliberate, effortful work" (Boyer, 2008). Cognitive science of religion researchers repeatedly emphasize that effortful cognitive reflection underpins atheism. A couple of prominent byproduct accounts (Barrett, 2010; Bering, 2010; Boyer, 2008) explicitly predict that atheism is rare, potentially superficial, and requires cognitive effort. That said, more measured versions of the byproduct account are compatible with a wider range of possible atheist prevalence rates and required levels of cognitive effort. Thus, byproduct accounts from the cognitive science of religion generally predict that atheism may arise in some cases through limited mentalizing, but (whether or not effort is necessary) that superior analytic thinking is probably the most important predictor of atheism.

Dual Inheritance

Some supernatural agent concepts might be cognitively stickier than others, by virtue of having contents that is more evocative, memorable, or intuitively compelling (Barrett, 2004; Boyer, 2008). However, it is a far step from mentally representing or remembering a supernatural agent to actually believing in one (Gervais & Henrich, 2010). To tackle the challenge of *belief in* (rather than just mental representation of) supernatural agents, work from cultural evolution and gene-culture coevolution has emphasized that religious belief emerges from the interaction of evolved cognitive architecture and cultural learning.

In this view, people are biased to learn some concepts rather than others due to either their *contents* (some ideas are memorable and evocative) or from the learning *context*. Several context-dependent learning strategies

[i] Anecdotally, many-to-most graduate students in cognitive science of religion have tried these studies to no avail.

may be especially important in religious belief and disbelief. Conformist transmission (learning common beliefs) (Henrich & Boyd, 1998), prestige-and success-biased learning (learning from winners) (Henrich & Gil-White, 2001), and behavioral cues diagnostic of underlying beliefs – termed credibility enhancing displays (CREDs) (Henrich, 2009) – combine to powerfully influence what people come to believe or disbelieve. This dual inheritance approach does predict that religious belief will be widespread, but also predicts that atheism might naturally result in cultural contexts devoid of consistent behavioral cues that a naive learner ought to believe in any given god (Gervais & Henrich, 2010; Gervais & Najle, 2015; Lanman, 2012; Lanman & Buhrmester, 2017). In a dual inheritance framework, the individual differences in refection or mentalizing highlighted by cognitive byproductists may predict atheism, but cultural cues are probably much more important.

These three broad approaches – secularization, cognitive byproduct, and dual inheritance – make similar predictions about religious belief: namely that it ought to be quite widespread. They make sharply divergent predictions, however, about the nature of disbelief. It is sensible, therefore, to consider the various potential predictors of religious disbelief as a way to contrast the various theories.

Four Pathways to Atheism

Distinct research trajectories have considered the preconditions for sustained belief in any given god. To currently believe in a god, one 1) must be able to mentally represent gods (Gervais, 2013; Norenzayan et al., 2012; Purzycki & McNamara, 2016; Willard & Norenzayan, 2013), 2) must be dispositionally or situationally motivated to believe in some gods (Kay et al., 2008), 3) must receive credible cultural cues that some gods are real (Gervais & Henrich, 2010; Gervais & Najle, 2015; Lanman & Buhrmester, 2017), and 4) must maintain this intuitive belief over time. Tweaks to any of these four components may instead yield disbelief in gods. Separate lines of research partially support this supposition. First, *mindblind atheism* describes the pattern whereby individual differences in advanced mentalizing abilities predict religious disbelief (Norenzayan et al., 2012; Willard & Norenzayan, 2013) in at least some samples (Maij et al., 2017). Second, *apatheism* describes the pattern whereby, although people are highly religiously motivated when life is insecure, unstable, and unpredictable, existential security instead predicts reduced religiosity (Inglehart & Norris, 2004; Kay et al., 2008). Third, *inCREDulous atheism* describes the pattern whereby a lack of credibility enhancing displays (CREDs) (Henrich, 2009) that one ought to believe in any gods is a good global predictor of atheism (Gervais & Najle, 2015; Lanman, 2012). Finally, *analytic atheism* describes the pattern whereby people who reflectively override their intuitions tend to be less religious than those who "go with their guts" (Pennycook et al., 2016; Shenhav et al., 2012), although the magnitude and consistency of this relation is debatable (Gervais et al.,

2018).

Predictions

Prominent theoretical approaches make subtly diverging predictions about which pathways to atheism (mindblind, apatheism, inCREDulous, or analytic) are most important (see Table 1). First, secularization models (Inglehart & Norris, 2004; Kay et al., 2008; Vail et al., 2012) posit that increases in existential security (wealth, health, education, etc.) reduce religious motivation. Thus, secularization approaches would predict that measures of existential security and secular institutions (general feelings of safety, faith in police, etc.) ought to be primary predictors of atheism. *Apatheism* is the most important pathway to disbelief, per secularization theories.

Second, cognitive science of religion and evolutionary psychology often view religion as a cognitive byproduct of other mental adaptations (Barrett, 2004; Boyer, 2008), such as mind perception (Gervais, 2013) or predator detection. In this view, challenges in the core cognitive faculties underlying such adaptations (e.g., advanced mentalizing) would predict disbelief, but the primary route to disbelief is people overriding their religious intuitions via effortful cognitive reflection. *Analytic atheism* is the most important pathway to disbelief, per cognitive byproduct theorists.

