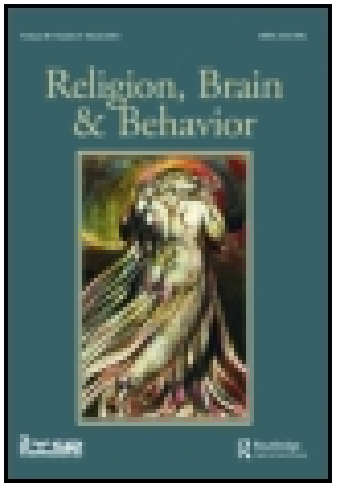

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MCI theory: a critical discussion

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In this paper, we critically review MCI theory and the evidence supporting it. MCI theory typically posits that religious concepts violate what we call *deep inferences*, intuitions stemming from our evolved cognitive architecture rather than *shallow inferences* that are specific and flexible informational units also used for inference-making. We point to serious problems facing the approach, and propose a few corrective measures, avenues for further research, and an alternative view.

Keywords: cognitive anthropology; cognitive science of religion; MCI theory; memory; religious concepts

1. Introduction

In recent years, minimal counterintuitiveness (MCI) theory has been a central theory in the cognitive science of religion. MCI theory attempts to explain the retention and transmission of religious concepts by accounting for concepts' structures and their interactions with the cognitive architecture of the human mind. Drawing from the most recent nativist turn in the cognitive sciences (Chomsky, 1980; Fodor, 1983; Samuels, 2002) and inspired by Sperber's (1996) nativism-infused epidemiological model of cultural transmission, MCI theory consists of a constellation of a few central ideas:

(1) Our evolved minds consist partly of innate inferential systems (i.e., knowledge that exists without explicit learning, conscious reasoning, or reflection), and these systems provide a wide range of inferential knowledge that we have about our world.
(2) Concepts and stories with content that minimally violate these inferences are easier to remember than ideas and narratives that are (i) entirely consistent with this inferential knowledge, or (ii) violate too many inferences (hence, "minimally counterintuitive").
(3) Ideas central to religious traditions largely consist of minimally counterintuitive concepts.
(4) The cultural ubiquity of religious concepts can be explained in part by virtue of their relatively higher retention rates.

Empirical testing of MCI theory has tended to focus on proposition (2) while accepting (1) and (3) as true, and therefore presumes that demonstrating (2) supports (4). This is probably due, in part, to (2) offering the most directly testable hypothesis. Proposition (1) can be extrapolated from a wide range of research on cognitive development focusing on

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the domain-specificity of some cognitive systems (e.g., Carey, 2009; Spelke & Kinzler, 2007; Wellman & Gelman, 1992). However, we maintain that it is not obvious how this research maps on to the specific inferences required for (2). Furthermore, point (3) has not yet been systematically demonstrated to a sufficient, ecologically valid, degree. Thus, (4) has yet to be demonstrated, and cannot be addressed through experimental manipulations of (2) alone.

The present work focuses on the different types of cognitive structures outlined by MCI theory at various points in the theory's history, and how these systems affect the viability of MCI concepts (MCIs) as a factor in the proliferation and spread of religious ideas. As pointed out by others (Barrett, 2008a; Purzycki & Sosis, 2010; Russell & Gobet, 2013), MCI theory has not been clearly and consistently formulated, and there is no consensus for what makes a concept an MCI. Therefore, critically evaluating, replicating, and comparing the empirical results of MCI theory is extremely difficult. MCI theory has failed to sufficiently *characterize* religious concepts, and its scope of inquiry is so narrow that it also fails to *explain* the persistence and ubiquity of religious concepts.

We critically review the literature in hopes of clarifying the contributions of MCI theory, problems in the theory and methods, and outstanding questions and assumptions in order to move inquiry forward. We first detail the history of the theory and related areas, and closely attend to the literature on cognitive architecture. In doing so, we point to the conceptual drift that has rendered the very notion of an MCI increasingly difficult to pin down. We conclude by suggesting that cognitive theories of religious concept transmission be grounded in local contexts by attending to the explicit cognitive models that people entertain. These suggestions point to a more ecologically minded theory of religion.

