Maturationally Natural Cognition

Impedes Professional Science and Facilitates Popular Religion

by

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Introduction

Both defenders and opponents have portrayed religion in a slow but inexorable intellectual retreat as science has relentlessly gained epistemic authority and cultural prestige. Since the Europeans' rediscovery of ancient science in the Middle Ages, many have attempted to forestall that retreat by squaring religious beliefs and doctrines with the theories and findings of the sciences. During this secular age, religion faces not only intellectual but social reversals too (Talmont-Kaminski 2013). In northern Europe the state provides citizens with many of life's basic requirements (education, health care, mass-transportation, etc.), and the churches are empty.

For a variety of reasons, however, obituaries for religion in the Western world are premature and probably ill-advised, as are hymns to the inescapable ascendancy and triumph of science. The reasons I explore are primarily *cognitive.* From the standpoint of their cognitive foundations, we have good reasons to expect religious ideas and beliefs will reliably erupt and persist in human populations and possess an appeal that science's elaborate procedures and

esoteric theories will never match. Humans' cognitive predilections largely obstruct scientific thought and interfere with scientific reasoning and understanding.

I devote the first section to distinguishing maturationally natural cognition from another version of fast cognitive processing and from slower, reflective cognitive processing that plays a prominent role in conscious mental life. The second section examines how maturationally natural cognition mostly impedes humans' attempts to learn and do science. Scientific representations are radically discontinuous with our maturationally natural conceptions of the world and require types of cognitive processing that are foreign to maturationally natural patterns of thought. In the third section, I show how, by contrast, religions engage humans' maturationally natural cognitive susceptibilities. Religious representations cue various maturationally natural cognitive processes and their concomitant default inferences. This makes religious ideas and practices appealing and insures that their easy acquisition. Finally, I examine some consequences of this comparison. I suggest that threats to the persistence of religion that science allegedly poses are exaggerated and that it is the continued flourishing of science that will likely prove the more difficult to sustain.

Maturationally Natural Cognition

Dual processing theories of cognition have prevailed in cognitive science for more than thirty years (Schneider and Shiffrin 1977; Shiffrin and Schneider 1977). Occasional dissenters (e.g., Keren and Schul 2009) have noted the vagueness of proposed criteria for distinguishing cognitive *systems*, mixed and inconclusive evidence for their support, and the availability of

alternative conceptions that might accommodate those findings, however, most researchers continue to favour dual process views (Evans and Frankish 2009; Kahneman 2012).

Dual process theories contrast two forms of human mental life, exhibiting constellations of contrasting properties. Slow reflective thinking is conscious, deliberate, explicit, conjectural, and easier to formulate linguistically. Mentally talking to ourselves involves this slow reflective processing. Proponents maintain that slow reflection is usefully distinguished from the tremendous amount of intuitive cognition that occurs, which is fast, (mostly) unconscious, automatic, implicit, presumptive, and comparatively difficult to formulate linguistically. With this intuitive mode of thinking we seem to know things instantly, and it is in this light that I have referred to such thought as 'cognitively natural' (McCauley 2000). A few relevant cues are sufficient to ignite such processing. Much of it is *so* natural that we are unaware how or why we know these things. For example, we routinely leap to conclusions about individuals' emotional states on the basis of their facial expressions, tones of voice, or bodily comportment, and we do so with little, if any, explicit awareness of what informed our inferential leaps. This is carried out *on-line* in the basements of human minds. Whether it concerns recognition of emotions, comprehension of utterances, or attribution of mental states to others, on-line intuitive cognition addresses problems of perception, cognition, and action immediately and unquestioningly.

Slow, conscious reflection is pursued upstairs. Slow reflection does not concern automatic mental operations, and to the extent that it is considered and laborious, it takes place *off-line.* Because of this and because thinking this way often builds on explicit instruction, I refer to this as 'unnatural' cognition (McCauley 2000). Slow reflection is thoroughly *cultural* in

its forms. It is what occupies lawyers when they prepare briefs: they formulate arguments carefully and consciously and explicitly ponder how claims are best put to insure proper understanding and appropriate rhetoric.

The remainder of this section concentrates on fast intuition, because this kind of human cognition itself needs subdividing. Fast intuition, whether it concerns perception, cognition, or action, comes in two forms.

Practiced Naturalness

A familiar English idiom describes capacities as becoming 'second nature'. Some perception, thought, and action become second nature to us after extensive experience in some domain, often supplemented by considerable teaching. Following a great deal of practice in some area, our perception, cognition, and action progressively shift from being conscious, laboured, and deliberate to unconscious, easy, and automatic. (Unnatural cognition can become natural cognition – second nature -- with practice (McCauley, forthcoming).) Depending upon the complexity of the domains, this transition might take years, as in acquiring a skill. Whether recognizing a tartan, calculating logarithms, or swinging a golf club, tasks that were once challenging begin to feel natural by virtue of frequent and extended exposure. We develop *expertise* in those domains.