Finally, dual inheritance models highlight the cultural learning processes (Kline, 2015; Rendell et al., 2011) underpinning religious beliefs (Evans, 2001; Lane et al., 2012; Richert et al., 2017; Willard et al., 2016) and disbelief, and largely predict that context-biased social learning – especially CREDs (Henrich, 2009) – would be strongly associated with degrees of religious belief (Gervais & Najle, 2015). Our dual inheritance approach predicts that CREDs would be most important, followed by other factors such as cognitive reflection, mentalizing, and perhaps existential security. *InCREDulous atheism* is central to dual inheritance approaches to religious disbelief.

Table 1: Predictions From Prominent Theories

Theory	Discipline	mindblind	apatheist	inCREDulous	analytic
Secularization	Sociology & Social Psych		+ + + +		
Cognitive Byproduct	Ev Psych & Cog Sci Rel	+ +	+		+ + + +
Dual Inheritance	Gene-Culture Coevolution	+	indirect	+ + + +	+ +

Note:
+ symbols indicate the predicted strength of each pathway to atheism, by theory
[1] mindblind = relatively lower in advanced mentalizing
[2] apatheist = relatively more existentially secure
[3] inCREDulous = exposed to relatively fewer religious CREDs
[4] Analytic = scoring relatively higher on cognitive reflection

We preregistered a set of analyses to simultaneously evaluate the predictions of secularism, cognitive byproduct, and dual inheritance models https://osf.io/kfasv in a probability sample of USAmericans. Specifically, we posed three broad questions:

I. *What are the relative predictive contributions of each pathway to atheism when considered simultaneously?*
II. *How do the four pathways interact with each other in predicting disbelief?*
III. *Does early work on each individual pathway successfully replicate in a nationally representative sample?*[ii].

To approach these questions, we contracted GfK to collect a nationally representative sample of USAmerican adults (N= 1417). Primarily, we were interested in predicting degrees of religious belief and disbelief with measures of 1) advanced mentalizing, 2) existential security, 3) exposure to religious CREDs, and 4) cognitive reflection. For robustness, we tested models using both continuous and dichotomous measures of religious disbelief. We also included a number of demographic and personality covariates to adjust for theory-adjacent but nonetheless documented correlates of religiosity. Full materials, data, and code are available at https://github.com/wgervais/disbelief-origins.

Methods

Sample

We contracted Growth from Knowledge (GfK), who specializes in nationally representative smapling, to gather a probability sample of USAmericans. This national probability sample included 1685 individuals that were broadly representative of the American population in terms of gender (50.14% female, 49.51% male, 0.35% listing another gender), age (M = 50.58, SD = 16.83), race/ethnicity, education, census region, household income, home ownership status, and residence within a metropolitan area[iii]. We excluded 268 participants who failed an attention check or who did not complete all measures, leaving a total of 1417 respondents, see Table 4. Inferences do not appreciably change under alternate exclusion criteria.

[ii] Analyses treating each core pathway in isolation rather than in a single combined model are presented in the Online Supplement

[iii] Note: Our precise sample demographics may look a bit different from census estimates on, for example, ethnicity or education. GfK guaranteed proper probability sampling for representativeness, but our precise measures were not identical to those used by the census. Apparent discrepancies are due to differing demographic measures and categories, rather than nonrepresentativeness of GfK's probability smapling.

Table 2: Sample Demographics

Category	Percent
Education	
< High School	7.55
High School	27.24
Some College	28.23
College +	36.98
God Belief	
Believer	81.27
Atheist	18.73
Religious Identity	
Catholic	22.94
Evangelical	38.46
Jehovah's Witness	1.34
Mormon	2.12
Jewish	2.40
Muslim	0.35
Orthodox	0.56
Hindu	0.35
Buddhist	0.64
UU	1.20
Other Christian	7.41
Other Non-Christian	0.71
No Religion	13.27
Atheist	5.15
Agnostic	5.29
Not Listed	4.73
Race/Ethnicity	
White	74.45
Black	8.68
Not Listed	4.30
Multiracial	10.16
Hispanic	2.40

Measures

Religious Belief

We tested models with two separate religious disbelief measures. First, we relied on a popular continuous measure of religious belief, the Supernatural Beliefs Scale (Jong et al., 2013), as our main dependent measure of religious belief. This scale was reliable, $\alpha = 0.95$, $M = 4.91$, $SD = 1.63$. As a robustness check, we also included a binary item in which participants simply indicated whether or not they believe in God.

We also included various other measures of religiosity which were used to gain a more fine-grained understanding of the demographics of our sample, and are summarized in Table 4. For example, we asked participants how often they attended services outside of weddings and funerals, as well as how often they pray. We also asked participants to indicate the religion with which they identify, and they were allowed to select multiple applicable categories (e.g., 'atheist' and 'agnostic'). We included these variables primarily for descriptive purposes.[iv]

Pathways to Religious Disbelief

We measured participants' mentalizing abilities, feelings of existential security, exposure to credible cues of religiosity (CREDs), and reflective versus intuitive cognitive style.

We measured advanced mentalizing abilities, which correspond to mindblind atheism, using the Perspective Taking Subscale of the Interpersonal Reactivity Index (Davis, 1980). This scale reached an acceptable level of reliability, $\alpha = 0.77$, $M = 4.79$, $SD = 0.78$.