2. Cognitive architecture and the genesis of MCI theory

MCI theory emerged from the crest of the latest wave of nativism in the cognitive and evolutionary psychological sciences (Barkow, Cosmides, & Tooby, 1992; Chomsky, 1980; Fodor, 1983; Hirschfeld & Gelman, 1994; Margolis & Laurence, 2013; Pinker, 2000, 2002). Two of MCI theory's principle architects – Scott Atran and Pascal Boyer – explicitly endorsed some of the chief tenets of nativism's new form, namely, that the mind is organized – at least in part – by modular architecture that often constrains the possible forms of cultural expression. As such, MCI research reiterates a long history of studies finding that novel, bizarre, or affective statements have a memory advantage over mundane or intuitive ideas (e.g., Collyer, Jonides, & Bevan, 1972; Hirshman, 1988; Hirshman, Whelley, & Palij, 1989; Kaplan & Pascoe, 1977; Kleinsmith & Kaplan, 1963; Lang, 1995; McDaniel & Einstein, 1989; McDaniel, Einstein, DeLosh, May, & Brady, 1995; Richman, Dunn, Kahl, Sadler, & Simmons, 1990; Riefer & Rouder, 1992; Schmidt, 1994; Waddill & McDaniel, 1998; Worthen, 2006). In this section, we attend to the most recent intellectual history of MCI theory in order to detail what made it significant, its inherent problems, and how these problems have persisted. In doing so, we develop a synthetic model of the cognitive structures that were relevant to MCI theory's original formulation and how these structures have been ignored or conflated in the literature.

2.1. Deep inferences and the biological foundations of "culture"

In the most formalized and conservative version of cognitive modularity, Fodor (1983, 1998) emphasizes four key components of cognitive modules: *encapsulation*, *inaccessibility*, *domain-specificity*, and *innateness* (Fodor, 1998, pp. 127–128).[1] *Encapsulation* –

which Fodor argues is the essence of modules – refers to the idea that modules process specific information that informs and mediates perception. This information does not directly affect other modules. Rather, an interface of some sort is required to allow multi-modular expression. Additionally, we cannot consciously alter encapsulated information, nor can other systems directly interfere with the primary operations of modules. In other words, it is *inaccessible*: "Information flow between modules – and between modules and whatever unmodularized systems the mind may contain – is constrained by mental architecture" (Fodor, 1998, p. 127). As such, modular systems also operate mandatorily (Fodor, 1983, pp. 52–55). Informational encapsulation and inaccessibility are closely related criteria; while they can interface, modular functions cannot be altered by conscious manipulation or other sources of knowledge. *Domain-specificity* is "the idea that all concepts are not equal, and that the structure of knowledge is different in important ways across distinct content areas … cognitive abilities are specialized to handle specific types of information" (Hirschfeld & Gelman, 1994, p. 3). While *innate* remains a fairly slippery notion, it variously refers to inborn, untutored, or genetically endowed faculties and information whose specific functions vary depending on specific inputs (see Margolis & Laurence, 2013; cf. Samuels, 2002, 2004). Fodorian modules are typically characterized as *perceptual* modules insofar as they guide our perceptions of reality rather than the corresponding ways that we *talk* about our perceptions.

To illustrate, let us consider one model of the "mindreading system" (Baron-Cohen, 1995; see Scholl & Leslie, 2001). Given the specific inputs (e.g., perceiving self-propulsion with goal direction or eye-like stimuli), we interpret this specific domain of inputs as mental states. The outputs are corresponding mental state concepts and corresponding behavioral protocols, which may have foundations in our biology. There are two points worth noting here. First, if our minds are structured in this fashion, then there are emergent levels of cognitive processing involved in the multitude of inferences we naturally generate about the world. This "mentalizing" system is much like language insofar as it is "put together on an assembly line composed of mental modules" (Pinker, 1999, p. 22). Each module consists of rules for computing a specific domain of inputs, and readies related systems, concepts, and behavioral procedures accordingly. This particular system provides inferential procedures for agency detection and attribution.

Second, note here that *mentalizing is not the same process as thinking about various mental states* or *mental state concepts' organization*; inferring that something has the potential for internal mental states (a mind) and actively thinking (or speaking) about mental state concepts and their relations (e.g., "pondering," "thinking," "figuring," "mulling," etc.) are not the same processes. Rather, we have a stored repertoire of mental state concepts that are organized into interconnected units (i.e., a mental state schema; see section 2.3.1). These correspond to specific inputs. For example, the sight of bloodshot eyes and furrowed eyebrows will trigger the appropriate specific mental state (angry), but it is by virtue of our mentalizing system that we infer that these features stem from internal states about which we can reason. The immediate process by which we can identify a mental state is not the same as the slower and more arduous process of understanding what that mental state means, what caused it, how it relates to other states, or how it will influence behavior, given the context (Apperly & Butterfill, 2009). This is what psychologists refer to as a dual processing model: we are endowed with the ability to act fast and respond to our environment (e.g., "that man is angry"), and with processes allowing us to reflect, reason, and update our understanding of that environment (e.g., "that man is angry because I ate all of the pancakes; maybe I shouldn't do that again"). Each kind of processing provides different kinds of inferences. This is a crucial point to which we shall return.