Experts have ready intuitions about what they master. Expertise need not involve the esoteric. Sometimes, experts are rare (e.g., high energy physics), but expertise can be quite widespread (e.g., dealing with a city's subway system). Perception, thought, and action[1] that have become second nature enjoy what might be called a 'practiced naturalness' (McCauley 2011). Human beings attain practiced naturalness in different domains, and what they obtain is

a function of their culture and time period. Learning how to ride a bicycle is widespread in cultures where bicycles are available, but no one possessed this skill in the ancient world.

Maturational Naturalness

Talk of 'second nature' implicitly presumes forms of cognition that are *first nature*, i.e., forms that are comparably unconscious, easy, and automatic, but which require little experience and no tutelage. Prominent discussions of such systems have underscored their innateness, their modularity, or both (Fodor 1983). Since both features are controversial (e.g., Barrett and Kurzban 2006) and since neither is necessary for characterizing such maturationally natural systems, I focus on other facets of these systems, remaining agnostic about their putative innateness and modular status (whatever each of those attributions mean).

The temptation to stress innateness arises, in part, from the fundamentality of the problems for human survival such systems address. Whether it is perceptual recognition of objects in the environment, cognitive discrimination of syntactic distinctions, or action responses to environmental contaminants, maturationally natural cognition addresses basic problems human beings must handle to get by in the world. Many maturationally natural systems (concerning perception and locomotion, for example) seem intimately connected to the evolution not only of our species but of others as well. No one *invented* maturationally natural capacities -- unlike the technologies with which humans can achieve practiced naturalness.

Most maturationally natural capacities appear early and are active by the time humans reach school age. This is why 'school age' is fairly uniform across cultures. By six years of age, humans can typically recognise agents, hypothesize plausibly about their mental states, control

their own locomotion, produce and comprehend everyday language, etc. Maturationally natural capacities are also functioning before we realise they are. Humans do not recall learning to walk or talk or read minds, as opposed to learning to ride a bicycle or to read and write. The emergence of maturationally natural capacities constitutes what we take to be normal development.

Their emergence also does not hang on any culturally distinctive support. Unquestionably, culture infiltrates and tunes maturationally natural systems. The same infants in a Mandarin speaking community who learn to speak Mandarin are no less able to learn to speak Catalan, if they had been raised among Catalan speakers. The development of such capacities does not depend upon direct teaching or explicit instruction. Nor does it turn on artifacts or the careful preparation of learning environments. No one needs to teach a normal child the language in which it is immersed. It will learn that language *on its own*.

Not only does establishing maturationally natural capacities not rely on culturally distinctive inputs, it may, in some cases, not rely on any distinctively cultural inputs. What appears to be a spontaneous emergence of a collective sign language among students at a Nicaraguan school for the deaf suggests that such capacities may emerge from basic features of human social interaction (Senghas et al. 2004; Coppola and Newport 2005).

Endless debates have swirled around maturationally natural capacities' origins. The relative specificity of the learning principles informing their development remains controversial. Few, however, dispute the fact that such cognitive systems constitute domain-specific capacities by the time they are operating. What school age children think about biological kinds and their inferences about them apply to that domain only. The underlying principles cannot be

generalized to language any more than the principles of a language can be applied to biological kinds.

Most of the time, the operations of maturationally natural systems are automatic and fast. That comports with the claim that these systems concern fundamental matters concerning survival. In some situations it is imprudent to insist on the highest standards of evidence. If preliminary indications suggest that a dangerous predator is nearby, fleeing, rather than striving for corroboration, is generally the better course. Consequently, satisfying a few diagnostic cues, their occasional fallibility notwithstanding, is enough to trigger our maturationally natural dispositions. These systems leap to conclusions woefully underdetermined by the available evidence. Participants cannot help interpreting some kinds of movements of dots on a screen as motions of animate agents, pursuing or fleeing from one another (Michotte 1963). This penchant for acting on relevant but slight evidence renders us susceptible to illusions, when some stimulus mimics cues sufficient to activate one of our maturationally natural systems. Humans' daily experiences with movie screens and televisions are obvious illustrations. Typically, we cannot help ourselves from reacting according to these systems' dictates.

As noted, focusing on maturationally natural systems escapes the burden of proof for modularity and innateness. Evolutionary psychologists have argued that humans possess dozens of innate, modularized capacities (Buss 2005). If any cognitive systems are innate or modular in the senses that Fodor or the evolutionary psychologists have advanced, they would qualify as maturationally natural systems. For more than fifty years language has been the leading candidate, although promising accounts eschew strong modular claims in its behalf (e.g., Christiansen and Chater 1999). Other putative cognitive modules that would qualify as

maturationally natural systems include the basic physics of solid objects (Spelke et al. 1992), contamination avoidance (Rozin et al. 1995), face recognition (Duchaine and Nakayama 2006), and theory of mind (Baron-Cohen 1995).

The Place of Maturationally Natural Cognition in Science

Maturationally natural cognition obstructs and intrudes upon scientific thought and, thereby, impedes scientific progress. By contrast, it undergirds popular religious thought and facilitates religion.