We measured feelings of existential security, which corresponds to apatheism, with a number of items assessing concerns that are salient to participants and participant faith in institutions like the government, health care, and social security to provide aid in the face of need (Willard & Cingl, 2017). Items measuring faith in institutions were reverse-scored, and all items were averaged together to form a composite index of existential insecurity ($\alpha = 0.77$, $M = 2.2$, $SD = 0.39$).

We measured cognitive reflection, which corresponds to analytic atheism, using nine items from the Cognitive Reflection Test (Frederick, 2005; Primi et al., 2016; Toplak et al., 2014). Our full index of cognitive reflection is composed of the sum of the 9 questions that each participant answered correctly, with a higher score thus indicating a more reflective and analytic cognitive style. The average score was 3.18, with a

[iv] Naturally, a variable like church attendance would be strongly (albeit imperfectly) associated with religious belief and disbelief. We did not include these religious demographic variables in our primary statistical models because the risks of multicollinearity and redundant variance with the outcome measure far outweigh any value of such models for theory testing, the primary goal of this project. Put simply: it is not entirely clear what any prominent theory predicts about what cognitive or cultural factors are associated with the residual variance in religious belief, independent of prayer and attendance. That said, our data are open and freely shared; we encourage curious researchers to explore trends with any religious demographics that interest them.

standard deviation of 2.66.

We measured exposure to CREDs, which corresponds to inCREDulous atheism, with the CREDs Scale (Lanman & Buhrmester, 2017). This scale assesses the extent to which caregivers demonstrated religious behaviors during the respondent's childhood, such as going to religious services, acting as good religious role models, and making personal sacrifices to religion. This scale was highly reliable, $\alpha = 0.93$, $M = 2.42$, $SD = 0.84$.

Personality Measures

We used the MINI-IPIP6 (Milojev et al., 2013) to measure the personality factors of Extraversion ($\alpha = 0.79$, $M = 3.69$, $SD = 1.12$), Agreeableness ($\alpha = 0.75$, $M = 4.96$, $SD = 0.92$), Conscientiousness ($\alpha = 0.68$, $M = 4.97$, $SD = 0.97$), Neuroticism ($\alpha = 0.75$, $M = 3.52$, $SD = 1.08$), Openness to Experience ($\alpha = 0.73$, $M = 4.69$, $SD = 1.01$), and Honesty-Humility ($\alpha = 0.76$, $M = 4.8$, $SD = 1.13$).

General Demographics

Finally, we included a demographics questionnaire to adjust for known religion-predictive participant characteristics. We assessed education level by asking participants what their highest level of education was, from no formal education to professional or doctorate degree. We used single face-valid items to assess both social (1 = very liberal to 7 = very conservative, $M = 4.07$, $SD = 1.77$) and economic (1 = very liberal to 7 = very conservative, , $M = 4.36$, $SD = 1.54$) political ideology.[v]

Correlations

Correlations among all analyzed variables appear in Figure 1 and Table 3.

[v]Relations between religion and political ideology are interesting, although not directly implicated by any of the prominent theories we tested. We encourage curious researchers to use our open data to test their own hypotheses about ideology.