A spate of research appealed to the use of cognitive modularity – with varying degrees of adherence to Fodor's conservative criteria – to characterize a host of human faculties: a cheater-detection module for social cognition (Atran, 2001b; Cosmides, 1989; Cosmides & Tooby, 1989; Sugiyama, Tooby, & Cosmides, 2002) and physical, psychological, biological, spatial, numerical, and musical modules (Atran & Medin, 2008; Premack & Premack, 2003, pp. 17–37). With all of these inferential systems, a considerable amount of our knowledge about the world is constrained, influenced, and made possible by our genetic endowments' interactions with the social and natural worlds that have shaped them. Many researchers hold that such mechanisms represent the biological foundations of our beliefs and behaviors and therefore explain a considerable amount of the limited variation in "culture."[2]

The cognitive development literature suggests that these modules (more commonly referred to as "domains" due to the more restrictive definitions of "module") are fairly wide-ranging categorical learning mechanisms. For example, infants can distinguish between "animate" and "inanimate" objects and apply different expectations and causal rules to them (Gelman, Durgin, & Kaufman, 1995; Gelman, Spelke, & Meck, 1983; Leslie, 1994; Spelke, Breinlinger, Macomber, & Jacobson, 1992), they can understand the basics of small numbers and amounts (McCrink & Spelke, 2010; Xu, Spelke, & Goddard, 2005), have a deep inferential system for basic physical relationships (Baillargeon, 2008), and they expect different qualities from liquids and solids (Hespos, Dora, Rips, & Christie, 2011; Hespos, Ferry, & Rips, 2009). Infants also recognize that some things have minds and some things do not (Baron-Cohen, Leslie, & Frith, 1985; Leslie, 1994; Wimmer & Perner, 1983).[3] Evolutionary psychological accounts of the human mind posit that such faculties were selected naturally as they solved socioecological problems in the distant past (Barkow et al., 1992; Barrett, Dunbar, & Lycett, 2002; Buss, 2004). These cognitive systems provide a rich database of knowledge about objects in our world. Additionally, our minds class representations of these objects in specific and predictable ways. It is the bridging of these two insights – that our minds have default intuitions about the way the world works and that our minds organize our world into hierarchically structured representations – that made MCI theory possible.

2.2. The rise of MCI theory

2.2.1. Intuitive ontology

One of the key insights from developmental psychology and cognitive anthropology is that we have *core* ontological categories that allow us to organize our world into relatively discrete classes of objects (Boster, 2005; Carey, 2009; D'Andrade, 1995; Keil, 1989; Spelke & Kinzler, 2007; Wellman & Gelman, 1992). In fact, there is considerable evidence that there are a few abstract categories into which humans organize their world. In the literature informing MCI theory, these are often listed as PERSON or HUMAN, ANIMAL, PLANT, ARTIFACT, and NATURAL OBJECT, although other or deeper categories are often listed as well.[4,5]

According to Boyer (1998, p. 878): "Identifying objects as belonging to such categories as PERSON, ANIMAL, PLANT, or ARTIFACT triggers the activation of specific forms of inference which focus on particular aspects of the objects considered and only handle information pertinent to that aspect." According to Atran (2002, p. 96), these "specific forms of inference" are "innate, modular expectations."[6] In this particular view, then, modular inferences interface with core ontological categories and their

constituent members. As Boyer (2010) later notes, when it comes to making sense of "evolved intuitive systems," the "understandings" that they provide:

> *are not necessarily 'innate'*, if this term means that they are present at birth and carry the same contents at different stages of development. That is, no-one needs to assume that infants' minds include, e.g. an animal concept that is identical to the intuitive understanding of animals in adults. All that is implied here is the capacity to form such understandings, given normal environments. It would be very surprising if cognition emerged fully-formed, when so many other evolved capacities take a long time to unfold. Humans are not born equipped with teeth or a working system of sexual drives. Throughout an organism's lifetime, many genes are tuned [*sic*] on or off during development at appropriate stages. (Boyer, 2010, p. 379, original emphasis; see also Boyer, 2001, pp. 112–120, 2003)

Here, Boyer highlights the ontogenetically ever-changing nature of the *qualitative* characteristics of how our intuitions operate. Yet, he maintains adherence to his emphasis on biologically rooted inferential systems. In other words, genes and their phenotypic expressions of ontogenetically triggered knowledge are not constant or fully formed in their initial states; rather, they interact with both the internal and external environments. But, in keeping with the basic tenets of evolutionary psychology, these "inference systems may be there because they provide solutions to problems that were recurrent in normal human environments for hundreds of thousands of years" (Boyer, 2001, p. 116).

