

**The Evolution of Religion: How Cognitive By-Products,
Adaptive Learning Heuristics, Ritual Displays, and
Group Competition Generate Deep Commitments to
Prosocial Religio**

Scott Atran, Joseph Henrich

► **To cite this version:**

Scott Atran, Joseph Henrich. The Evolution of Religion: How Cognitive By-Products, Adaptive Learning Heuristics, Ritual Displays, and Group Competition Generate Deep Commitments to Prosocial Religio. *Biological Theory*, Massachusetts Institute of Technology Press (MIT Press), 2010, 5, pp.18-30. ijn_00505193

HAL Id: ijn_00505193

https://jeannicod.ccsd.cnrs.fr/ijn_00505193

Submitted on 22 Jul 2010

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Dear Author,

Attached for your review are the typeset pages of the article, etc. you have written for *Biological Theory*. Please check for accuracy and consistency, placement of illustrations, and answer any queries noted at the end of the pages.

Within three days of receipt, please return these pages to Dan Bouchard at the MIT Press.

You may return your corrected proofs using an overnight delivery service, fax, or email. If you send corrections by email, please list the corrections in the body of the email. Send to:

Dan Bouchard
The MIT Press Journals
238 Main Street, Suite 500
Cambridge, MA 02142

Fax: 617-258-5028
Email: bouchard@mit.edu

If you notice the letters “FPO” on your figure art, this indicates that the figure is either in color or will be shot as a halftone by the printer to capture shades of gray. The FPO marker will not appear on the printed figure. If you want figure art to be printed in color, you must send a check for the printing costs (\$1,200 for the first page; \$600 for each subsequent page, as noted in the “Information for Contributors”) to the MIT Press. If you cannot procure a check within three days, you must acknowledge in writing (e.g. cover letter or email) your agreement to pay for the costs. Figure art lacking either of these two things will be printed in black and white by default.

You may order reprints of your article by going to the MIT Press Journals reprint ordering site: www.sheridan.com/MITpress/eoc There is no deadline for ordering, and you may use this system to order additional reprints at any time. If the system is not yet ready to accept orders for a current issue, please use the email reminder function. You are the only one receiving this letter; please coordinate with your co-authors.

You can leave phone messages at (617) 258-0588, or feel free to contact me by e-mail at bouchard@mit.edu.

We depend upon your prompt attention to the proof to ensure timely delivery of the journal. If your corrections are not received by the deadline, your article may be published as is.

Thank you very much for your help.

Sincerely,
Dan Bouchard

The Evolution of Religion: How Cognitive By-Products, Adaptive Learning Heuristics, Ritual Displays, and Group Competition Generate Deep Commitments to Prosocial Religions

Scott Atran

CNRS
Institut Jean Nicod
Paris, France

5 &

John Jay College of Criminal Justice
New York, NY, USA

&

10 ISR and Ford School of Public Policy
University of Michigan
Ann Arbor, MI, USA
saturan@umich.edu

Joseph Henrich

15 Department of Economics and Department of Psychology
University of British Columbia
Vancouver, BC, Canada
joseph.henrich@gmail.com

Abstract

Understanding religion requires explaining why supernatural beliefs, devotions, and rituals are both universal and variable across cultures, and why religion is so often associated with both large-scale cooperation and enduring group conflict. Emerging lines of research suggest that these oppositions result from the convergence of three processes. First, the interaction of certain reliably developing cognitive processes, such as our ability to infer the presence of intentional agents, favors—as an evolutionary by-product—the spread of certain kinds of counterintuitive concepts. Second, participation in rituals and devotions involving costly displays exploits various aspects of our evolved psychology to deepen people’s commitment to both supernatural agents and religious communities. Third, competition among societies and organizations with different faith-based beliefs and practices has increasingly connected religion with both within-group prosociality and between-group enmity. This connection has strengthened dramatically in recent millennia, as part of the evolution of complex societies, and is important to understanding cooperation and conflict in today’s world.

Keywords

by-product hypothesis, credibility enhancing displays, cultural transmission, cooperation, group competition, high gods, minimally counterintuitive, morality, religion, rise of civilization

45 [An] advancement in the standard of morality and an increase in the number of well-endowed men . . . who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy, were always ready to give aid to each other and to sacrifice themselves for the common good, would be victorious over other tribes.

— Charles Darwin, *The Descent of Man*

50 This synthesis integrates insights from studies of the cognitive foundations of religion with evolutionary approaches to human cooperation to derive a deeper understanding of the origin and development of prosocial religions. We argue that the cultural evolution of prosocial religions and the historical rise of large-scale civilizations involve the dynamic interaction of the by-products of adaptive cognitive mechanisms (e.g., minimally counterintuitive beliefs and overextended agent concepts), adaptive learning heuristics (e.g., emulation of successful and prestigious individuals), credibility-enhancing ritual displays (e.g., self-sacrifice and costly commitments to seemingly preposterous beliefs), and cultural group selection for those packages of rituals, devotions, and beliefs that best sustain in-group prosocial norms (e.g., monumental undertakings, sacred values).

65 Many religions pose an evolutionary enigma because they require costly commitments to beliefs that violate both core aspects of logical consistency and our intuitive expectations about how the world works, both of which are otherwise crucial for successfully navigating the world (Atran and Norenzayan 2004). Religious practices are often costly in terms of material sacrifice (ranging from human sacrifice to prayer time), emotional expenditure (inciting fears and hopes), and cognitive effort (maintaining conflicting models about the nature of the world). One anthropological review of religious offerings concludes: “Sacrifice is giving something up at a cost. . . . ‘Afford it or not,’ the attitude seems to be” (Firth 1963).

75 At the same time, the origin of large-scale cooperative human societies is also an evolutionary puzzle because people frequently cooperate and trade with non-relatives in ephemeral interactions (Fehr and Fischbacher 2003). Thus, while the evolutionary mechanisms associated with kinship, reciprocity, and reputation clearly influence cooperation in important ways, they do not capture the fullest extent of human prosociality. Kinship cannot explain cooperation among non-relatives (Henrich and Henrich 2007), though “fictive kinship”—a cultural manipulation of kin psychology—may contribute to mobilizing larger groups (Johnson 1987; Atran 2003). Reciprocity does not suffice to explain cooperation beyond dense social networks, small villages, or tightly knit neighborhoods (Hruschka and Henrich 2006; Allen-Arave et al. 2008; Atran 2010). Neither direct nor indirect reciprocity can explain cooperation in transient interactions in large populations, because reputational information rapidly degrades as a function of pop-

ulation size, or in large-group interactions such as those associated with many kinds of public goods or common dilemmas (Boyd and Richerson 1988; Panchanathan and Boyd 2003; Nowak and Sigmund 2005; Mathew and Boyd 2009). Even more telling is that none of these mechanisms explains the variation in cooperation among human societies, or the massive expansion of cooperation in some societies over last 10 millennia (Henrich et al. 2005).

95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585
590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760
765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985
990
995

Converging lines of field and experimental evidence suggest that cultural evolution, building on certain innate cognitive foundations, has favored the emergence of beliefs in powerful moralizing deities concerned with the prosocial behavior of individuals beyond kin- and reciprocity-based networks (Norenzayan and Shariff 2008). Cross-cultural analysis of 186 societies has found that larger and more complex societies were much more likely to subscribe to potent deities directly concerned with morality and willing to punish norm violators (Roes and Raymond 2003; Johnson 2005). Studies conducted across a diverse range of societies including foragers, farmers, and herders, show that professing a world religion predicts greater fairness toward ephemeral interactants (Henrich et al. 2010). Experiments with North Americans show that unconsciously activating religious concepts lead to reduced cheating and greater generosity toward strangers (Bargh and Chartrand 1999; Mazar and Ariely 2006; Shariff and Norenzayan 2007), except among ardent atheists. Together, these cross-cultural, historical, and experimental findings suggest that (1) religion—as a phenomenon with potentially deep roots (Klein 1989)—has not always been about high moralizing gods and (2) modern world religions may have evolved to create a potent linkage between the supernatural and the prosocial. Thus, we hypothesize that cultural evolutionary processes, driven by competition among groups, have exploited aspects of our evolved psychology, including certain cognitive by-products, to gradually assemble packages of supernatural beliefs, devotions, and rituals that were increasingly effective at instilling deep commitment, galvanizing internal solidarity, and sustaining larger-scale cooperation.