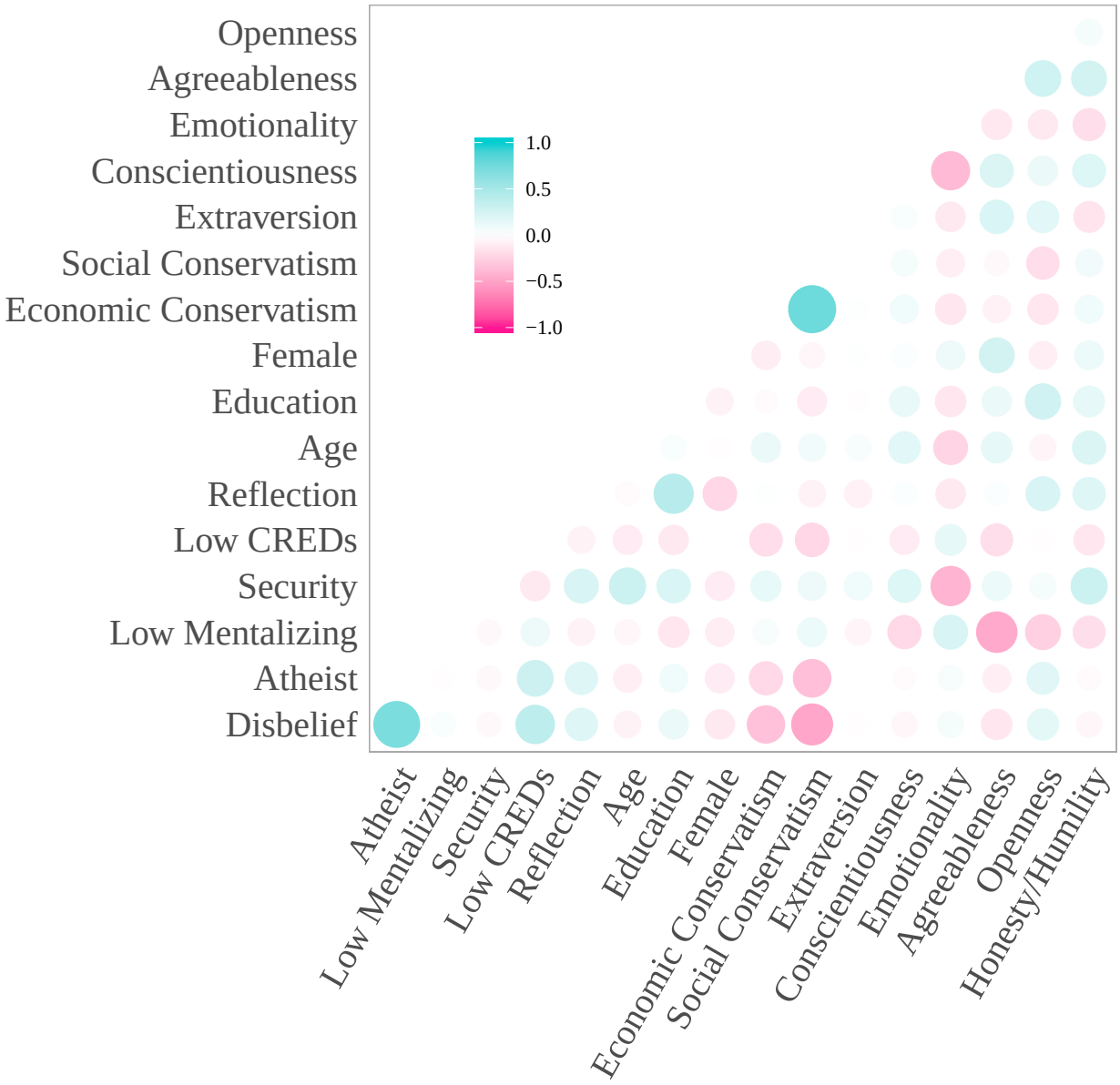

Figure 1: Correlation plot of all analyzed variables. Circle size and luminance depicts relationship strength, color depicts positive or negative relationship.

Table 3: Full Correlation Matrix

	Disbelief	*Atheist*	*Low.Mentalizing*	*Security*	*Low.CREDs*	*Reflection*	*Age*	*Education*	*Female*	*Econ*	*Social*	*Extraversion*	*Conscientiousness*	*Emotionality*	*Agreeableness*	*Openness*	*Humility*
Disbelief	1.00	0.71	0.04	-0.04	0.38	0.19	-0.07	0.12	-0.12	-0.34	-0.48	-0.01	-0.05	0.06	-0.14	0.16	-0.05
Atheist	0.71	1.00	-0.01	-0.04	0.29	0.19	-0.09	0.09	-0.11	-0.21	-0.35	0.00	-0.02	0.05	-0.09	0.18	-0.03
Low Mentalizing	0.04	-0.01	1.00	-0.04	0.10	-0.07	-0.05	-0.14	-0.10	0.05	0.11	-0.06	-0.21	0.23	-0.46	-0.26	-0.18
Security	-0.04	-0.04	-0.04	1.00	-0.12	0.23	0.30	0.22	-0.11	0.14	0.10	0.09	0.20	-0.41	0.11	0.06	0.30
Low CREDs	0.38	0.29	0.10	-0.12	1.00	-0.07	-0.11	-0.12	0.00	-0.19	-0.22	-0.01	-0.11	0.15	-0.18	-0.01	-0.14
Reflection	0.19	0.19	-0.07	0.23	-0.07	1.00	-0.03	0.41	-0.22	0.01	-0.07	-0.08	0.03	-0.12	0.03	0.23	0.19
Age	-0.07	-0.09	-0.05	0.30	-0.11	-0.03	1.00	0.04	-0.01	0.12	0.08	0.05	0.17	-0.23	0.15	-0.06	0.21
Education	0.12	0.09	-0.14	0.22	-0.12	0.41	0.04	1.00	-0.07	-0.02	-0.11	-0.01	0.13	-0.14	0.12	0.27	0.15
Female	-0.12	-0.11	-0.10	-0.11	0.00	-0.22	-0.01	-0.07	1.00	-0.10	-0.05	0.01	0.03	0.10	0.26	-0.09	0.11
Econ	-0.34	-0.21	0.05	0.14	-0.19	0.01	0.12	-0.02	-0.10	1.00	0.77	0.01	0.09	-0.14	-0.08	-0.14	0.09
Social	-0.48	-0.35	0.11	0.10	-0.22	-0.07	0.08	-0.11	-0.05	0.77	1.00	0.00	0.06	-0.09	-0.04	-0.19	0.08
Extraversion	-0.01	0.00	-0.06	0.09	-0.01	-0.08	0.05	-0.01	0.01	0.01	0.00	1.00	0.04	-0.12	0.22	0.17	-0.15
Conscientiousness	-0.05	-0.02	-0.21	0.20	-0.11	0.03	0.17	0.13	0.03	0.09	0.06	0.04	1.00	-0.37	0.21	0.12	0.20
Emotionality	0.06	0.05	0.23	-0.41	0.15	-0.12	-0.23	-0.14	0.10	-0.14	-0.09	-0.12	-0.37	1.00	-0.13	-0.12	-0.18
Agreeableness	-0.14	-0.09	-0.46	0.11	-0.18	0.03	0.15	0.12	0.26	-0.08	-0.04	0.22	0.21	-0.13	1.00	0.28	0.26
Openness	0.16	0.18	-0.26	0.06	-0.01	0.23	-0.06	0.27	-0.09	-0.14	-0.19	0.17	0.12	-0.12	0.28	1.00	0.06
Humility	-0.05	-0.03	-0.18	0.30	-0.14	0.19	0.21	0.15	0.11	0.09	0.08	-0.15	0.20	-0.18	0.26	0.06	1.00