Radically Counterintuitive Scientific Representations

The sciences advance, usually sooner rather than later, representations that are *radically* unlike the deliverances of our maturationally natural cognitive systems. The sciences reliably traffic in radically counterintuitive representations that imply that the world is not as our maturationally natural systems suggest. The world, in short, is not as it appears. Radically counterintuitive representations improve upon our maturationally natural conceptions of things and show why they work when they do.

The theories and concepts of the sciences reorder and recategorise things by presenting new, unobvious regularities based, in psychology and social science no less than in physical science, on mechanisms and forces that are not perceptually manifest (McCauley 1986). The sciences offer more penetrating explanations than our maturationally natural folk physics, folk biology, and folk psychology. Scientific theories do not just make sense of the familiar world; they also have implications for how things work in unfamiliar environments. This gives scientific claims theoretical depth. They must be extended to circumstances either inexplicable before,

inaccessible before, or, often, unknown before. Scientists devise technologies to access those

exotic environments. The experimental investigation of the theories' implications in unexplored

settings constitutes a major means for testing them against the world and extending

knowledge.

Such endeavors inevitably result in representations that diverge drastically from our

commonsense conceptions of the world. Consider one of the first ground-breaking discoveries

of modern science, viz. that the earth moves. We are all Copernicans. Yet we retain the

language of pre-Copernican conceptions, almost no one ever looks at the sky within a

Copernican framework, and when we do, it can be startlingly disconcerting (Churchland 1979

and 2012).

General science education and some familiarity with basic practices of modern medicine

make it more difficult to imagine how radically counterintuitive the germ theory of disease

once was. That theory's counterintuitiveness earlier in history explains why it took more than

150 years from inventing microscopy and the discovery of micro-organisms for scientists to

consider the possibility that some might play an important role in infectious diseases. To people

of that time, such microscopic creatures did not seem remotely equal to the effects such

diseases produce in macroscopic organisms. More recently, new sciences of the human

mind/brain have unearthed phenomena that overturn some of our most basic folk

psychological assumptions. These include a variety of what seem conceptually impossible

pathologies, such as blindness denial (Churchland 1983).

Probably the single most influential feature of science contributing to religion's

inexorable intellectual retreat is how modern scientific progress has marked an advancing

restriction on domains in which appeals to agent causality are any longer deemed legitimate. In nonscientific cultures, everything can be agents capable of acting, including heavenly bodies, the seas, the wind, mountains, and more. Maturing physical sciences have discredited and supplanted agentive explanations of wondrous celestial events such as comets and supernovae and wondrous geological events such as earthquakes, volcanoes, and tsunamis. The combination of Darwin's theory of evolution and the subsequent rise of cellular and molecular biology eliminated any need for appeals to agent causality in the biological realm. Vitalism, the notion that vital spirits were responsible for life, was moribund in biological science by the early twentieth century. Over the last fifty years, the cognitive and brain sciences have begun to weaken the grip of appeals to conscious mental operations even *within ourselves* as satisfactory explanations of much human conduct.

Difficulties Associated with Cognitive Processing in Science

Most, though not all, of the cognitive processes on which the sciences depend are as unnatural as their radically counterintuitive representations. Humans have no problem cooking up hypotheses and when facing upended expectations, toddlers and preschool children seek evidence in exploratory play and carry out explanatory reasoning (Legare 2012; Legare et al. 2010). But science involves more than mere sensitivity to evidence. It requires recognizing, collecting, generating, analysing, and assessing *relevant* empirical evidence for the purpose of testing and criticizing theories. *Those* processes demand forms of thought and types of practice that humans, including scientists, find difficult to learn and master.

That difficulty is a function of these intellectual tasks' cognitive unnaturalness. The necessary skills do not rely on standard cognitive equipment. An extended education in

mathematics and science gives scientists plenty of practice with these culturally invented cognitive tools, but any naturalness their use assumes is thoroughly *practiced*. Scientists have the same maturationally natural penchants of mind that other humans do, and the cognitive processes associated with the half of science concerned with criticizing theories are not abetted by any maturationally natural dispositions. Their deliverances can interfere with scientists' judgement, reasoning, and memory just as they can with anyone else's.

The cognitive science of science has uncovered many barriers to grasping scientific claims and doing good science. Maturationally natural dispositions reliably intrude in their proprietary domains. Since they operate *automatically*, neither explicit, reflective knowledge nor even long histories of practice undo their operations or influence, especially in unfamiliar settings. Most constitute obstacles to learning and doing science.

Michael McCloskey and his colleagues (Caramazza, McCloskey and Green 1981; McCloskey 1983; McCloskey, Washburn, and Felch 1983) showed that most naïve participants rely on their folk physics when making judgements about the motions of objects. Surprisingly, they also showed that roughly one quarter of participants who had successfully completed a course in basic mechanics also reverted to their pre-Galilean folk intuitions when queried about objects' motions. Maturationally natural, folk physics intruded and swamped reflectively acquired physical knowledge, leading them to ignore such basic physical principles as inertia. Recently, Deborah Kelemen and her colleagues (2012) have shown that even professional scientists are vulnerable to similar lapses in other areas, when demands on cognitive processing are extreme, for example, when handling tasks under acute time pressure. Their instantaneous maturationally natural deliverances prevail.