Ordinary Cognition Produces Extraordinary Agents

Humans are purpose-seeking, cause-inferring, story-telling animals (Gazzaniga et al. 2009). As Hume noted in *The Natural History of Religion*, the greater the impact of events on our lives, the greater is our drive to impose purpose and coherence on those events. This view is backed by a recent experiment in which people were asked what patterns they could see in arrangements of dots or stock market figures (Whitson and Galinsky 2008). Before asking, the experimenters made half the participants feel a lack of control. Those who experienced a lack of control were more likely to see patterns and processes underlying the randomness, suggesting that under uncertainty

145 we are more likely to find preternatural explanations for the
randomness. Both cross-cultural experiments and surveys indicate
that people more readily ascribe to the veracity of narratives
containing counterintuitive elements (e.g., miracles) when
primed with death (Norenzayan and Hansen 2006), or when
facing danger or insecurity, as with pleas of hope for God's
150 intervention during wartime (Argyle and Beit-Hallahmi 2000).
Such findings help explain both cross-national analyses showing
that a country's religiosity (devotion to a world religion) is
positively related to its degree of existential insecurity (Norris
and Inglehart 2004), and why certain kinds of religions enjoy
155 revivals in challenging times. The issue then becomes: how
and why does purpose-seeking and cause-inferring so often
deliver supernatural agents?

Religious traditions center on supernatural agents, such as
gods, angels, or ancestor spirits. This includes religions such
160 as Buddhism and Taoism, which doctrinally eschew personifying
the supernatural, but whose adherents routinely worship an
array of deities that behave in ways that violate our intuitive
expectations about how the world works (Pysiäinen 2003).
Mundane agent concepts are central players in what psycholo-
165 gists refer to as folkpsychology, associated with a Theory of
Mind module(s) (ToM), which is a cognitive system devoted
to making inferences about the beliefs, desires, and intentions
of other minds (Baron-Cohen 1995). Recent functional mag-
netic resonance imaging (fMRI) studies confirm that people's
170 statements about God's involvement in social events, as well
as the deity's purported emotional states, reliably engage ToM-
related regions of the brain (Kapogiannis et al. 2009).

Agent concepts may be hair-trigger in our cognitive pro-
175 cessing, allowing us to readily respond under uncertainty to
potential threats by intelligent predators (Guthrie 1993). From
this evolutionary vantage, agent's proper evolutionary domain
encompasses animate species, but its actual domain inadver-
tently extends to moving dots on computer screens, voices in
the wind, faces in clouds, complicated contrivances like
180 eyes, and virtually any complex design or uncertain circum-
stance of unknown origin (Sperber 1996). Children and adults
spontaneously interpret the contingent movements of dots and
geometrical forms on a screen as interacting agents with dis-
tinct goals and internal goal-directed motivations (Heider and
185 Simmel 1944; Bloom and Veres 1999; Csibra et al. 1999).
Young children spontaneously overattribute agency to all sorts
of entities (clouds, computers), and may thus be predisposed
to construct agent-based representations of many phenom-
ena (Keleman 2004). Such reliably developing programs pro-
190 vide efficient reactions to a wide—but not unlimited—range
of stimuli that would have been statistically associated with
the presence of dangerous agents in ancestral environments.
Mistakes, or “false positives,” would usually carry little cost,
whereas a true response could provide the margin of survival.
195 This reactive bias was likely adaptive, at least until supernat-

ural agents were harnessed by cultural evolution to begin de-
manding costly actions and cooperation, under threat of divine
punishment or offers of sublime rewards.

How do our minds make agent concepts into gods? Cogni-
200 tive approaches propose that supernatural concepts exploit ordi-
nary mental processes to construct counterintuitive concepts
(Boyer 2001; Atran 2002; Barrett 2004). Religious beliefs are
counterintuitive because they violate universal expectations
about the world's mundane structure. This includes the basic
205 categories of our “intuitive ontology” (i.e., the ontology of
our semantic system), such as person, animal, plant, and
substance (Whyte 1993; Sperber et al. 1995). Experimental
studies reveal that children across cultures do not violate such
categorical constraints in learning word meaning; for example,
210 people cannot literally melt, and neither can animals joke, trees
walk, nor rocks tire (Keil 1979). Experiments with Americans
and Indians illustrate a gap between religious utterances and
the mental processing of religious concepts (Barrett and Keil
1996; Barrett 1998). When asked to describe their deities, sub-
215 jects produced abstract theological descriptions of gods that
are able to (1) do anything, including anticipating and reacting
to everything all at once, (2) know the right thing to do, and
(3) dispense entirely with perceptual information and calcula-
tion. However, when asked to respond to narratives about
220 these same gods, people interpreted their deities as being in
only one place at a time, puzzling over alternative actions, and
looking for evidence to make a decision. In short, people men-
tally represent gods using our intuitive ontology, so abstract
theological propositions give little insight into how people
225 actually think about supernatural agents (Malley 2004). Much
recent work suggests this intuitive ontology results from, or
interacts with, certain universal modes of causal construal,
including folkmechanics (object cohesion, contact, and contin-
uity in movement), folkbiology (teleological development of
230 species-like essences and relations), and folkpsychology (in-
tentional, goal-directed, interactive agents).

Most religious beliefs minimally violate the expectations
created by our intuitive ontology and these modes of con-
235 strual, thus creating cognitively manageable and memorable
supernatural worlds. For example, agents that resemble us
emotionally, intellectually, and physically except that they can
move through solid objects and live forever (angels, ghosts,
and spirits) fit the bill. Table 1 provides examples of minimal
violations.

Cognitive approaches hypothesize that although intuitive
240 concepts transmit well, concepts that minimally deviate from
intuition transmit better, while those that deviate greatly can-
not transmit successfully because they overload cognitive pro-
cesses that drive inferential reasoning and relevance (Atran and
Sperber 1991). Invisible statues that cry exist in two places at
245 once and get hungry only on leap years are not easy to enter-
tain. Minimally counterintuitive concepts are remembered and

Table 1. Mundane relations between universal categories and modes of reasoning. Changing any one cell (+ to – or – to +) yields a minimal counterintuition. Thus, switching the cell (– folkpsychology, substance) to (+ folkpsychology, substance) yields a thinking talisman; switching (+ folkpsychology, person) to (– folkpsychology, person) yields a zombie (Barrett 2000; Atran and Norenzayan 2004).

Semantic Categories	Belief Domains (and Associated Properties)					
	Folkmechanics		Folkbiology		Folkpsychology	
	Inert	Vegetative	Animate	Psycho-Physical, e.g., Hunger, Fatigue, etc.	Epistemic, e.g., Belief, Desire, etc.	
Person	+	+	+	+	+	
Animal	+	+	+	+	–	
Plant	+	+	–	–	–	
Substance	+	–	–	–	–	

retransmitted more readily than either intuitive or highly counterintuitive concepts. Recall experiments indicate that minimally counterintuitive concepts and beliefs enjoy a cognitive advantage in memory and transmission over intuitive concepts and mundane beliefs (Barrett and Nyhof 2001). Results have been observed immediately, as well as after a three-month delay, in samples from the United States, France, Gabon, Nepal (Boyer and Ramble 2001), as well as from Maya (Atran and Norenzayan 2004). Whether counterintuitive concepts are believed in, or committed to, more is another matter (think Jesus vs. Zeus), which is addressed below (also see Gervais and Henrich forthcoming).

The advantages in mnemonic and transmittability for minimally counterintuitive representations beg the question of why such representations don't occupy most of scriptures, folktales, and myths. The Bible or the Koran, for example, involve successions of mundane events—walking, eating, sleeping, marrying, fighting, and suffering—interspersed with a few counterintuitive occurrences, often involving miracles or the appearance of supernatural agents. One explanation is that counterintuitive ideas are transmitted as elements in narrative structures. Studies have explored this by examining (1) the cognitive structure of folktales, and (2) the relative cultural success of each tale (Norenzayan et al. 2006). Minimally counterintuitive folktales (containing two to three supernatural events or objects) were substantially more widespread than folktales containing fewer counterintuitive elements (less than two) or those with too many counterintuitive elements (more than three).

In brief, counterintuitive concepts and beliefs, as long as they come in small doses, help people remember and presumably retransmit the intuitive statements, as well as the underlying knowledge that can be inferred from them. A small proportion of minimally counterintuitive elements give a story a mnemonic advantage over stories with no or too many counterintuitive elements. This dual aspect of supernatural belief sets—commonsensical and counterintuitive—

renders them intuitively compelling yet fantastic, eminently recognizable but surprising. Cross-cultural experiments indicate that such beliefs grab attention, activate intuition, mobilize inference, and can accommodate seemingly contrary events and interpretations, in ways that facilitate their mnemonic retention, cultural transmission, and historical survival.