How, then, do these inference systems inform intuitive ontological categories? Figure 1 illustrates a common inference set-to-category model.[7] Multiple perceptual cues prime a core ontological system, which in turn allows for further inferences based on ontological membership. Recall the earlier discussion of the mentalizing system, which consists of a discrete *set* of perceptual rules for a specific domain of information rather than merely a single inference. Consider an object that exhibits a specific set of motion cues that prime the "Animacy" system. This object must also trigger a specific set of rules to determine whether the object is either an ANIMAL or a HUMAN.

The solid arrows in Figure 1 indicate typical inference sets and their corresponding ontological categories, whereas dotted arrows indicate weak or infrequent connections. For example, we typically grant animacy and mentality to HUMANs and ANIMALs, and all categories are informed by systems that generate physical assumptions about the way the world works. Biological inferences (e.g., species essentialism) apply only to PLANTs, ANIMALs, and HUMANs. Some of these inferences apply only to *specific* ontological categories. So, our "Mentality" system does not *typically* inform things that fall into the PLANT or ARTIFACT category (see below). In other words, while we may readily detect agency from objects that fall into the HUMAN and ANIMAL category, we do not generally do so with ARTIFACTs and PLANTS. Conversely, we tend to expect that when PLANTs and ARTIFACTs move, they are moved by external forces and objects, not internal motivational states. Likewise, "Mentality," "Animacy," and "Biology" do not typically inform objects placed into the NATURAL, OBJECT, or ARTIFACT categories. Similarly, physical inference systems make us expect that solid objects cannot pass through one another, will fall toward the earth, and cannot spontaneously disappear (see Baillargeon, 2008).

To summarize:

> intuitive ontology comprises (1) a set of broad perceptually grounded categories and (2) a set of aspect-specific inferential principles activated by these categories. They constrain the range of inferences to be derived from available information, by triggering a set of definite intuitive expectations about the observable features and likely underlying properties of different types of objects, beyond objects actually experienced. (Boyer, 1998, p. 879)

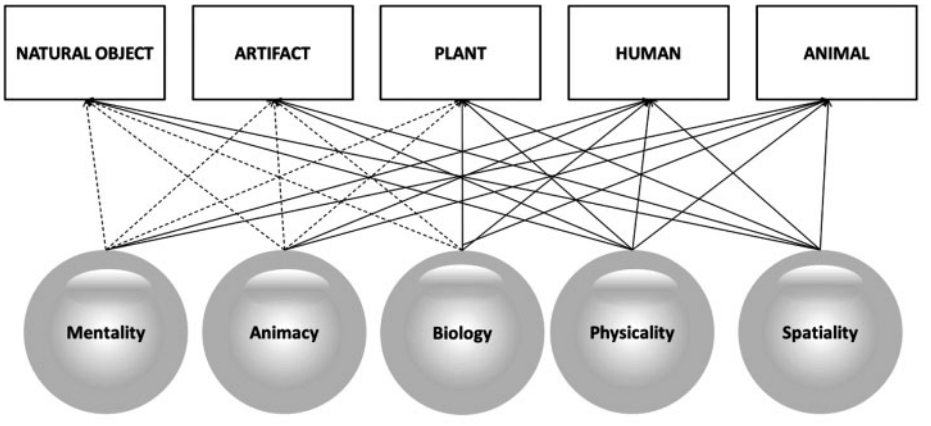

Figure 1. Deep inferential systems informing basic ontological categories.
Note: An alternative way to illustrate this would be to hierarchically organize ANIMATEs and INANIMATEs, and have branches to ANIMALs, HUMANs, ARTIFACTs, and PLANTs, but the point remains the same. What is unclear is what constitutes core domains, their hierarchical relationships, and whether or not these core domains are, indeed, only schemas.