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A variety of research over the past forty years has shown that even well-trained participants perform poorly on experimental tasks investigating their command of the deductive and probabilistic inferences science routinely involves. Dozens of studies show that our intuitions about probabilities violate normative principles (Kahneman, Slovic, and Tversky 1982; Gilovich, Griffin, and Kahneman 2002). Participants ignore base rate information, sample sizes, and regression to the mean. They employ maturationally natural heuristics, such as representativeness, which holds that 'like goes with like' (Gilovich 1991: 136). Operating with this heuristic can lead to neglect of elementary rules of probabilistic inference, when judgements of similarity are based on considerations that do not track objective probabilities. Tversky and Kahneman (2002: 20, emphasis added) hold that this and other such heuristics inform our '*natural* assessments' of probabilities.

Although these heuristics apply across domains, they satisfy the features outlined earlier for maturationally natural systems. They operate unconsciously, automatically, and intuitively. Their verdicts occur instantly. For most everyday problems, they do well enough, however, they are biased and, as those many studies demonstrate, fallible. Their decrees are inadequate in the exotic environments scientists seek or create in their experiments. Consequently, they are utterly inadequate for scientific purposes. The research shows that laypersons are not the only people susceptible to those heuristics' operations. Tversky and Kahneman (2002: 20) found 'no effect of statistical sophistication' in how participants performed in assessing probabilities of conjunctions and their conjuncts. More than eighty per cent of their 'highly sophisticated respondents' followed dictates of the representativeness heuristic rather than normative probability theory. In other studies, monetary rewards for

correct answers failed to improve performance (Camerer and Hogarth 1999). This illustrates Tversky and Kahneman's claim that even once apprised of the correct answer and the reasoning for it, the incorrect answer the heuristic promotes still *feels right*.

The history of research on conditional deductive inference is longer and no more encouraging. Peter Wason (1966) provided striking evidence that seventy to eighty per cent of participants were either susceptible to one or both fallacies connected with the simplest form of hypothetical inference, or impervious to the validity of *modus tollens* inferences, or manifested all three of these problems. The Wason four card selection task one of the most frequently examined designs in modern experimental psychology for the next two decades, as researchers searched for features of the task responsible for producing such consistently dismal findings. Leda Cosmides discovered that formulating the Wason selection task in terms of social contracts unfailingly boosted participants' performance (Cosmides and Tooby 2005).[2] Crucially, though, hypothetical reasoning in science rarely concerns social contracts. The findings about the Wason selection task suggest that conditional inference about the implications of scientific theories is a skill most humans cannot typically execute correctly, yet it is a key capacity in the recognition, generation, analysis, and assessment of empirical evidence.

Scientists are perfectly normal human beings cognitively. That is also true about their *social* psychology. Scientists have the same susceptibilities to self-interest and motivated perception as others. In science this can result in a confirmation bias for preferred theories and viewpoints. Coalitional loyalties and outright fraud can mar scientific proceedings (Gratzer 2000).

One of the consequences of humans' penchant for such fallacies and frailties is that scientific rationality is best understood as the outcome of the operations of scientific *communities*, rather than of individual scientists. Science compensates for the cognitive and character weaknesses of individual scientists through institutional arrangements aimed at insuring that everyone's work is checked by, if not everyone else, then at least parties with competing views. Scientific institutions (journals, university departments, professional societies, etc.) insist on the public availability of scientific work, including apparatus, designs, and findings. The scientific community seeks the replication of experimental results and demands it, if they are credibly disputed. These measures are designed to increase the probabilities that the collective outcome of scientific activity in the long run improves upon individuals' efforts in the short run.

The Place of Maturationally Natural Cognition in Religion

The goal of the previous section was to convey how our maturationally natural predilections of mind impede science. By contrast, the objective of this section is to highlight how many of those same capacities abet religion. My second parallel thesis is that popular religion largely *depends* on *ordinary* variations in the operations of various, domain specific, maturationally natural, cognitive mechanisms.

Although some individuals are not religious, religion arises in *every* human culture. Unlike professional science, which is comparatively rare in human history, religion is culturally universal. Religious ideas and practices invariably erupt in human populations, across a wide

array of physical and cultural settings. Maturationally natural dispositions of mind spur

recurring patterns in the stories, beliefs, practices, and artifacts of popular religion.

A sidebar: this contrasts not only with the radically counterintuitive representations and

cultivated cognitive processing science involves. It also diverges from the often substantially

counterintuitive representations and sophisticated forms of inference that extended

theological reflection involves. Theological reflection is more like the intellectual work of

professional science than the cognition that informs popular religion. Theology, like science but

unlike popular religion, is not ubiquitous in human societies. Both theology and science turn on

the invention of literacy and the development of centres of learning devoted to concentrated

reflection on ideas that sharply diverge from humans' maturationally natural deliverances.