Natural Origins of Faith

The above helps explain the success of, for example, folktales and scriptures. However, this approach misses the difference between Moses' miracles and Mickey Mouse's antics (Atran 1998). Or, why the faithful of one religion do not adopt beliefs in the gods of other religions once they learn about them (Gervais and Henrich forthcoming). So, the question is why do people become deeply committed to particular counterintuitive agents or stories—so committed that they would die for their beliefs?

We are a cultural species. Unlike other animals, humans have evolved to rely heavily on acquiring behavior, beliefs, motivations, and strategies from others in their group. These psychological processes, shaped by natural selection, focus our attention on both those domains and individuals that likely to possess fitness-enhancing information (Henrich and Gil-White 2001; Richerson and Boyd 2005). Human social learning generates vast bodies of know-how and complex practices that accumulate and improve over generations. Studies of small-scale societies show that survival and reproduction are dependent on cumulative bodies of information related to hunting (animal behavior), edible plants (seasonality, toxicity, etc.), medical knowledge, technical manufacture, and so on (Liebenberg 1990; Henrich and McElreath 2003; Henrich 2008).

Because of the dependence that human ancestors increasingly had to place on such complex, often nonintuitive, products of cumulative cultural evolution, natural selection may have favored a willingness to rely on culturally acquired

320 information—filtered through our adaptive biases—over our
direct experience or basic intuitions. To see this, consider that
many foragers process plant foods to remove toxins without
325 without conscious knowledge of what happens without processing
(Beck 1992). Such foods often contain low dosages of toxins
that cause little harm for months or even years, and don't badly
330 damage the food's flavor. However, such toxins will accumu-
late and eventually cause severe health problems and death. A
naïve learner who favors his own experience of eating the foods
without the arduous processing will do less work in the short
run, but possibly die in the long run. Place faith in traditional
335 practices, without understanding why, can be adaptive. Simi-
larly, manufacturing complex technologies or medicines often
involve a sequence of important steps, most of which cannot be
skipped without producing an inferior outcome. Experimentation
is of limited use in rearranging or dropping steps because
340 even a relatively small number of steps yield a combinatorial
explosion of possible alternative procedures. Learners must
have faith, and copy all steps. This suggests that a willingness
to sometimes rely on faith—to believe in cultural traditions
over experience or intuitions—is likely a product of evolving
in a world with complex cultural adaptations.

Supporting evidence comes from developmental psychol-
ogy, which documents a potent tendency for "over-imitation"
345 in children, and recently demonstrated how deeply over-
imitation influences our acquisition and encoding of concepts
(Lyons et al. 2007). This comes across most starkly in stud-
ies comparing children and chimpanzees. When both species
observe demonstrations of a task involving multiple steps, chil-
dren accurately copy all steps, including steps that direct visual
350 inspection and are unnecessary. Chimpanzees do some copy-
ing, but skip unnecessary steps, leading them to more efficient
repertoires than children (Horner and Whiten 2005). Children
implicitly assume that if the model performed a seemingly
unnecessary action, it was probably important, even if they
355 cannot understand precisely why.

With the evolution of language, this faith in cultur-
ally transmitted information became vulnerable to exploita-
tion by individuals—particularly successful and prestigious
360 individuals—able to transmit practices or beliefs they them-
selves might not hold. Language makes exaggeration, dis-
tortion, manipulation, and deception easy and cheap. Before
language, learners observed and inferred people's underlying
beliefs or desires by their behavior. Those wishing to deceive
would have to actually perform an action to transmit it. To
365 avoid being manipulated by models proficient at altering or
exaggerating commitments to certain beliefs, evolutionary ap-
proaches suggest that humans may have evolved cognitive
abilities that examine the fit between a model's words (ex-
pressed beliefs) and actions. In figuring out who to learn from,
370 learners consider both a model's cues of success, skill, and
prestige (among other cues) and whether a models' expressed

beliefs are supported by diagnostic actions that permit an as-
sessment of the model's underlying degree of commitment
to their expressed beliefs. For example, if a potential model
375 rails against prostitution, but then uses prostitutes for his own
clandestine recreation, a learner should de-weight this model's
influence in cultural transmission with regard to prosecuting
prostitution. This means that if a model's belief causes him to
perform "costly displays"—that is, actions that would be too
380 costly for someone with different beliefs to perform—learners
should be more willing to learn from this model. If a model is
successful or prestigious in the eyes of learners, and performs
costly displays cueing deep commitment to his expressed be-
liefs, then learners should more readily adopt and believe in (be
385 committed to) the models' expressed beliefs (Henrich 2009).

Experimental findings support this. Thus, young children
are generally unwilling to sample a novel food offered by a
stranger as "something to eat" without first seeing the stranger
eat it (Harper and Sanders 1975). Developmental studies of the
transmission of altruistic giving show that neither preaching
390 nor exhortation to charity is effective without opportunities to
observe costly giving by models (Henrich and Henrich 2007).
Studies of children's beliefs about the existence of entities like
intangible germs, angels, and mermaids show that children
only subscribe to those agents whom adults seem to endorse
395 through their daily actions, and remain skeptical of unendorsed
supernatural agents (Harris et al. 2006). Similarly, interviews
with a diverse sample of parents from highly religious Chris-
tian, Jewish, Mormon, and Muslim families reveal that parents
see religion holding their children on a virtuous life course pri-
400 marily because of their costly investments in "practicing (and
parenting) what you preach" (Marks 2004).

This suggests an approach to devotions (fasting, celibacy,
etc.) and rituals as having evolved culturally (at least in part)
to deepen people's commitments to counterintuitive beliefs.
405 Counterintuitive beliefs have a mnemonic advantage, but not
a belief advantage. Both direct experience and our own intu-
itions often contradict counterintuitive beliefs, and reality does
not readily provide decisive evidence in their favor. (There
are many potentially counterintuitive beliefs that can be em-
410 pirically grounded through arduous scientific effort—think
quantum teleportation, evolution, etc.—but common sense and
experience doesn't favor even these beliefs.) This puts coun-
terintuitives at a disadvantage relative to mundane or intuitive
beliefs. Rituals and devotions can help overcome this disad-
415 vantage through acts of costly commitment (Henrich 2009).

In this view, costly ritual or devotional acts may have
evolved as a means to convince learners of the personal com-
mitment of either the rest of the congregation (exploiting con-
formist biases in our learning) or of locally prestigious models
420 (Henrich 2009). Rituals and devotions exploit our reliance
on diagnostic actions to deepen commitment to counterin-
tuitive beliefs. They also link performance of costly acts to

social success, thereby perpetuating the transmission of belief–
425 commitment across generations. Formal cultural evolutionary
models show that costly displays (e.g., ritual sacrifice) can in-
terlock with and sustain counterintuitive beliefs, which would
not be otherwise sustained by cultural evolution. By contrast,
430 fairy tales are counterintuitive, easily remembered, and may
help to transmit moral messages by grabbing attention with
themes having emotional impact; but nothing is socially im-
perative or sacred about them or their message. No one in the
learner’s community demonstrates via costly acts their deep
commitment to the truth of such stories, actors, or ideas.

435 Because of our adaptive need, at times, to rely wholly
on cultural information in the face of inconsistent experience
or contradictory implications, natural selection likely favored
something of a psychological immune system that cements
adherence to adopted beliefs. Experiments suggest that once
440 people sincerely commit to religious beliefs, attempts to un-
dermine them through reason and evidence can stimulate the
strengthening of personal commitments (Festinger et al. 1956).
Since many religious beliefs are logically inscrutable and im-
mune to empirical falsification, a failed prophecy (direct evi-
445 dence) may mean that more introspection and commitment is
needed.

These lines of reasoning and evidence suggest that com-
mitment to supernatural agents tends to spread in a population
to the extent it elicits costly displays, usually in the form of
450 ritual ceremonies, offerings, devotions, and sacrifices. When
community leaders and congregations demonstrate commit-
ment to supernatural beliefs in costly rites, observers who
witness these commitments are more inclined to trust and fol-
low participants. Such trust and following often extend to wider
455 sets of mundane beliefs and associated actions because (1) peo-
ple tend to follow, and give the benefit of doubt to, models with
proven success and commitment in one valued domain as they
move into other domains (hence, advertisers get famous peo-
ple to sell their wares) (Henrich and Gil-White 2001); and (2)
460 many counterintuitive beliefs violate our intuitive ontology,
and are thus literally preposterous (like many poetic tropes);
they can only be meaningfully interpreted in terms exogenous
to the beliefs themselves. Consequently, religious trust and
following carry over to other beliefs and actions associated
465 with ritualized actions, including cooperative works, charity,
commerce, moral norms, and warfare.