Barrett (2008a) elaborates on the implications of this summary:

> The reason intuitive cognition plays such a powerful role in explaining various cultural phenomena is that whether or not an idea or practice is intuitive … is *not anchored to a particular cultural context*. *Such considerations are not culturally variable*. *Intuitive cognition is regarded as part of basic human nature* and thereby can be appealed to for explaining cross-cultural recurrence. (Barrett, 2008a, p. 311, emphasis added)

In this sense, "intuitive cognition" is variously characterized as innate, modular, evolved, "not anchored to a particular cultural context," "not culturally variable," and a "part of basic human nature."

This is partly why the rise of the cognitive science of religion was so enticing; it provided the groundwork to investigate formally the relationship between "basic parts of human nature" and how they interact with specific local contexts. For those of us committed to interrogating this relationship and interested in why humans are a religious species, the picture became so much clearer and was far more nuanced than the just-so stories of "it's learned." From this context, MCI theory developed as a cognitive alternative to standard approaches to religion that were not concerned with the nature of the human mind. This alternative helped craft a framework designed to account for the apparently abundant variation in religious beliefs with a few principles grounded in human biology.

Let us call inferences that are found early in childhood, which may or may not correspond to core domains and their constituent members, *deep inferences*. *Deep inferences* consist of implicit, inferential knowledge provided by cognitive faculties. We contrast these with *shallow inferences* that consist of accessible and more specific relationships between concepts, including reflective information that may or may not be consistent with *deep inferences*. We also distinguish *deep inferential* processes from their conceptual-lexical equivalents (e.g., perceiving that a dog is motivated by internal mental

states is not necessarily the same thing as hearing someone say it, just as describing an optical illusion's effect is not the same thing as perceiving the illusion) and "universal," folk understandings (e.g., all animals breathe, take up space, etc.). In keeping with traditional spectra, *deep inferences* are the "natural" end of human cognition, whereas *shallow inferences* are more obviously "cultural." So, an example of a *deep inference* at work would be that an object moving without relying upon any external force in ways detected as nonrandom would be perceived as having a mind. A *shallow inference* might be that upon seeing this object's fur, drool, and forward-facing ears, you determine that it is a dog and it wants a bone.[8]

2.2.2. Religion and the epidemiology of representations

Sperber (1996, p. 113) notes that cognitive modules, as "adaptations to an ancestral environment – are crucial factors in cultural attraction. They tend to fix a lot of cultural content in and around the cognitive domain the processing of which they specialize in." Here Sperber talks of cognitive modules as both processors and attractors of cultural information. Note the distinction made here between modules and "cultural content." For instance, mental state concepts get "fixed in and around" the mental state domain that mentalizing systems are designed to compute. More precisely, faculties devoted to making sense of minds link themselves to conceptual equivalents of mental states. Here again, the distinction between processors and their accumulated conceptual data remains crucial to this view. Relevant to the domain of religion, Sperber (1996, p. 140) predicts that "beliefs which violate head-on module-based expectations … thereby gain a salience and relevance that contribute to their cultural robustness." Consistent with this view, Boyer (1994) popularized the argument for the "counterintuitiveness" of religious ideas insofar as they are "counterontological" (Boyer 2001); such ideas are made possible by default conceptual domains and are easier to retain because they violate the default, *deep inferences* informing these core categories (Barrett, 2000; Boyer, 2000, 2001).

This, then, is the essence of MCI theory: the reason why religious beliefs are so widespread is that they consist of content that violates *deep inferences*. They do this in two ways: *breaches* and *transfers* (Barrett, 2008a; Boyer, 2000; Boyer & Ramble, 2001). Breaches contain a violation of one of the default inferences to ontological categories (e.g., "a man that walks through walls" violates intuitive physics that happens to inform the HUMAN category). Transfers apply an inference specific to one category to an object belonging to another category (e.g., "a statue that listens to your prayers" attributes agency, an inference made about animate entities, to an inanimate ARTIFACT). So, the field of dotted lines in Figure 1 illustrates where transfers take place. Notice that transfers take place only by applying inferences typically granted to agents (ANIMALs and HUMANs) to non-agents (ARTIFACTs, PLANTs, and NATURAL OBJECTs).