Assertions about how one god can be three persons are no less counterintuitive than claims

about multiple personality disorder. In literate religions in large-scale societies, theologians and

religious leaders formulate, teach, and police radically counterintuitive doctrines that

participants learn and affirm. Still, such training probably has no more influence in *on-line*

cognition and inference about religious matters than McCloskey's research suggests scientific

training has on people's inferences about basic mechanics.[3] Theological and scientific

educations both aspire to substantive commitments and reflective habits of mind that attain a

practiced naturalness capable of operating beside and independently of humans'

maturationally natural presumptions. Still, whether proposals are theological or scientific,

maturationally natural systems' intrusions are probably impossible to expunge. End of sidebar.

Compared with science and theology, popular religion relies on assumptions that are

more common, materials that are more familiar, and judgements and inferences that are more

intuitive. The ideas and patterns of thought popular religion engages are naturally appealing to human minds. The items of popular religion inherit their forms by engaging various maturationally natural penchants of mind that are in place as the consequence of considerations that have nothing to do either with one another or with religion.

Modestly Counterintuitive Religious Representations

The most conspicuous cognitive products of popular religion encompass only *modestly* counterintuitive representations of special sorts of agents, *at most*. Those representations arise on the basis of *normal* variations in the operations of garden variety, domain specific, maturationally natural cognitive equipment. I canvass the character of the *products* of religious cognition by taking up the preceding sentences' three italicized comments.

Why do the products of popular religion count as only *modestly* counterintuitive representations? Because, as Pascal Boyer (2000 and 2001) has argued, they contain limited violations of maturationally natural intuitions in just a few familiar domains. Boyer holds that popular religious representations are constrained on two fronts. First, they concern humans' intuitions in but three maturationally natural ontological domains: intuitive physics, intuitive biology, and intuitive psychology. Both developmental (e.g., Karmiloff-Smith 1992) and cross-cultural evidence (such as Atran et al. 2002; Callaghan et al. 2005) substantiate the recurrence of these domain specific systems in human minds. Second, Boyer underscores that violations come in only two varieties: transfers and breaches.

Transfers involve the application of properties and principles from one of these three ontological domains to items that are not usually counted as eligible instances of that domain. Talk about living mountains transfers the properties of an organism to a physical entity that is

not an organism. Representations of snakes that talk transfer the sophisticated psychological

capacities underlying language use in conversation to organisms incapable of such exchanges.

Breaches arise when a representation violates some default assumption connected with

intuitive physics, intuitive biology, or intuitive psychology. Representations of persons who can

walk through walls contravene the principle of intuitive physics that holds that two physical

things cannot occupy the same space at the same time. Conceptions of humans born from

mollusks violate the principle of species essentialism in folk biology, which entails that

organisms descend from organisms of the same kind. Representations of gods who can read

our every thought violate the folk psychological assumption that our thoughts are our own.

Boyer argues that religious representations are quite modestly counterintuitive --

indeed, typically *minimally* counterintuitive in that customarily these representations

encompass no more than one transfer or one breach. The snake who talks to Adam and Eve is

loquacious (with the requisite psychological sophistication) but reptilian in all other respects.

Jesus transforms water into wine, but he and the other wedding guests drink it normally; if they

drink enough, it might have intoxicating effects; if they spill it, it might stain their clothes,

because it is otherwise just like wines produced the standard way.

Religions' modestly counterintuitive representations possess significant advantages in

the marketplace of ideas. Because they violate maturationally natural expectations about the

world, they grab our attention. Experimental evidence (Barrett and Nyhof 2001), including

cross-cultural research (Boyer and Ramble 2001), suggests that minimally counterintuitive

representations, in particular, are also more memorable, at a variety of retention intervals, than

are representations of everyday items (a plaid couch), representations of curious items that do

not violate maturationally natural ontological assumptions (a chocolate couch), and representations of items that violate multiple ontological assumptions (a couch that only remembers things that did not happen).[4] Minimally counterintuitive representations' mnemonic advantage over less modestly counterintuitive representations indicates that grabbing attention and memorability involve a tradeoff. Representations with more violations may grab attention better, but are less likely to be recalled. Furthermore, a majority of Barrett and Nyhof's (2001) experimental participants exhibited a tendency at a three month retention interval to recall odd items (a bright pink newspaper blowing in the wind) *as* minimally counterintuitive items (a bright pink newspaper that runs).

Minimally counterintuitive representations constitute an attractor in the space of possible cognitive representations. They approximate a cognitive sweet spot. They attract attention, and the items they represent are easier to remember under most circumstances than other sorts of things. Crucially, though, the advantages of quite modestly counterintuitive representations also enlist a bevy of default inferences, which provide a considerable body of information about the items in question *cost-free*.