Supernatural agents that incentivize costly sacrifices will
tend to spread, creating an emerging linkage between degree
of commitment to belief and costly displays. For example,
470 alongside prohibitions against various social ills (e.g., murder,
adultery, and theft), God commanded the Israelites to keep holy
the Sabbath or suffer death. Demands for rituals, devotions,
and sacrifices guarantee intergenerational transmission of deep
commitments (Alcorta and Sosis 2005), as children infer deep
475 commitment from costly actions of adults (Henrich 2009).

Because the deeply committed actually believe in the agent’s
incentives, sacrifices and rituals needn’t seem (subjectively)
costly.

Religions have culturally evolved to deploy a variety of
other means to ratchet up faith and commitment. Faith in 480
otherwise inscrutable content is deepened and validated by
communion: collectively engaging emotions and motivations
using music, rhythm, and synchrony. Of people reporting a
religious experience, music is the single most important elic-
itor of the experience, followed by prayer and group services 485
(Greeley 1975). Listeners as young as three years old reli-
ably associate basic emotions—anger, sadness, fear, joy—with
musical structures (Trainor and Trehub 1992). Recent study
finds that strangers acting in synchrony—marching, singing,
and dancing—cooperate more in subsequent group exercises, 490
even in situations requiring personal sacrifice. Synchronous ac-
tion (rhythmically moving together) increases cooperation by
strengthening social bonds among group members, even when
no positive emotion is attached to the movement (Wiltermuth
and Heath 2009). The ability of music, rhythm, and synchrony 495
to instill commitment and trust is also apparent why military
drills and routines developed over the centuries to train soldiers
and build armies (McNeil 1982).

This indicates that groups and institutions that survive and
spread will possess both costly displays (devotions and rituals) 500
of commitment and values that glorify such sacrifices for group
beliefs. The Navajo, for example, are among the most success-
ful cooperators and survivors of Native American groups, with
men spending upwards of one-third, and women one-fifth,
of their productive time on “priestly rites” (Kluckhohn and 505
Leighton 1946). Historical studies suggest that early Chris-
tianity spread to become the majority religion in the Roman
Empire through costly displays such as martyrdom and char-
ity (e.g., risking death by caring for sick non-Christians during
epidemics; Stark 1997). Strengthening the group through 510
ritual participation and costly displays also applies to a variety
of modern movements for civil and human rights that grow
by “waging peace” in the battle for public opinion, including
those modeled on the nonviolent doctrines and costly commit-
ments (imprisonment, harassment, etc.) of Gandhi and M. L. 515
King (Smith 1996). Martyring spiritual leaders often stimu-
lates the spread of their ideas by providing persuasive displays
of the leader’s deep commitment.

Below, we sketch a cultural evolutionary process that as-
sembles these otherwise disparate elements into a general ac- 520
count of the evolution of religions.

Coevolution of Counterintuitive Beliefs and Norms for Complex Societies

Counterintuitive beliefs are readily recalled and retransmit-
ted. Rituals and devotions involving costly displays, music, 525

rhythm, and synchrony can ratchet up the belief in, and commitment to, these counterintuitive beliefs. Now, the questions are (1) how do these elements of effective rituals and devotions get assembled and linked with particular supernatural agents?; 530 (2) why do these supernatural agents so favor prosocial behavior, by forbidding stealing, lying, murdering, adultery, and so forth?; and (3) why does this seem more prevalent in recent and increasingly large and complex societies? A rising tide of evidence suggests that religious beliefs, rituals, devotions, 535 and social norms have coevolved in interlocking cultural complexes in a process driven by competition among alternative complexes.

As a species we rely heavily on acquiring key aspects of our behavior by observing others. Humans readily acquire 540 social strategies, practices, beliefs, and preferences via cultural learning in ways consistent with evolutionary predictions. Children acquire altruistic behaviors or other costly norms via observation and inference, and will spontaneously apply imitated standards to others, sanctioning them if necessary 545 (Henrich and Henrich 2007; Rakoczy et al. 2008). Game theoretic analyses show that when cultural learning is combined with social interaction, a variety of different stable states (i.e., social norms or institutions) emerge. Unlike genetic transmission, this is even true in larger scale cooperative endeavors 550 (Henrich and Boyd 2001; Panchanathan and Boyd 2004), in which both cooperative and defecting states can remain stable. When the aforementioned cognitive mechanisms for weighting costly displays are included as part of cultural learning, belief-action combinations yield many different stable states, including those in which the actions are individually costly, 555 and potentially cooperative (Henrich 2009).

Existence of alternative stable sets of norms across human societies creates conditions in which competition among groups will favor the emergence of prosocial norms—that is, 560 norms that lead to success in competition with other groups. The most important norms are likely to be those that increase cooperation (e.g., in warfare and economic production) or reduce within-group conflict, by regulating sexual relationships or managing disputes. Because this process involves competition among stable states, modeling shows that it does not suffer the challenges typically associated with the genetic group selection of altruism (Boyd and Richerson 2002). 565

This process is capable of assembling those combinations of supernatural beliefs, rituals, and devotions that most 570 reinforce cooperative or other prosocial norms. Religious elements can operate in at least four interrelated ways. First, observation and participation in costly rituals are likely to induce deep commitment to associated norms, leading to greater intrinsic motivation to comply (Henrich 2009). Second, supernatural policing and incentives (heaven vs. hell) can buttress 575 more worldly norm-sustaining mechanisms, such as punishment, signaling, and reputation (Gintis et al. 2001; Henrich

and Boyd 2001; Panchanathan and Boyd 2004). By augmenting these mechanisms, supernatural beliefs have culturally selective advantages over purely secular mechanisms (Johnson 580 2005). At the margins, the additional psychological threat of supernatural incentives reduces the costs of punishing violators, provides a threat when no human eyes are watching, and may tilt the balance in situations when the benefits of defecting (charging a vast enemy) exceed the potential worldly costs. If 585 a transgressor has faith in divine awareness and retribution, then external policing, capture, and punishment “automatically” come from within. By reinforcing worldly mechanisms where they are weak (e.g., monitoring large populations), supernatural beliefs can help extend the scale and intensity of 590 cooperation. Third, when supernatural punishment is either indiscriminate or collective, third parties have a direct incentive to keep norm violators in line. If people believe that their god will punish everyone (say, by a drought) for the misdeeds of a few (e.g., adultery), then everyone has an incentive to keep 595 everyone else in line.

The fourth way religion can galvanize prosocial norms is by making gods the authors of sacred canons or values that authenticate society—in the minds of believers—as having 600 an existence above a mere aggregation of its individuals and institutions (Durkheim 1995; Wilson 2002). Beyond simply the authority of authorship, the ineffability of sacred “propositions” (e.g., “God is merciful to believers,” or “this land is holy”) effectively places them beyond logical or empirical scrutiny (Rappaport 1999). Recent work reveals that children’s 605 beliefs in God as the creator of everything favors essentializing of social categories, meaning that religious beliefs about divine creators predict the inferring that ethnic/religious category membership is stable (immutable: these effects seem limited to human categories, and do not influence judgments 610 about artifacts or animals). This suggests that competition among socioreligious groups will favor beliefs that galvanize and reify group membership by extending our intuitive system for essence-based inferences (used for thinking about biological kinds; Atran 1998) to the relevant human social categories 615 (Diesendruck and Haber 2009). By sparking our tendency to essentialize some categories (e.g., biological species), beliefs in supernatural creators may facilitate (psychologically) the unification of diverse tribes into a single, stable, immutable 620 people, and God’s people.

The same evolutionary process will favor distinct markers of group members, often in the form of taboos. These emerge as nonnegotiable prohibitions about beliefs and behaviors that systematically covary with sacred (less observable) beliefs and values (Durkheim 1995; Wilson 2002). Punishment for transgression of taboos provides concrete markers and proof of 625 the meaning and importance of what is sacred for a society. Together, sacred values and taboos bound moral behavior at the most basic level of conduct in society (sex, diet, dress,

630 and greetings) and at the most general level (warfare, rule,
work, and trade). Together with religious rituals, devotions,
and insignia, such practices can foster a cohesive group identity
and increase solidarity vis-à-vis other groups. Here religion exploits
635 and extends our “tribal psychology” that has long
marked group boundaries through language, dialect, and dress
(McElreath et al. 2003).