Note:
Correlation matrix for analyzed variables
[1] Econ = economic conservatism
[2] Social = social conservatism

Results

Analytic Strategy

We used Bayesian estimation throughout. Bayesian estimation allows us to evaluate the credibility of different parameter estimates, given data and statistical models (Etz & Vandekerckhove, 2018; Kruschke, 2010, 2013; McElreath, 2016; Wagenmakers et al., 2016). Most analyses report a point estimate reflecting the most credible parameter estimate as well as a highest posterior density interval (HPDI), the region in which the 97% most credible estimates lie. We chose 97% coverage because it is no more arbitrary than any other cutoff, but provides a very conservative range of plausibe values. We also report a variety of posterior probabilities, which state the probability of something ($\beta > 0$, etc.) being true, given data and model. Heuristically, the posterior probabilities have the properties people misintuit frequentist p-values as having (e.g., the probability of some hypothesis being true) (Oakes, 1986), and the HPDIs have the properties people misintuit frequentist confidence intervals as having (e.g., the probability that a parameter lies in that range) (Hoekstra et al., 2014). We used gently regularizing priors throughout, primarily deployed to buffer against model overfitting. Inferences are highly robust to non-ludicrous alternative priors. Full materials, data, and code are available at https://github.com/wgervais/disbelief-origins.

Relative Contributions

Our most important analyses considered the relative contributions of all four pathways operating in concert. As preregistered, we conducted analyses in which the four core factors predict individual differences in belief and disbelief, both in the presence and absence of additional covariates. Multicollinearity among key predictors was not problematic, correlations ranged from r = -.12 to .22. In our full model predicting a continuous multi-item measure of religious disbelief (see Measures for details), witnessing fewer credible displays of faith proved to be by far the most powerful predictor of religious disbelief (see Table 2 and Figure 1). Credibility enhancing displays of faith predict belief, and their absence predicts atheism, $\beta = 0.28$, [0.23, 0.34][vi], $P(\beta > 0 \mid data) = 1$[vii]. Cognitive reflection remained a consistent predictor of religious disbelief, $\beta = 0.13$, [0.07, 0.19], $P(\beta > 0 \mid data) = 1$, but following earlier cross-cultural work (Gervais et al., 2018) its predictive power was relatively meager. Lower scores on a measure of advanced mentalizing abilities[viii] were reliably but weakly associated with disbelief, $\beta = 0.05$, [-0.01, 0.11], $P(\beta > 0 \mid data) = 0.96$, and existential security predicted essentially nothing. Clearly, low religious CREDs is the strongest predictor of atheism

[vi] Values in brackets are 97% highest posterior density interval (HPDI).

[vii] $P(\beta > 0 \mid data) = 1$ indicates a posterior probability exceeding .99.

[viii] We preregistered a possible quadratic relationship between mentalizing and disbelief. For theoretical and statistical reasons, we depart from preregistration and don't analyze the quadratic here. See online Supplement for further discussion.

when all four potential pathways are considered simultaneously.