This is why I claimed that popular religion wields modestly counterintuitive representations *at most.* Plentiful violations of maturationally natural assumptions quickly cross-up which inferences hold; however, modestly counterintuitive representations that involve one or two violations at most (e.g., a burning bush that is not consumed by the fire and that talks) are mostly *not* counterintuitive. Knowing that something is an intentional agent, even if it can read minds, allows inferences that it has goals, desires, preferences, and beliefs,

that it finds some attitudes and behaviours offensive, and that it is disinclined to help anyone who displays them.

Although transfers in religious narratives usually implicate only one property explicitly (recall that garrulous serpent), they presume the importation of *all of the default inferences* associated with the domain of the transferred item. Any talking snake also schemes, tempts, acts, and enjoys the status of an intentional agent with mental representations. Breaches work differently. They are specific, violating but a single default assumption. Religious representations that rely on a breach preserve all of that domain's default assumptions, save the one that is breached. The Jesus who violates our physical intuitions by walking on water still weighs more than twenty pounds, uses energy to walk, and reflects light.

Why are the variations in the operation of this everyday cognitive equipment *normal*? They count as normal because they arise in many other contexts. The modestly counterintuitive representations in which religions traffic appear in everything from folk tales, fantasy, and fiction to commercials, comic books, and cartoons. Possessing maturationally natural capacities, especially theory of mind, outfits people to acquire religion in a way that is not true about science.

Maturationally Natural Cognitive Processing Facilitates Religion

Religions' most noticeable cognitive representations are those of *agents* manifesting counterintuitive properties. Such representations' abilities to cue theory of mind and, more generally, humans' intuitive psychology occasion religious people's inferences about all sorts of religious matters. I will return to these in the second half of this subsection. Humans' intuitive physics, biology, and psychology, however, do not exhaust the maturationally natural capacities

that religions cash in on. Religions can instigate cognitive processing by engaging other maturationally natural propensities. Two brief examples must suffice.

First, religions frequently elicit group loyalty by profiting from humans' inclination to aid kin. Reflection on kin selection and inclusive fitness, in particular, preceded and inspired evolutionary psychologists' theories and research over the past two decades. W. D. Hamilton's formal modelling of organisms' genetic interests pointed to the genetic advantages, under a variety of circumstances, of favouring kin, sometimes even distant kin and at a considerable cost to oneself (Hamilton 1963, 1964, 1970). Evolutionary psychologists have hypothesized that human psychology is sensitive, though not necessarily consciously sensitive, to relevant information about kin, and have carried out empirical studies that support that hypothesis (Kurland and Gaulin 2005). Automatic, unconscious sensitivities and biases in the treatment of conspecifics bear the earmarks of maturationally natural aptitudes.

Many religions cue fictive kin. People often address one another with familial titles. Priests are 'fathers'. Nuns are 'sisters'. Freud (1961) headlined what is, perhaps, the most obvious illustration -- father gods. A religion's followers are the father-god's children. As siblings, e.g., 'brothers and sisters in Christ', they become candidates for aid and support. Religions are not the only human arrangements that take advantage of this proclivity. People often use the titles and modes of address associated with kinship to reinforce affiliations with allies and friends.

Second, various cognitive scientists of religion (Hinde 1999; Boyer 2001) have argued that the standard view of the connection between religion and morality has things backwards. They maintain that people are inclined to moral conduct not because the gods command it, but,

instead, the gods characteristically command such conduct as a means of capitalising on evolved intuitions that incline us towards such conduct. Those intuitions concern such matters as the care of the young and vulnerable, the distribution of resources, reciprocity, respect for social hierarchies, purity with regard to a host of features concerned with humans' bodies, and the treatment of in-group members (Haidt and Bjorklund 2008).

Religions activate theory of mind in myriad ways. I will briefly describe three. Even in literate cultures, religious representations and beliefs are primarily transmitted through myths and stories. Such narratives carry significant cognitive advantages in comparison to science's experimental papers and review articles! Agents' actions drive narratives. Most human minds readily understand a world of agents interacting with one another and their environments.[5] Ordinarily, agents act rationally; thus, their reasons for action can serve in a framework for explaining those actions. A series of events connected through agent causality is endowed with instant plausibility and striking mnemonic advantages, by comparison to a comparable string of events connected mechanically (Piatelli-Palmerini 1994; Gregory 2009). An elementary principle of probability theory is that the probability of a series of events is the product of the various individual events' probabilities. It follows that even an extended series of probable events will itself be highly *improbable*. Yet when the threads of agents' intentions, reasons, and actions stitch events together, humans not only find the series plausible, but often regard the outcome as *inevitable*. Because maturationally natural assumptions about how agents work, which myths and stories trigger, are so basic, narratives' consumers are typically oblivious to how those assumptions' entitle the representations of the gods that populate them.