For example, the Hebrew Kingdom of Judah used circumcision,
dietary laws, and a prohibition against work on the Sabbath (etc.)
640 as displays of commitment to their God. This enabled the alliance
of Hebrew tribes to set themselves apart from coastal peoples
(e.g., Philistines, Canaanites) and forged a unification that withstood
stronger invaders (e.g., Egyptians, Babylonians) (Sweeney 2001).
Violating the Sabbath, along with idolatry, were considered the
645 gravest violations and punishable by death (Phillips 1970). These
were both costly and arbitrary markers of corporate identity relative
to the concrete needs of social life shared with other groups
(in contrast to prohibitions on stealing, adultery, murder, etc.).
Disregard of these was considered a reliable signal of sin and failure
650 of commitment. From this perspective, groups using such costly
markers succeed because they (1) transmit commitment in the next
generation, (2) eliminate, or identify, those lacking sufficient
commitment to the group and its god(s) (Irons 1996; Sosis and
Alcorta 2003), and (3) psychologically demarcate the group in
655 ways that engage our tendency to essentialize and reify group
boundaries.

Norms are often attached to powerful emotions (anger, guilt,
shame) that can be amplified by certain religious beliefs into dread,
awe, or anxiety. This leads to strong reactions against norm violators
660 that range from bad-mouthing to banishment, and from manhandling
to murder. Experiments show that when norms are associated with
the sacred, they become emotionally charged and less influenced by
material calculations and tradeoffs (Tetlock 2003). In conflict situations,
665 as in the Middle East, recent research reveals that material offers
from one group to another proposing that norms associated with
sacred values be relaxed or abandoned generate moral outrage,
and increase people’s readiness to support lethal violence. Such
sacred values appear to be somewhat immune to the rationality of
670 *realpolitik* or the marketplace, implying that a “business-like”
approach to negotiations in conflicts involving sacred values may
backfire (Atran et al. 2007; Ginges et al. 2007; Dehghani et al.
2009). From our perspective, increasing the material incentives to
a believer in exchange for violating sacred values might result in
675 substantial increasing of the signaling value obtained from rejecting
the material payoffs. The target of the signal might be God, one’s
fellows, or one’s self.

The line sketched here allows some predictions about the historical
emergence of supernatural agents. Gods of increasingly complex
680 societies should evolve to be more concerned with (1) in-group
cooperation (help your co-religionists),

harmony (no stealing, lying, or adultery), and fair exchange,
(2) sexual and family relations (increasing reproduction of new
adherents), and (3) the performance of commitment-inducing
685 rituals (Roes 1995; Roes and Raymond 2003; Johnson 2005).
To better police and reward adherents, the gods of emerging
complex societies need more knowledge of mortal behavior
(evolution of omniscience) and more power to reward and
punish (thus, an afterlife in heaven or hell). This allows gods
690 to monitor people in ephemeral or anonymous situations, and to
provide potent incentives, if they can instill deep commitment.
Along these lines, beliefs in an eternal, blissful afterlife for the
faithful emerged likely only after 500 B.C. in Eurasia, with the
rise of cosmopolitan religions such as Hinduism, Mahayana
695 Buddhism, and Christianity (McNeil 1991).

The Religious Rise of Civilizations

Scholars have long suspected a link between certain religious
forms and the emergence of complex societies. In the 14th century,
historian Ibn Khaldūn examined different waves of invasion in the
695 Maghreb and argued that enduring dynastic power stems from
religious “group feeling,” with its ability to unite desires, inspire
hearts, and support mutual cooperation (Khaldūn 2005). Historical
work suggests that the beliefs, rituals, and norms (e.g., inheritance
rules, ethnic equality, judicial procedures) of Islam spread initially
700 by providing a means of unifying the warring Arabic tribes,
giving them the ability to cooperate, conquer, and gradually
assimilate surrounding peoples (Levy 1957). Contemporary studies
indicate that Islam spread into Sub-Saharan Africa by drawing
people into tighter religiously based networks of trust that facilitate
705 trade and economic success (Ensminger 1997). As expected, this
process is galvanized by costly devotions and rituals (fasting, frequent
prayer, taboos on pork and alcohol) that demarcate believers from
everyone else. Similar considerations apply to the ongoing spread
710 of evangelical Protestantism in Asia, Africa, and Latin America
(Freston 2001).

The archaeological record reveals a clear, coevolutionary connection
between religion, ritual, and complex societies. Recent finds indicate
715 that rituals became much more formal, elaborate, and costly as
societies developed from foraging bands into chiefdoms and states
(Marcus and Flannery 2004; cf Whitehouse 2004). In Mexico before
4000 B.P., for example, nomadic bands relied on informal, un-
scheduled, and inclusive rituals. The same goes for contemporary
720 foragers, such as the San of Africa’s Kalahari desert, whose ad-hoc
rituals (e.g., trance dancing) include all community members,
and are organized according to the contingencies of rainfall,
hunting, and illnesses (Lee 1979).

Then, with the establishment of permanent villages and multi-
village chiefdoms (4000–3000 B.P.), rituals are managed by social
725 achievers (prestigious “Big Men” and chiefs)

and scheduled by solar and astral events. This also appears to be the case for pre-dynastic Egypt (6000–5000 B.P.) and China (4500–3500 B.P.), as well as for North American chiefdoms. After the state was formed in Mexico (2500 B.P.), important rituals were performed by a class of full-time priests, subsidized by society, using religious calendars and occupying temples built at enormous costs in labor and lives. This is also true for the earliest state-level societies of Mesopotamia (after 5500 B.P.) and India (after 4500 B.P.), which, as in Mesoamerican, practiced fearsome human sacrifice (Campbell 1974). Combining this with comparative ethnography suggests that high moralizing gods likely coevolved with costly regularized rituals, creating a mutually reinforcing cultural nexus capable of enhancing internal cooperation and harmony, while providing a justification to exploit out-groups.

Combining these observations with recent work in psychology illuminates a linkage between monumental architecture and religion. The earliest civilizations are known for their impressive monuments, usually in the form of temples, pyramids (tombs), and ziggurats (altars) that may have served at least two important psychological purposes: (1) as costly displays of commitment from the society's leaders, or society in general, they help to instill deeper commitments to religious/group ideologies in learners; and (2) as "religious primes," their visibility may stimulate prosocial behavior. As noted, experiments show that believers give more money to others and cheat less when primed with religious concepts; a giant temple in the market square may provide a salient cue that evokes, if only at the margins, more prosocial behavior. Societies that better exploit these aspects of our psychology could outcompete others.

Cultural Group Selection

Our species' heavy reliance on social learning spontaneously gives rise to norms and informal institutions (stable equilibria), which vary in their group-level competitive properties. Ecological and social pressures, especially with the spread of agriculture, favor norms and institutions that strengthen and extend the social spheres of cooperation and trust while sustaining internal harmony. Deep commitments to certain kinds of religious beliefs and practices can cement both adherence to prosocial norms and a willingness to sanction norm violators, thereby increasing group solidarity and competitiveness with other groups. Religious beliefs and practices, like group-beneficial norms, can spread by competition among social groups in several ways, including warfare, economic production, and demographic expansion. Such cultural representations can also spread through more benign interactions, as when members of one group preferentially acquire behaviors, beliefs, and values from more successful groups.

These processes of cultural group selection have both theoretical and empirical grounding. Theoretically, findings from

a growing literature of formal models of cultural evolution illuminate three important facts. First, nothing in the modeling of these processes requires "essentializing" culture, nor do these models assume away variation within groups. These models permit within-group variation, and show that cultural group selection can operate even in the face of ample within-group variation (Boyd and Richerson 2002; Henrich 2004; Boyd et al. 2003). Second, no assumptions about discrete or high fidelity replication are required in models of cultural evolution, and assuming that strong cognitive attractor exists do not obviate the importance of other selective processes (Henrich and Boyd 2002; Henrich et al. 2008). Third, important concerns about older models involving the genetic group selection of altruism do not apply to these cultural evolutionary models. There are several reasons for this but three important ones revolve around: (1) the non-vertical nature of cultural inheritance (Henrich and Boyd 2001), (2) the speed of cultural adaptation (Boyd et al. n.d.), and (3) presence of multiple stable equilibria (Henrich 2004).