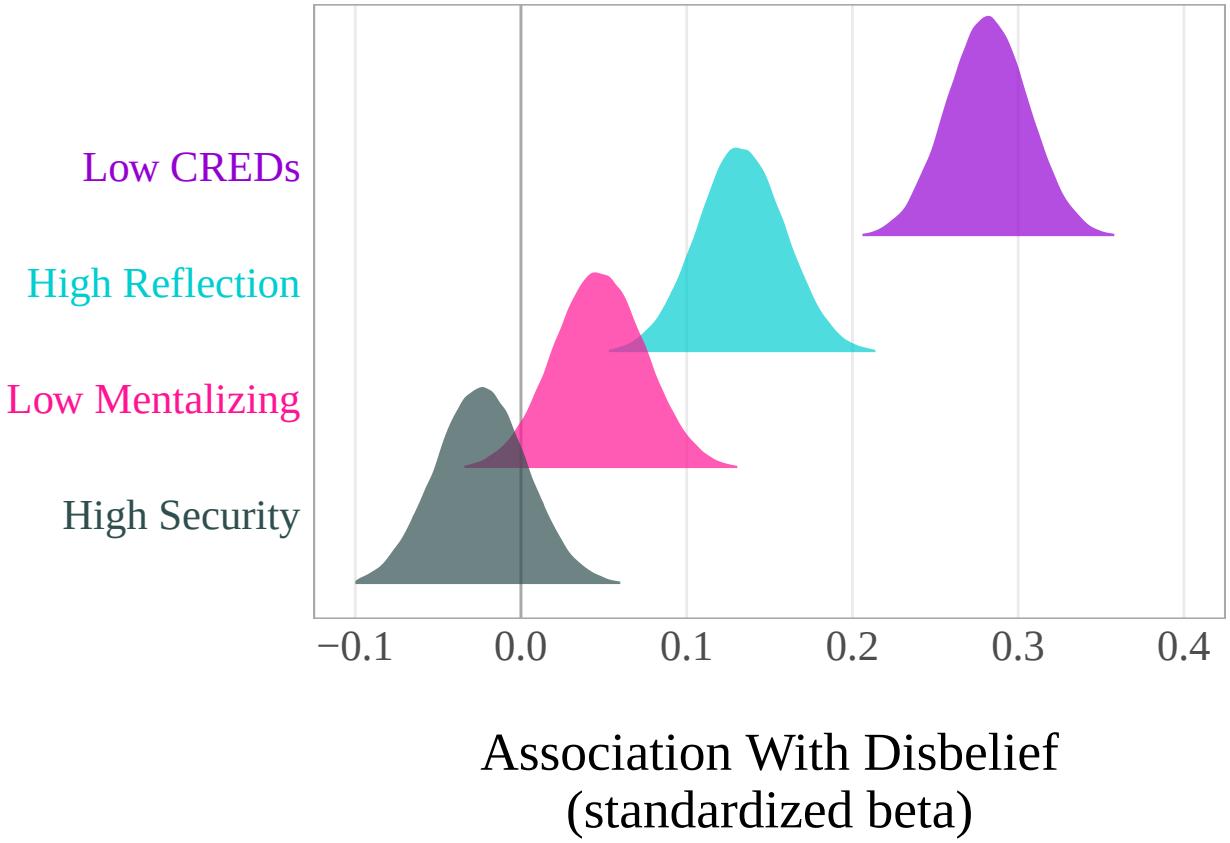

Figure 2: Posterior densities illustrating how strongly each factor predicts disbelief. Height in each density indexes credibility of estimate: values higher up each curve are better guesses.

Atheism: Binary Measure

We also measured religious disbelief with a simple binary (No, Yes) belief in God item. As a robustness check, we reran our full model analysis as a logistic model predicting atheism rates on the binary measure. Unsurprisingly, results closely matched the continuous full model. Aside from demographic covariates, only fewer religious CREDs, $beta = 0.83$, [0.61, 1.05], $\mathrm{P}(beta > 0 \mid data) = 1$, and more cognitive reflection, $beta = 0.38$, [0.17, 0.59] $= \mathrm{P}(beta > 0 \mid data) = 1$, predicted atheism. However, fewer religious CREDs again emerged as a stronger predictor of atheism than did cognitive reflection. To illustrate, we considered the posterior produced by our model, marginalized at various levels of our predictors. Specifically, we compared the hypothetical probability of atheism for model-predicted individuals who are either perfectly inCREDulous (scoring at floor for religious CREDs) but typical on all other variables, or else perfectly analytical (scoring at ceiling on cognitive reflection) but otherwise typical. The predicted odds of atheism are

Table 4: Predicting Disbelief: Full Model Summary

Variable	Beta	HPDI	Pr
Low Mentalizing	0.05	[-0.01, 0.11]	0.96
High Security	-0.02	[-0.08, 0.04]	0.2
Low CREDs	0.28	[0.23, 0.34]	> 0.99
High Reflection	0.13	[0.07, 0.19]	> 0.99
Age	0.01	[-0.04, 0.07]	0.67
Education	0.04	[-0.02, 0.1]	0.92
Male	0.07	[0.02, 0.13]	> 0.99
Social Lib	0.44	[0.35, 0.52]	> 0.99
Economic Cons	0.04	[-0.04, 0.12]	0.84
Extraversion	0.02	[-0.03, 0.08]	0.82
Conscientiousness	0.02	[-0.04, 0.07]	0.72
Neuroticism	0.00	[-0.06, 0.07]	0.54
Low Agreeableness	0.10	[0.04, 0.17]	> 0.99
Openness	0.07	[0.02, 0.13]	> 0.99
Honesty/Humility	0.04	[-0.02, 0.1]	0.92

Note:

[1] Beta = standardized beta
[2] HPDI = 97% Highest posterior density interval
[3] Pr = posterior probability of Beta > 0

about 90% higher for a purely inCREDulous individual, P($atheism \mid inCREDulous$) = 0.31, [0.24, 0.39], than for a purely analytic individual, P($atheism \mid analytic$) = 0.2, [0.13, 0.28], *odds ratio* = 1.87, [0.93, 3.03], P($inCREDulous > analytic \mid data$) = 0.99. This relative difference in predictive strength for CREDs and cognitive reflection, replicated across continuous and binary measures of disbelief, is most consistent with a dual inheritance approach.

Hypothesized Interactions

Next, we probed for preregistered interactions[ix] finding an interaction between cultural learning and reflective cognitive style, β = -0.08, [-0.12, -0.03], P($\beta > 0 \mid data$) = 1. We considered the association between disbelief and reflective cognitive style among those comparatively high and low on religious CREDs (Figure 2), finding that reflective cognitive style primarily predicts religious disbelief among those who were also comparatively low in cultural exposure to credible religious cues of faith. Indeed, cognitive reflection moderately predicted religious disbelief among those witnessing the fewest religious CREDs, β = 0.26, [0.15, 0.35], P($\beta > 0 \mid data$) = 0, but not at all among those highest in religious CREDs, β = -0.01, [-0.13, 0.1], P($\beta > 0 \mid data$) = 0.6. These patterns highlight the interactive predictive roles of cultural context and evolved intuitions on religious

[ix] Preregistered analyses probing for interactions with mentalizing yielded nothing of particular note and are summarized in the Online Supplement.

cognition. This interaction is consistent with a dual inheritance perspective, but not obviously predicted by other prominent theoretical approaches