Agents can act on the material world, but their social interactions with one another

provoke the most sophisticated inferences about minds and the relations between the agents

who possess them. Myths and stories make the gods and their actions plausible. Their

plausibility, their counterintuitive properties, and their interests in human conduct render them

particularly alluring candidates for social interaction. Rituals are salient vehicles for carrying out

individual and collective transactions with these agents (Sorensen 2007). Tom Lawson and I

(1990; McCauley and Lawson 2002) have argued that religious rituals engage maturationally

natural cognitive machinery in human minds devoted to distinguishing agents from other things

in the world and actions from other events. Rituals cue their representations as actions, which

provoke spontaneous inferences about what is transpiring.

Rituals also incorporate a variety of features that have salutary cognitive effects for

perpetuating religions and their ritual systems. These features include rituals' rigid adherence

to scripts, their repetition and redundancy, their concentration on hazard precautions of

various kinds, and their focus on low level features of action (Boyer and Liénard 2006; Liénard

and Boyer 2006). These features tend to obscure two things; first, that little, if anything, of

instrumental significance has occurred and, second, that how what has occurred achieves

anything remains unexplained. Boyer and Liénard hold that demands for attention to low level

features of action in rituals leads to inattention to rituals' putative goals ('goal-demotion'), to

overloading memory, to the prevention of automaticity, and to the suppression of thought

(Nielbo and Sorensen 2011). Moment by moment on-line demands in rituals discourage the

development of either reflective distance or practiced naturalness (Boyer and Liénard 2006).

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Stewart Guthrie (1993) advances the most developed version of an anthropomorphic theory of religion in our time. Guthrie highlights our maturationally natural perceptual inclinations to detect human forms and faces based on fragmentary evidence. He too accentuates the hypersensitivity of such systems and their susceptibility to illusions. Subsequent experimental evidence (e.g., Bateson et al. 2006) corroborates Guthrie's hypothesis about the importance of humans' perceptual sensitivities to the presence of other humans. Although he notes that ' . . . what matters is not so much the physical appearance of gods as their behaviour', Guthrie stresses that anthropomorphism results from 'an unconscious perceptual strategy' (1993, pp. 193, 200). Religious icons most directly exploit this perceptual strategy.

Justin Barrett spotlights a *psychological* anthropomorphism, for which engaging theory of mind is at least as prominent as engaging the perceptual strategy that Guthrie underscores. In a study that tested participants' cognitive representations and inferences (and that included no perceptual component beyond reading texts), Barrett and Frank Keil (1996) furnished evidence that people reliably revert to their intuitive representations of agents in their on-line cognitive processing. After priming participants' consciously affirmed, explicit religious representations, Barrett and Keil had their participants read passages describing humans interacting with God. Crucially, the passages' contents were *fully consistent* with the participants' previously articulated, theologically correct pronouncements. Nevertheless, when participants tackled a free recall task immediately thereafter, they automatically transformed the passages' contents to conform to their maturationally natural intuitive assumptions about how normal agents and their minds work. In their on-line recall, participants no longer thought

about their theologically correct representations of God. Instead, they conceived of God as rather like Superman. In their on-line cognitive processing, religious participants presume that the gods are basically like us, regardless of what they say when they consciously reflect on their (theologically correct) religious representations.

This intrusion of maturationally natural assumptions in on-line religious thought is comparable to the intrusion of folk physical assumptions in on-line physical thinking in McCloskey's work. In both cases maturationally natural intuitions swamp the radically counterintuitive representations of theology and science (respectively) that participants acquired on the basis of painstaking formal education. Maturationally natural proclivities of mind subvert the enforcement of theologically correct doctrines and reinforce popular religious conceptions.

Some Consequences of Comparing the Cognitive Foundations of Science and Religion

Examining the cognitive bases of professional science and popular religion yields at least three consequences bearing on those enterprises' fates as knowledge communities. Compared to contemporary discussions of such matters, all three consequences examine less-travelled paths.

First, science poses no significant challenge to the persistence of religion. Recent attacks on religion (Dawkins 2006; Harris 2004; Hitchens 2007), based, in part, on extolling science, are unlikely to prove successful. This is not to say that no logical conflicts exist but only that people are not typically argued out of positions that they did not adopt on the basis of argument in the first place. Religion may meet with more or less popularity, as cultural and material conditions

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vary (Talmont-Kaminski 2013), but our maturationally natural penchants insure that religious ideas and representations will constantly surface in populations of human minds. Nothing that science or that any other intellectual endeavor generates will make religion go away. Neither the scientific enterprise, nor any particular scientific finding, nor antireligious polemics will undo the appeal of religious representations. Every human culture has had its ghosts and gods. Human minds generally find religious representations ideas that are good to think.

This is all contrary to the ironic confluence of opinion between many religious people and many critics of religion. Both hold that science threatens the survival of religion. In doing so, both simultaneously underestimate the appeal of religion, the ease of its acquisition, and the difficulty of learning, mastering, and producing science. They also misjudge the ingenuity of theologians. No revolutionary scientific accomplishment has surpassed theologians' abilities after a time to accommodate it.