Boyer and Ramble (2001, p. 537) suggest that "culturally successful religious concepts belong to a small number of recurrent types or *templates*" that have the following features: a "pointer to a particular domain concept" (e.g., HUMAN, ANIMAL, etc., emphasis in original), "an explicit representation of a violation of intuitive expectations," and "a link to (nonviolated) default expectations for the category." Moreover, "Religious *concepts*," they state, "are more specific than *templates*, in that they add to the template two other entries" – "a slot for additional encyclopedic information"

and "a lexical label" (Boyer & Ramble, 2001, p. 537). Elsewhere (Boyer, 2001, p. 54, emphasis in original), "template" refers to "recipes … that build religious concepts by producing inferences on the basis of some information provided by other people and by experience" *and* the aforementioned ontological categories (Boyer, 2001, p. 50; see too Purzycki, 2010, 2011a; Tremlin, 2006, p. 92). This is not a conflation since Boyer is making distinctions between various mental phenomena. He is *not* arguing that we have a religious or ANIMAL module, for instance, but rather a suite of inferences that predictably gives rise to prototypical kinds of statements. Through this distinction, Boyer continued the conversation regarding the nature of mental representations and the underlying faculties that manage and enrich their representation.[9]

MCI theory continues to be a primary area in the field and "counterintuitive" continues to characterize religious concepts in the literature (e.g., Cohen, 2007; McCauley, 2011; Slone, 2004; Tremlin, 2006).[10] There has been a surfeit of studies focused on memorizing lists and narratives containing MCIs (Banerjee, Haque, & Spelke, 2013; Barrett & Nyhof, 2001; Boyer & Ramble, 2001; Gregory & Barrett, 2009; Johnson, Kelly, & Bishop, 2010; Norenzayan, Atran, Faulkner, & Schaller, 2006; Porubanova, Shaw, McKay, & Xygalatas, 2014; Porubanova-Norquist, Shaw, & Xygalatas, 2013; Purzycki, 2010; Willard, Henrich, & Norenzayan, n.d.). Boyer and Ramble (2001), in their inaugural studies, found that MCIs were easier to remember than intuitive statements (INT), breaches were recalled better than transfers, and breaches of artifacts were recalled in higher frequency than persons, but transfers showed no significant difference across these categories. Barrett and Nyhof (2001) read American Indian folk tales to participants and found that the MCIs were recalled more easily than INTs. They also found that MCIs were recalled more frequently than bizarre items (BIZ) in crafted stories. Both were recalled in greater numbers than INTs, even three months after exposure. Focusing on entire lists as units of recall, Norenzayan et al. (2006) found that among four conditions of lists varying in the proportion of MCI items, participants in the "entirely intuitive" condition (18 intuitive items) recalled more items than those in any other condition (the "minimally counterintuitive" condition had five MCIs, the half counterintuitive or "equal" condition had nine, and the "maximally counterintuitive" [MAX-CIs] had 13). However, after one week, those in the MCI condition recalled more items than those in any other condition. They also found that more culturally "successful" stories from the Grimm folk tales had two to three MCI items in them. Slone, Gonce, Upal, Edwards, and Tweney (2007) found that while MAX-CIs and INTs varied in recall according to how easy it was for raters to visualize them (easy-to-visualize items were easier to recall than difficult-to-visualize items), MCIs showed no variation in recall across ease of visualization.

Gregory and Barrett (2009) found that "necessary epistemic congruences" (e.g., "a four-sided square"), INTs (e.g., "a quick squirrel"), and "necessary epistemic incongruences" (e.g., "a spherical cube") were recalled equally. The lattermost type of statement was recalled better than MCIs. And, MCIs did *not* show an overall memory advantage (but participants younger than 26 did remember MCIs better than their older counterparts). Johnson et al. (2010) found that while the amount of counterintuitive content showed no significant effect on recall, items with a single counterintuitive element showed significantly better recall than those with more than one and counter-schematic items (see section 3) after a one-week delay. Gibbon (2008) analyzed Islamic sermons in Turkey and found that sermons typically contain one or two MCIs. Barrett, Burdett, and Porter (2009) analyzed the counterintuitive content of European folk tales, finding that a majority have MCIs with only a single violation of default inferences.

A majority of these MCIs were animals (and agents) rather than plants or artifacts. Harmon-Vukić and Slone (2009) found that the degree to which statements in narratives have a causal relationship to other elements predicts memory of stories and story elements better than counterintuitiveness alone. Purzycki (2010) found that humorous MCIs are recalled better than unfunny MCIs, funny non-MCIs, and unfunny INTs. Hornbeck and Barrett (2013) conducted a memory study in a virtual reality program using *visual* elements and found that there were no significant differences in recall between MCIs and INTs. While forgetting INTs and forgetting MCIs were both correlated with time after initial exposure, participants did not forget MCIs as rapidly. Note that in these studies, researchers *assume* that the materials used in their studies resemble religious ideas. We return to this below.