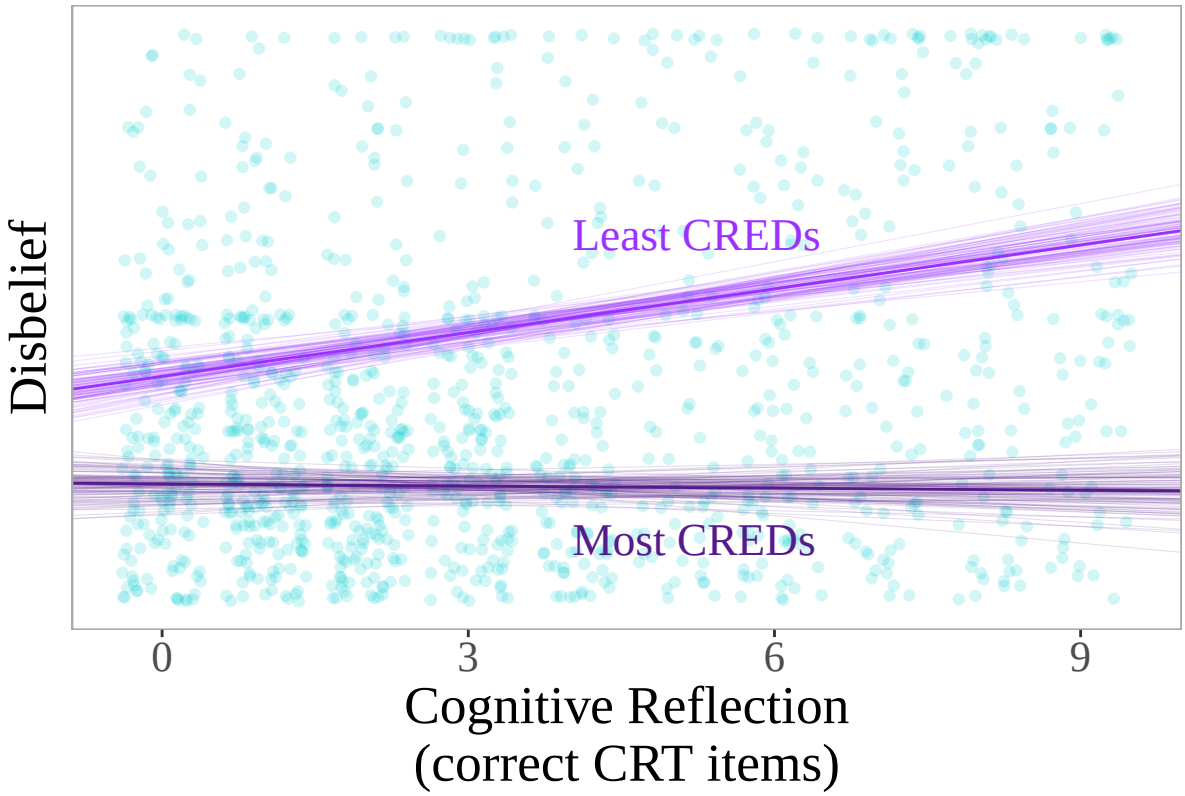

Figure 3: Cognitive reflection primarily predicts disbelief among individuals who are also relative low in exposure to religious CREDs. Each cluster contains 100 regression lines drawn from the posterior to illustrate estimate uncertainty and regions of highest posterior density. Y-axis depicts the entire range of possible values for the arbitrarily scaled continuous measure.

Discussion

Summary

Overall, this study is one of the most comprehensive available analyses of the cognitive, cultural, and motivational factors that predict individual differences in religious belief and disbelief (see also Willard & Cingl, 2017). Consistent patterns emerged, suggesting that lack of exposure to credibility enhancing displays of religious faith is a key predictor of atheism. Once this context-biased cultural learning mechanism is accounted for, reflective cognitive style predicts some people being slightly more prone to religious disbelief

than their cultural upbringing might otherwise suggest. That said, this relationship was relatively modest. Advanced mentalizing was a robust but weak predictor of religious belief, and existential security did not meaningfully predict disbelief. This overall pattern of results closely matched predictions of a dual inheritance approach but are difficult to reconcile with other prominent theoretical approaches (see Table 1 and Figure 1). These results speak directly to competing theoretical perspectives on the origins of religious disbelief culled from sociology, social psychology, evolutionary psychology, cognitive science of religion, cultural evolution, and gene-culture coevolution.

Alternatives and Limitations

Of the four primary atheism predictors that we used to test prominent theories, religious CREDs emerged as a clear empirical winner. In some ways, however, our tests may have been methodologically stacked in this variable's favor. Like the self-reports of religious disbelief, this measure includes self-report items about religious upbringing. Thus there is shared method variance associated with this predictor that is less evident for others. Further, predictors varied in both reliability and demonstrated validity. We chose these measures simply because they have been used in previous research; that said, previous use does not necessarily imply that the measures were sufficient.