Empirically, both detailed ethnographic studies and historical analyses support the importance of cultural group selection (see Henrich 2009 for additional cases). Ethnographically, to illustrate cultural group selection both via the emulation of more prestigious groups and direct economic competition, consider the well-documented case of three adjoining populations: the Itza' Maya of Guatemala's Petén lowlands, Spanish-speaking Ladino immigrants from diverse regions, and Q'eqchi Maya who arrived in clusters of families and neighbors from the highlands (Atran et al. 2002). Among the Itza' Maya, one important predictor of sustainability is their consensus on supernatural (as opposed to human) forest preferences. This cultural consensus about which species are most valuable and worthy of protection accords well with the anthropogenic character of the forest in the Classic era of Maya civilization. The researchers' hypothesis is that spirit preferences represent a summary of experience accumulated over generations. Itza' Maya believe spirits to be "guardians" of the forest. Spirits help people who do not harm the survival prospects of certain species (as spirits see those prospects). Hurting the forest can result in accidents, illness, and worse (punishment). This research team has witnessed Itza', bitten by deadly pit vipers, refuse to be taken for anticoagulant treatment, until they venture into the forest to ask spirits for guidance or forgiveness. It matters little if supernatural threats are real or not: if people believe in them, threats of punishment become real deterrents (Durkheim 1995).

Evidence indicates that much of this knowledge is being transmitted to Ladinos. Experimental elicitations show that Itza' knowledge predicts relative success in short- and long-term agroforestry. By attending to Itza' models of behavioral success in agroforestry, and to Itza' stories that embed that behavior in context, prestigious Ladinos have managed to acquire

835 a subset of Itza' knowledge of the ecological relationships
between humans, animals, and plants. Social network analysis
suggests how this knowledge and practice has spread through
the Ladino community. It seems the initial lack of any commu-
840 nunal Ladino religion or corporate structures, combined with the
uncertainty created by immigration into a novel environment,
made Ladinos open to learning from Itza' (Sosis and Bressler
2003).

In contrast to Ladinos, migrant Q'eqchi, who have strong
and highly ritualized religious institutions, pay little heed to
845 Itza'. The Q'eqchi retain allegiances only to the spirits of
their native highlands and have no knowledge of Itza' beliefs.
Q'eqchi send delegations back to the highlands to consult
deities when they have agricultural troubles in the lowlands.
Q'eqchi's mental models of the forest are correspondingly
850 poor, as are their associated agroforestry practices, which are
commercially oriented and unsustainable.

These divergent beliefs mean that the Q'eqchi are now
spreading more rapidly than the other two groups. In fact,
Q'eqchi practices are well adapted to present "open-commons"
855 conditions in Guatemala that encourage massive immigration
from the overcrowded highlands into the ecologically fragile
lowlands. There is little incentive to avoid destructive prac-
tices: if one part of the forest is destroyed, Q'eqchi simply mi-
grate. In this context, Itza' practices are currently maladaptive.
860 By making costly commitments to preserve the forest, Itza'
make it easier for the highly ritualized, corporately disciplined
Q'eqchi to exploit it. Thus, Itza' may be subsidizing their own
cultural extinction in the competition among ethnic groups.

Historically, the impact of the cultural group selection
865 on the interrelationship between religious beliefs and costly
rituals/devotions is apparent in a study of 83 utopian com-
munes in the 19th century (Sosis and Bressler 2003). Reli-
gious groups with more costly rituals were more likely to
survive over time than religious groups with fewer costly ritu-
870 als. Differential group survival yielded an increase in the mean
number of costly rituals per group over time. The above the-
ory and evidence suggest that such rituals and devotions likely
generated greater commitment and solidarity within groups
(Henrich 2009). Indeed, members and leaders explicitly ac-
875 knowledged that costly demands increased members' religious
commitment (Sosis and Bressler 2003).

The relation of rituals to prosocial behavior toward in-
group members is demonstrated in a variety of ways. Among
880 Israeli kibbutzim (cooperatives), individuals from religious
kibbutzim cooperated more in behavioral experiments than
those from nonreligious ones, with increased cooperativeness
of religious members attributed to greater ritual participation
(Ruffle and Sosis 2006). Religious kibbutzim also economi-
885 cally outperform secular ones (Fishman and Goldschmidt
1990; Ruffle and Sosis 2006). Surveys of Palestinians and Is-
raeli settlers in the West Bank and Gaza reveal that a person's

frequency of attendance at religious services predicts support
for martyrdom missions. This relation is independent of time
spent in prayer. Similar findings emerge for representative
890 samples of religious Indians, Russians, Mexicans, British, and
Indonesians: Greater ritual attendance predicts both declared
willingness to die for one's deities, and belief that other re-
ligions are responsible for problems in the world (Ginges et
al. 2009). Finally, a study of 60 small-scale societies reveals
895 that males from groups in the most competitive socioecologies
(with frequent warfare) endure the costliest rites (genital mutil-
ation, scarification, etc.), which "ritually signal commitment
and promote solidarity among males who must organize for
warfare" (Sosis et al. 2007).

Cultural group selection shapes religious beliefs and rites
900 to manipulate our psychology to increase solidarity and com-
mitment. Such patterns, observed across history and in the
anthropological record, reemerge in today's terrorist groups
(Atran 2003). Even avowedly secular national and transna-
tional movements retain many agentive (anthropomorphic) and
905 transcendental (sacred) aspects of traditional religions (An-
derson 1991): nations ritually mourn, rejoice, and demand
sacrifice, and the "naturalness" of causes that defy prior hu-
man history (universal justice, equality, and liberty) is any-
thing but empirically or logically self-evident (Atran 2010). As
910 we argue that sociopolitical complexity coevolved with both
commitment-inducing rituals and beliefs in high moralizing
gods, our efforts also dovetail with recent work indicating that
cultural group selection, driven by differences in sociopolitical
complexity, is crucial to understanding the global distribution
915 and diversity of languages (Currie and Mace 2009).

In sum, religion, as an interwoven complex of rituals, be-
liefs, and norms, plausibly arises from a combination of (1) the
mnemonic power of counterintuitive representations, (2) our
evolved willingness to put faith on culturally acquired beliefs
920 rooted in the commitment-inducing power of devotions and
rituals, and (3) the selective effect on particular cultural com-
plexes created by competition among societies and institutions.
None of these evolved for religion per se. The mnemonic power
of minimally counterintuitive representations appears to be
925 a by-product of our evolved expectations about how the world
works and our fitness-enhancing requirement to pay attention
to anomalies. The faith we sometimes place in culture over
our own experience and intuitions is a cognitive adaptation,
resulting from our long dependence on vast bodies of complex
930 cultural knowledge. Reliance on costly displays evolved to
provide partial immunity against manipulation. The power of
rhythm and synchrony in ritual to build solidarity (Wiltermuth
and Heath 2009) likely arises from our imitative and ToM abil-
ities. Cultural evolution, driven by competition among groups,
935 exploits each of these cognitive processes to fashion sets of
counterintuitive beliefs, rituals, and norms that spread by inter-
group transmission, conquest, or reproductive differentials. As

940 a result, for large-scale societies, these complexes tend to include potent supernatural agents that monitor and incentivize actions that expand the sphere of cooperation, galvanize solidarity in response to external threats, deepen faith, and sustain internal harmony.

945 Significant advances in the study of religious cognition, the transmission of culture, and the evolution of cooperation are all relatively recent. Bringing these new insights, in combination with older ideas, to bear on phenomena as complex as moralizing religions and large-scale societies will be an ongoing challenge. The argument and evidence presented here provides a plausible scenario showing how synthetic progress is possible. More rigorous study is needed on the evolved psychology and cultural processes associated with the role of counterintuitive agents and costly rituals in scaling up the scope of trust and exchange of sacred values and taboos in sustaining large-scale cooperation against external threats, and also of maintaining social and political causes that defy self-interest. Empirical research that combines in-depth ethnography with both cognitive and behavior experiments among diverse societies, including those lacking a world religion, is crucial to understanding how religion influences our cognition, decision-making, and judgments. The formal modeling of cultural evolutionary processes should be combined with historical and archeological efforts to apply these emerging insights to broad patterns of history. These joint efforts should further illuminate the origins and development of religions, and the cooperation and conflicts they engender. There may be no more urgent study needed in the world today.