Other studies investigated MCI effects in areas other than memory. One (De Cruz, 2013) assessed how people *generate* MCIs by having people imagine aliens and supernatural beings. While supernatural beings were rated as minimally counterintuitive, aliens were *more* counterintuitive than supernatural beings. One study analyzed variation in reading time of various ideas with the assumption that reading time varied as a function of processing time. It found that MCIs take more processing time than INTs (Harmon-Vukić, Upal, & Sheehan, 2012). There has also been a cultural phylogenetic account of a single story with MCIs (Stubbersfield & Tehrani, 2013) finding that INTs were just as stable as MCIs throughout the evolution of a single folk tale. Lisdorf (2004) found that MCI concepts are more common than "bizarre" or INTs in Roman prodigies recorded between 218 and 44 BCE. One study (Pyysiäinen, Lindeman, & Honkela, 2003) found that MCIs were considered to be more "religious" than INTs. A more recent study (Fondevila et al., 2012) found neurological and behavioral evidence that participants viewed unfamiliar religious MCIs taken from various traditions around the world (e.g., "From his beard came out asteroids") as more plausible than nonreligious MCIs (e.g., "From his beard came out wardrobes"), suggesting that actual religious MCIs are *more* intuitive than nonreligious MCIs. How the mind makes a distinction between the two remains unknown.

The core feature of MCI theory is the ability to account for higher retention (and presumably transmission) of certain ideas, along with the assumption that religious ideas violate *deep inferences*. But this focus largely elides the specific content of religious concepts. In other words, MCI theory is not so much concerned with the "cultural" content of religious ideas as it is with how those concepts violate deeper psychological faculties. Before we return to this in more detail, we ask: how can we attend to the content of religious concepts as distinct from the content that violates *deep inferences*?

2.3. Shallow inferences, content, and cultural models

2.3.1. Cultural schemas

Recall that the original idea in MCI theory was that violations of *deep inferences* make concepts "catchy." While there may be default modular or core domain-level inferences devoted to the ARTIFACT, PERSON, ANIMAL, and PLANT domains, there are no modular or core domain-level inferences *specifically* devoted to "statues," "Christ," "dogs," or "roses." Such extensions of the theory would require relaxing or redefining the central features of modules or core domains as initially conceived (see Atran, 2001a; Atran & Medin, 2008, pp. 279–280, note 3; Sperber, 1996). We might immediately think of "marble," "bearded," "cats," and "love" when exposed to such concepts, but these associations are at the semantic or *schematic* level of cognitive processing. A schema in

this sense is "the organization of cognitive elements into an abstract mental object *capable of* being held in working memory with default values or open slots which can be variously filled in with appropriate specifics" (D'Andrade, 1995, p. 179, emphasis added).[11] Furthermore, we can update schemas with experience.

So, we might readily infer that dogs *like* things because we naturally make these inferences by way of core systems devoted to making sense of minds (Baron-Cohen, 1995; Premack & Woodruff, 1978). However, there are no *deep inferences* devoted to inferring that dogs like *bones*, *fire hydrants*, and *licking peanut butter off of little brothers' faces*. These are associations that are mentally stored as cognitive models or schemas. Schemas can also be locally and individually specific; dogs might function as beasts of burden or food, not as "man's best friend" or "welcome in homes." When such schemas are shared, they are "cultural" schemas or models (see Alba & Hasher, 1983; D'Andrade, 1992, 1995, pp. 122–149; Garro, 2000; Shore, 1996; Strauss & Quinn, 1997).

Humans intuit things all of the time that do not obviously require information from *deeper* sources. Take the following examples:

- Roses are ———, violets are ———.
- Lucy in the sky with ——————.
- Colorless green ——— sleep furiously.
- Los ticka toe ——————.

We have schematic models in our heads that allow us to fill in the "correct" information when we are exposed to it: roses are *red*, violets are *blue*; Lucy is in the sky with *diamonds*; and colorless green *ideas* sleep furiously. Fans of the rock band Melvins likely share a cultural schema of the lyrics to "Hooch," the first song of their album *Houdini*. This cultural schema allows them to infer that the word *rest* completes the fourth phrase, but readers unfamiliar with the song will lack the appropriate schematic content. The point is, cultural schemas are *shared* and socially transmitted inferential systems that we gather from our social and natural environments. Exposure to these statements allows us to rapidly pull up information retained in long-term stores to fill in the blanks, provided that the required cultural schema is familiar to us. Unlike the relative rigidity of modules, schemas are more flexible clusters of informational units that are neither informationally encapsulated nor inaccessible, and are domain-general relative to modules. The processes involved in some schemas' organization might be domain-specific (e.g., taxonomies, folk psychology, etc.), along with the retrieval systems used to recall statements, but the content itself is a hierarchically organized cluster of semantic informational units. Schemas are also susceptible to the effects of conceptual framing and reformulation (Strauss & Quinn, 1997, pp. 48–82).