As with measurement quality, sample diversity is a recurrent concern in psychological research (Henrich et al., 2010; Rad et al., 2018; Saab et al., 2020). Most psychology research nowadays emerges from convenience samples of undergraduates and Mechanical Turk workers. These samples are fine for some purposes, quite limited for others (Gaither, 2019), and are known to depart from representativeness (Callegaro et al., 2014; MacInnis et al., 2018). While our nationally representative sampling allows us to generalize beyond samples we can access for free (in lab) or cheap (MTurk), even a large nationally representative sample barely scratches the surface of human diversity (Henrich et al., 2010; Rad et al., 2018; Saab et al., 2020). As such, we encourage similar analyses across different cultures (Willard & Cingl, 2017). Diversifying the samples that make up the empirical portfolio of evolutionary approaches to religion is especially necessary because cultural cues themselves emerged as the strongest predictor disbelief in this and related work (Gervais et al., 2018; Gervais & Najle, 2015; Maij et al., 2017; Willard & Cingl, 2017). Without diverse samples, including and *especially* extending well beyond nationally representative samples in the USA, researchers can only aspire to ever more precisely answer a mere outlier of an outlier of our most important scientific questions about human nature.

We measured and tested predictors of religious belief and disbelief. This outcome measure is quite narrow in scope, in terms of the broader construct of religiosity. Further, our supernatural belief scale – while it

has been used across cultures – is fairly Judeo-Christian-centric. We suspect that a broader consideration of religiosity in diverse societies may yield different patterns. The WEIRD people problem isn't just a sampling issue; it also reflects an overreliance on the theories, constructs, and instruments developed by WEIRD researchers to test their weird hunches.

Although it is not featured in any of the core theoretical perspectives we evaluated, social liberalism was consistently the strongest covariate of religious disbelief. The intersection of religious and political ideology is an interesting topic in its own right, and merits further consideration. Interestingly, disbelief if anything was associated with fiscal conservatism in this sample. This suggests that simple "believers are conservative" tropes are oversimplifications. Ideology and religiosity are multifaceted and dissociable, but certainly of interest given rampant political polarization in the USA and elsewhere. That said, religion-ideology associations, whatever they may be, are largely orthogonal to existing cultural and evolutionary theories of religious belief and disbelief.

Theoretical Implications

We evaluated predictions about the origins of disbelief from three prominent theoretical perspectives: secularization, cognitive byproduct, and dual inheritance. Comparing the predictions in Table 1 with the results of Figure 1, it is clear that our results are most consistent with the dual inheritance perspective. Indeed, this was the only theoretical perspective that predicted prominent roles for both inCREDulous atheism and analytic atheism. Given the primacy of cultural learning in our data, any model that does not rely heavily on context-biased cultural learning is likely a poor fit for explaining the origins of religious disbelief. By extension, such theoretical models are necessarily incomplete or faulty evolutionary accounts of religion. Simply growing up in a home with relatively fewer credible displays of faith predicted disbelief, contra prior assertions from the cognitive science of religion that disbelief results from "special cultural conditions" and "a good degree of cultural scaffolding" (Barrett, 2010). Instead, disbelief emerges quite naturally and easily in the mere relative absence of repeated and credible cues of others' belief.

Analytic atheism is perhaps the most discussed avenue to disbelief in the literature (Pennycook et al., 2016; Shenhav et al., 2012) and broader culture (Dawkins, 2006), but its popularity greatly overstates its actual influence. Although in this sample there was consistent evidence of analytic atheism, the overall trend was modest, the trend itself varied considerably across exposure to CREDs, and sufficient religious CREDs buffered believers against the putatively corrosive influence of reflective cognition on faith. Despite claims that atheism generally requires cognitive effort or reflection (Barrett, 2010; Boyer, 2008), analytic atheism – as in other recent work (Gervais et al., 2018) – does not appear to be an especially general or powerful

phenomenon.

It is initially puzzling that existential security proved impotent in our analyses, as it appears to be an important factor in explaining cross-cultural differences in religiosity (Barber, 2013; Inglehart & Norris, 2004; Solt et al., 2011). It is possible that our analyses were at the wrong level of analysis to capture the influence of existential security, which may act as a precursor to other cultural forces. There may actually be a two-stage generational process whereby existential security demotivates religious behavior in one generation, leading the subsequent generation to atheism as they do not witness credibility enhancing displays of faith. This longitudinal societal prediction merits future investigation.

Finally, this work has implications beyond religion. Presumably, many beliefs arise from an interaction between core cognitive faculties, motivation, cultural exposure, and cognitive style. The general dual inheritance framework adopted here may prove fruitful for other sorts of beliefs elsewhere. Indeed, a thorough exploration of the degree to which different beliefs are predicted by cultural exposure relative to other cognitive factors may be useful for exploring content- versus context-biased cultural learning, and the contributions of transmitted and evoked culture. As this is a prominent point of contention between different schools of human evolutionary thought (Laland & Brown, 2011), such as evolutionary psychology and cultural evolution, further targeted investigation may be productive.

Coda

The importance of transmitted culture and context-biased cultural learning as a predictor of belief and disbelief cannot be overstated. Combined, this work suggests that if you are guessing whether or not individuals are believers or atheists, you are better off knowing how their parents behaved – Did they tithe? Pray regularly? Attend synagogue? – than how they themselves process information. Further, our interaction analyses suggest that sufficiently strong cultural exposure yields sustained religious commitment even in the face of the putatively corrosive influence of cognitive reflection. Theoretically, these results fit well within a dual inheritance approach, as evolved cognitive capacities for cultural learning prove to be the most potent predictor of individual differences in the cross-culturally canalized expression of religious belief. Atheists are becoming increasingly common in the world, not because human psychology is fundamentally changing, but rather because evolved cognition remains fairly stable in the face of a rapidly changing cultural context that is itself the product of a coevolutionary process. Faith emerges in some cultural contexts, and atheism is the natural result in others.

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