Acknowledgments

We wish to thank the National Science Foundation for support.

970 References

Alcorta CS, Sosis R (2005) Ritual, emotion, and sacred symbols: The evolution of religion as an adaptive complex. *Human Nature* 1: 323–359.

Allen-Arave W, Gurven M, Hill K (2008) Reciprocal altruism, rather than kin selection, maintains nepotistic food transfers on an Ache reservation. *Evolution and Human Behavior* 29: 305–318.

975 Anderson B (1991) *The Imagined Communities: Reflections on the Origin and Spread of Nationalism*. London: Verso.

Argyle M, Beit-Hallahmi B (2000) *The Social Psychology of Religion*. New York: Routledge.

980 Atran S (1998) Folkbiology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences* 21: 547–609.

Atran S (2002) *In Gods We Trust*. New York: Oxford University Press.

Atran S (2003) Genesis of suicide terrorism. *Science* 299: 1534–1539.

985 Atran S (2010) *Talking to the Enemy: Faith, Brotherhood, and the (Un)Making of Terrorists*. New York: Ecco/Harper Collins.

Atran S, Axelrod R, Davis R (2007) Sacred barriers to conflict resolution. *Science* 317: 1039–1040.

AO5
990 Atran S, Medin DL (2008) *The native mind and the cultural construction of nature*. Cambridge, MA: MIT Press.

Atran S, Medin D, Ross N, Lynch E, Vapnarsky V, Ek' EU, Coley J, Timura C, Baran M (2002) Folkecology, cultural epidemiology, and the spirit of the commons: A garden experiment in the Maya lowlands, 1991–2001. *Current Anthropology* 43: 421–450.

Atran S, Norenzayan A (2004) Religion's evolutionary landscape: Counter-intuition, commitment, compassion, communion. *Behavioral and Brain Sciences* 27: 713–770. 995

Atran S, Sperber D (1991) Learning without teaching. In: *Culture, Schooling and Psychological Development* (Tolchinsky-Landsmann L, ed), 39–55. Norwood, NJ: Ablex. 1000

Bargh JA, Chartrand TL (1999) The unbearable automaticity of being. *American Psychologist* 54: 462–479.

Baron-Cohen S (1995) *Mindblindness*. Cambridge, MA: MIT Press.

Barrett JL (1998) Cognitive constraints on Hindu concepts of the divine. *Journal for the Scientific Study of Religion* 37: 608–619. 1005

Barrett JL (2000) Exploring the natural foundations of religion. *Trends in Cognitive Science* 4: 29–34.

Barrett JL (2004) *Why Would Anyone Believe in God?* Walnut Creek, CA: AltaMira Press.

Barrett JL, Keil FC (1996) Conceptualizing a nonnatural entity: Anthropomorphism in God concepts. *Cognitive Psychology* 31: 219–247. 1010

Barrett JL, Nyhof MA (2001) Spreading nonnatural concepts. *Journal of Cognition and Culture* 1: 69–100.

Beck W (1992) Aboriginal preparation of Cycads seeds in Australia. *Economic Botany* 46: 133–147. 1015

Bloom P, Veres C (1999) The perceived intentionality of groups. *Cognition* 71: B1–B9.

Boyd R, Gintis H, Bowles S, Richerson PJ (2003) The evolution of altruistic punishment. *Proceedings of the National Academy of Sciences of the USA* 100: 3531–3535. 1020

Boyd R, Richerson P (1988) The evolution of reciprocity in sizable groups. *Journal of Theoretical Biology* 132: 337–356.

Boyd R, Richerson P (2002) Group beneficial norms can spread rapidly in a structured population. *Journal of Theoretical Biology* 215: 287–296.

Boyd R, Richerson J, Henrich J (n.d.) Rapid cultural adaptation can facilitate the evolution of large-scale cooperation. Manuscript. University of British Columbia.

Boyer P (2001) *Religion Explained*. New York: Basic Books.

Boyer P, Ramble C (2001) Cognitive templates for religious concepts: Cross-cultural evidence for recall of counter-intuitive representations. *Cognitive Science* 25: 535–564. 1030

Campbell J (1974) *The Mythic Image*. Princeton, NJ: Princeton University Press.

Csibra G, Gergely G, Biró S, Koós O, Brockbank M (1999) Goal attribution without agency cues. *Cognition* 72: 237–267. 1035

Currie TE, Mace R (2009) Political complexity predicts the spread of ethnolinguistic groups. *Proceedings of the National Academy of Sciences USA* 106: 7339–7344.

Dehghani M, Iliev R, Sachdeva S, Atran S, Ginges J, Medin D (2009) Emerging sacred values: The Iranian nuclear program. *Judgment and Decision Making* 4: 990–993. 1040

Diesendruck G, Haber L (2009) God's categories: The effect of religiosity on children's teleological and essentialist beliefs about categories. *Cognition* 110: 100–114.

Durkheim E (1995) *Elementary Forms of Religious Life*. New York: Free Press. 1045

Ensminger J (1997) Transaction costs and Islam: Explaining conversion in Africa. *Journal of Institutional and Theoretical Economics* 153: 4–28.

Fehr E, Fischbacher U (2003) The nature of human altruism. *Nature* 425: 785–791. 1050