Second, religion relies on institutional support far less than science. Impressive religious gatherings, edifices, practices, and arrangements notwithstanding, religion has much less need of institutional structures than appearances suggest. Religion, after all, has prehistoric roots and is no less prominent in hunter-gatherer societies than in large-scale societies. The contemporary prominence of religions of the book, which clearly depend upon literacy, publications, and schools, should not impede appreciating that those accoutrements are unnecessary for either the eruption or continuation of religion. Obviously, extravagant institutional trappings are not sufficient for religion either. Critics and participants note the Church of England's steady decrease in participation and religiosity, regardless of its institutional status. That religiosity and religions arise and endure when they are directly

suppressed, by governments or other religions, is further testimony to the peripheral role of institutions in religions' invention and prolongation.

Institutions, by contrast, are indispensable for the perpetuation of science. Since scientific rationality relies on scientific communities, science is inherently institutional. An extensive educational and research infrastructure bolsters professional science. Science is almost exclusively pursued under the auspices of the most imposing institutions in human history, viz., governments, militaries, universities, corporations, research institutes, foundations, and hospitals.

Institutions pursuing scientific education and research are the most conspicuous illustrations, but professional societies, scientific meetings, publication outlets, and processes for distributing scarce resources and for safeguarding scientific integrity are vital and logistically complicated. Science does not rely on unregimented scepticism. Founding the Royal Society in England and the Royal Academy in France in the 1660s was pivotal to the consolidation and continuation of early modern science. Each formulated and enforced evidential standards, supported research projects, and sponsored regular scientific meetings to demonstrate and test apparatuses and findings. Both also produced and disseminated scientific publications (Jardine 2000). Maintaining such institutions is the price of serious, ongoing scrutiny of explanatory proposals.

Third, professional science's dependence on such institutions points to the first salient reason why, contemporary appearances to the contrary notwithstanding, it is science's persistence, not that of religion, that is fragile over the long term. Sustaining scientific institutions is both costly and complex (Stephan 2012). The outlays for educating scientists are

substantial. Mere entry to most fields requires nearly two decades of schooling and apprenticeship. The costs of scientific research are unrelenting. Progress commonly hangs on developing sophisticated technologies that enable scientists to observe, simulate, or produce the exotic circumstances necessary to explore theories' implications.

Maintaining journals, professional societies, national academies, and the like are expensive too, but authenticating and safeguarding the scientific process is, in some ways, an even greater challenge. The institutions of modern science foster conditions that routinely produce knowledge that is uncongenial to the institutions -- governments, corporations, armies, etc. – which provide the money that science needs. Science's survival turns on the collective success of political, military, commercial, and philanthropic institutions from which it must, simultaneously, preserve its independence. Funders' intrusions reducing science's critical distance from such institutions are inimical to its epistemic authority.

Financing an educational system sufficient to train a steady supply of new scientists and underwriting the institutional arrangements of modern science pose formidable economic and political challenges even for the wealthiest societies. In the face of competing legitimate needs and the sheer limits on resources, let alone the pervasive temptations of political expediency, sustaining major scientific enterprises wants ample doses of both intellectual and political courage.

Science is also fragile because it traffics in difficult ideas and forms of thought. Early on the sciences abandon the deliverances of our maturationally natural cognitive capacities. Science constantly discloses principles by which the world operates that we find unintuitive, abstruse, and difficult to learn, recall, and employ. In many domains that is because our

maturationally natural perceptions and conceptions intrude. Some ideas have natural

disadvantages cognitively. If humans find religious ideas good to think, the opposite is true

about most scientific ideas. This is the price of their radical counterintuitiveness.

Religious ideas naturally inspire inferential leaps. Inferential leaps in science, by

contrast, only occur after years of formal training and the mastery of large bodies of scientific

knowledge. Most humans take years to acquire the inferential abilities, particularly in

mathematics, that most sciences demand, and the research indicates that, once learned,

whatever practiced naturalness they develop notably depends upon the familiarity of problems,

materials, and contexts.

Religion's exploitation of maturationally natural cognitive dispositions, its recurrence

across cultures, and its comparative independence of elaborate institutions suggest it is here to

stay. Professional science's position is nearly the opposite on these counts. Its cognitive

unnaturalness, its rarity in human history, and its overwhelmingly social and institutional

character all point to its fragility.[6]

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Endnotes

[1] Instead of employing the triumvirate of 'perception, cognition, and action,' I will use 'cognition' only hereafter. It will stand for all three, unless indicated otherwise either directly or in context.

[2] Controversy has raged about Cosmides and Tooby's hypothesis for explaining their findings (Buller 2005; Richardson 2007), but those findings have stood.

[3] Research in the cognitive science of religion suggests that the inculcation of doctrines may be even more vulnerable to erosion in the face of maturationally natural intrusions -- more on this anon.

[4] This thesis has inspired considerable experimental work (Gonce et al. 2006; Norenzayan et al. 2006; Tweney et al. 2006; Upal et al. 2007). See Barrett 2008 for an overview of this research.

[5] For a discussion of exceptions to this generalization, see Baron-Cohen 1995 and 2003.

[6] I wish to thank Tamara Beck and Matthew Homan for helpful comments.