The Evolution of Religion

- Festinger L, Riecken H, Schachter S (1956) When Prophecy Fails. Minneapolis, MN: University of Minnesota Press.
- Firth R (1963) Offering and sacrifice. *Journal of the Royal Anthropological Institute* 93: 12–24. 1055
- Fishman A, Goldschmidt Y (1990) The orthodox kibbutzim and economic success. *Journal for the Scientific Study of Religion* 29: 505–511.
- Freston P (2001) *Evangelicals and Politics in Asia, Africa and Latin America*. New York: Cambridge University Press.
- 1060 Gazzaniga MS, Ivry RB, Mangun GR (2009) *Cognitive Neuroscience*, 3rd ed. New York: Norton.
- Ginges J, Atran S, Medin DL, Shikaki K (2007) Sacred bounds on rational resolution of violent political conflict. *Proceedings of the National Academy of Sciences of the USA* 104: 7357–7360.
- 1065 Ginges J, Hansen I, Norenzayan A (2009) Religious and popular support for suicide attacks. *Psychological Science* 20: 224–230.
- Gintis H, Smith EA, Bowles S (2001) Costly signaling and cooperation. *Journal of Theoretical Biology* 213: 103–119.
- Greeley A (1975) *The Sociology of the Paranormal*. Beverly Hills, CA: Sage.
- 1070 Guthrie S (1993) *Faces in the Clouds*. New York: Oxford University Press.
- Harper L, Sanders KM (1975) The effect of adults' eating on young children's acceptance of unfamiliar foods. *Journal of Experimental Child Psychology* 20: 206–214.
- Harris P, Pasquini ES, Duke S, Asscher JJ, Pons F (2006) Germs and angels: The role of testimony in young children's ontology. *Developmental Science* 9: 76–96. 1075
- Heider F, Simmel S (1944) An experimental study of apparent behavior. *American Journal of Psychology* 57: 243–259.
- Henrich J (2004) Cultural group selection, coevolutionary processes and large-scale cooperation. *Journal of Economic Behavior and Organization* 53: 3–35. 1080
- Henrich J (2008) A cultural species. In: *Explaining Culture Scientifically* (Brown M, ed), 184–210. Seattle, WA: University of Washington Press.
- Henrich J (2009) The evolution of costly displays, cooperation, and religion: Credibility enhancing displays and their implications for cultural evolution. *Evolution and Human Behavior* 30: 244–260. 1085
- Henrich J, Boyd R (2001) Why people punish defectors: Weak conformist transmission can stabilize costly enforcement of norms in cooperative dilemmas. *Journal of Theoretical Biology* 208: 79–89.
- 1090 Henrich J, Boyd R, Bowles S, Camerer C, Fehr E, Gintis H, McElreath R, Alvard M, Barr A, Ensminger J, Hill K, Gil-White F, Gurven M, Marlowe F, Patton JQ, Smith N, Tracer D (2005) "Economic man" in cross-cultural perspective: Behavioral experiments in 15 small-scale societies. *Behavioral and Brain Sciences* 28: 795–815.
- 1095 Henrich J, Ensminger J, McElreath R, Barr A, Barrett C, Bolyanatz A, Cardenas JC, Gurven M, Gwako E, Henrich N, Lesorogol C, Marlowe F, Tracer F, Ziker J (2010) Markets, religion, community size, and the evolution of fairness and punishment. *Science* 327: 1480–1484.
- 1100 Henrich J, Gil-White F (2001) The evolution of prestige. *Evolution and Human Behavior* 22: 165–196.
- Henrich NS, Henrich J (2007) *Why Humans Cooperate: A Cultural and Evolutionary Explanation*. Oxford: Oxford University Press.
- Henrich J, McElreath R (2003) The evolution of cultural evolution. *Evolutionary Anthropology* 12: 123–135. 1105
- Horner V, Whiten A (2005) Causal knowledge and imitation/emulation switching in chimpanzees and children. *Animal Cognition* 8: 164–181.
- Hruschka D, Henrich J (2006) Friendship, cliquishness, and the emergence of cooperation. *Journal of Theoretical Biology* 239: 1–15.
- Irons W (1996) In our own self-image. *Skeptic* 4(2): 50–52.
- 1110 Johnson G (1987) In the name of the fatherland: An analysis of kin term usage in patriotic speech and literature. *International Political Science Review* 8: 165–174.
- Johnson D (2005) God's punishment and public goods. *Human Nature* 16: 410–446.
- Kapogiannis D, Barbey AK, Su M, Zamboni G, Krueger F, Grafman J (2009) 1115 Cognitive and neural foundations of religious belief. *Proceedings of the National Academy of Sciences of the USA* 106: 4876–4881.
- Keil F (1979) *Semantic and Conceptual Development*. Cambridge, MA: Harvard University Press.
- Keleman D (2004) Are children "intuitive theists"? Reasoning about purpose 1120 and design in nature. *Psychological Science* 15: 295–301.
- Khaldūn I (2005) *The Muqaddimah: An Introduction to History*. Princeton, NJ: Princeton University Press.
- Klein RG (1989) *The Human Career: Human Biological and Cultural Origins*. Chicago, IL: University of Chicago Press. 1125
- Kluckhohn C, Leighton D (1946) *The Navajo*. Cambridge, MA: Harvard University Press.
- Lee R (1979) *The !Kung San: Men, Women and Work in a Foraging Society*. New York: Cambridge University Press.
- Levy R (1957) *The Social Structure of Islam*. Cambridge, UK: Cambridge 1130 University Press.
- Liebenberg L (1990) *The Art of Tracking*. Cape Town, South Africa: David Philip Publishers.
- Lyons DE, Young AG, Keil FC (2007) The hidden structure of overimitation. *Proceedings of the National Academy of Sciences of the USA* 104: 19751– 1135 19756.
- Malley B (2004) *How the Bible Works: An Anthropological Study of Evangelical Biblicalism*. Walnut Creek, CA: AltaMira Press.
- Marcus J, Flannery KV (2004) The coevolution of ritual and society: New C-14 dates from ancient Mexico. *Proceedings of the National Academy of Sciences of the USA* 101: 18257–18261. 1140
- Marks L (2004) Sacred practices in highly religious families. *Family Process* 43: 217–231.
- Mathew S, Boyd R (2009) When does optional participation allow the evolution of cooperation? *Proceedings of the Royal Society B* 276: 1167–1174. 1145
- Mazar N, Ariely D (2006) Dishonesty in everyday life and its policy implications. *Journal of Public Policy and Marketing* 25: 117–126.
- McElreath R, Boyd R, Richerson PJ (2003) Shared norms and the evolution of ethnic markers. *Current Anthropology* 44: 122–129.
- McNeil WH (1982) *Pursuit of Power*. Chicago, IL: University of Chicago 1150 Press.
- McNeil WH (1991) *The Rise of the West*. Chicago, IL: University of Chicago Press.
- Norenzayan A, Atran S, Faulkner J, Schaller M (2006) Memory and mystery: The cultural selection of minimally counterintuitive narratives. *Cognitive 1155 Science* 30: 531–553.
- Norenzayan A, Hansen IG (2006) Belief in supernatural agents in the face of death. *Personality and Social Psychology Bulletin* 32: 174–187.
- Norenzayan A, Shariff AF (2008) The origin and evolution of religious prosociality. *Science* 322: 58–62. 1160
- Norris P, Inglehart R (2004) *Sacred and Secular*. New York: Cambridge University Press.
- Nowak MA, Sigmund K (2005) Indirect reciprocity. *Nature* 437: 1291–1298.
- Panchanathan K, Boyd R (2003) A tale of two defectors: The importance of 1165 standing for the evolution of indirect reciprocity. *Journal of Theoretical Biology* 224: 115–126.
- Panchanathan K, Boyd R (2004) Indirect reciprocity can stabilize cooperation without the second-order free rider problem. *Nature* 432: 499–502.
- Phillips A (1970) *Ancient Israel's Criminal Law: A New Approach to the 1170 Decalogue*. New York: Schocken.
- Pyysiäinen I (2003) Buddhism, religion, and the concept of "God." *Numen—International Review for the History of Religions* 50: 147–171.

- Rakoczy H, Wameken F, Tomasello M (2008) The sources of normativity: Young children's awareness of the normative structure of games. *Developmental Psychology* 44: 875–881.
- Rappaport RA (1999) *Ritual and Religion in the Making of Humanity*. Cambridge, UK: Cambridge University Press.
- Richerson P, Boyd R (2005) *Not by Genes Alone*. Chicago, IL: University of Chicago Press.
- Roes FL (1995) The size of societies, stratification, and belief in high gods supportive of human morality. *Politics and the Life Sciences* 14: 73–77.
- Roes FL, Raymond M (2003) Belief in moralizing gods. *Evolution and Human Behavior* 24: 126–135.
- Ruffle BJ, Sosis R (2006) Cooperation and the in-group out-group bias: A field test on Israeli kibbutz members and city residents. *Journal of Economic Behavior and Organization* 60: 147–163.
- Shariff AF, Norenzayan A (2007) God is watching you. *Psychological Science* 18: 803–809.
- Smith C (1996) *Disruptive Religion*. New York: Routledge.
- Sosis R, Alcorta C (2003) Signaling, solidarity, and the sacred: The evolution of religious behavior. *Evolutionary Anthropology* 12: 264–274.
- Sosis R, Bressler ER (2003) Cooperation and commune longevity: A test of the costly signaling theory of religion. *Cross-Cultural Research* 37: 211–239.
- Sosis R, Kress H, Boster J (2007) Scars for war. *Evolution and Human Behavior* 28: 234–247.
- Sosis R, Ruffle BJ (2003) Religious ritual and cooperation: Testing for a relationship on Israeli religious and secular kibbutzim. *Current Anthropology* 44: 713–722.
- Sperber D (1996) *Explaining Culture: A Naturalistic Approach*. Oxford: Blackwell.
- Sperber D, Premack D, Premack A, eds (1995) *Causal Cognition*. New York: Oxford University Press.
- Stark R (1997) *The Rise of Christianity*. New York: Harper Collins.
- Sweeney M (2001) *King Josiah of Judah*. New York: Oxford University Press.
- Tetlock P (2003) Thinking the unthinkable: Sacred values and taboo cognitions. *Trends in Cognitive Science* 7: 320–324.
- Trainor L, Trehub S (1992) The development of referential meaning in music. *Music Perception* 9: 455–470.
- Whitehouse H (2004) *Modes of Religiosity: A Cognitive Theory of Religious Transmission*. Walnut Creek, CA: AltaMira Press.
- Whitson JA, Galinsky AD (2008) Lacking control increases illusory pattern perception. *Science* 322: 115–117.
- Whyte WF (1993) *Street Corner Society: The Social Structure of an Italian Slum*. Chicago, IL: University of Chicago Press.
- Wilson DS (2002) *Darwin's Cathedral: Evolution, Religion, and the Nature of Society*. Chicago, IL: University of Chicago Press.
- Wiltermuth SS, Heath C (2009) Synchrony and cooperation. *Psychological Science* 20: 1–5.

Queries

- AQ1: Author: Please provide details for text citation “Gervais and Henrich forthcoming.”
- AQ2: Author: Please provide details for “Gervais and Henrich forthcoming.”
- AQ3: Author: Please confirm the deletion of “(4)”.
- AQ4: Author: Please provide details for text citations “Henrich and Boyd 2002” and “Henrich et al. 2008.”
- AQ5: Author: Reference “Atran S, Medin DL (2008)” has not been cited in the text; please check.
- AQ6: Author: Reference “Sosis R, Ruffle BJ (2003)” has not been cited in the text; please check.