We can be creative in our responses by filling in the blanks "inappropriately" (i.e., in a way that is not culturally correct, or that does not match the way that the blank was intuitively filled). So, someone might say "Roses are *painfully clichéd*" instead of "red" and "violets are *totally cheap and not blue at all*" instead of "blue." Such responses are "counterintuitive" as well, but not in the technical sense of MCI theory. Rather, such creative insertions are *counter-schematic* because they violate schemas (see section 3.2). *Counter-schematic* concepts resemble the aforementioned "transfers" insofar as we can reverse or negate conceptual relationships (e.g., man bites dog). We can also reflectively constrain schematic outputs by qualifying them. So, thinking about "green" might prime other color concepts (i.e., activating your color term schema and following its contents). Thinking about *green things* will elicit a narrow range of information within that category, and *green animals* elicits a still narrower range. Most MCI research – and

perhaps the cognitive science of religion at large – is not interested in such conceptual relations; the theory presumes to attend to *deep inferences* rather than *shallow* ones. As such, the literature largely ignores conceptual salience or distance. Connectionist models, however, have had a lot to say about conceptual relationships. In other words, features of connectionism keep the "cultural" part of cognition intact.

2.3.2. Connectionism

Connectionism has often been presented as the most formidable challenge to nativist, modular models of the human mind (Bechtel & Abrahamsen, 2002, pp. 120–199; Clark, 1991; Elman et al., 1996; Fodor & Pylyshyn, 1988; Horgan & Tienson, 1991; Marcus, 1998; McClelland, Rumelhart, & Hinton, 1992; Pinker & Prince, 1988; Seidenberg, 1994). Some theorists, however, make compelling arguments "that the putative incompatibility between connectionism and nativism has been much exaggerated" (Ramsey & Stich, 1990, p. 201; see too Anderson, 2007; Calabretta & Parisi, 2005). Like modularity and nativism, connectionism's commitments have a notably deep intellectual history (see Beakley & Ludlow, 1992, pp. 245–246). One traditionally recognized difference between connectionism and modularity is the former's willingness to allow a more domain-general model of the mind than the latter. Elman et al. (1996, p. 101) note that while "nothing intrinsic to the connectionist frame precludes modularity … The real questions [are] to what extent is the modular structure pre-existing as opposed to emergent; and, second, what are the functional contents of the modules."[12]

Connectionism models the mind on input/output units, activation values, "weighted connections," and rules for learning (Bechtel & Abrahamsen, 2002, p. 20). According to Bechtel and Abrahamsen (2002, p. 38): "for a connectionist system, learning is accomplished not by adding or modifying propositions, but rather by changing the connection weights between the simple units." Connectionism focuses on learning, retention of, and the relationships between informational units, whereas modularity assumes that there are innate learning principles and computational systems already at work in processing input. While connectionism is analogous to neurocircuitry (i.e., units are analogous to neurons and their connections are akin to synapses), modularity is analogous to "organs" or systems, as Chomsky (1980, p. 60) proposed.[13] As social scientists, we can calculate predictive models about "connection weights" at the conceptual level by virtue of the frequency and salience of conceptual relationships.

Figure 2 details a hypothetical model of a dog schema with varying "weights" between concepts, as indicated by width and solidity of the connections. If we were to ask people what comes to mind when they hear "dog," we imagine people would say "cat" more often than "purple" or "runs into walls," thus, the tenuous connection to these latter concepts. The thicker connection width, typically quantified in connectionist models, can also indicate frequency or salience within a specific sample. As individuals, we can explore and reflect upon our schematic models of dogs and their units. When we constrain our thinking to "dogs' physical features," we activate "dogs" + "physical features," which together activate such concepts as "four legs," "furry," "tongue," "wagging tail," and so forth. Adding conceptual restrictions causes more information to gain salience and accessibility.

As researchers, we can quantify and measure these relationships in a variety of ways, such as implicit association, response time, and triad tasks. We can also analyze free-list data by measuring the frequency and salience (i.e., an item's varying conceptual links to

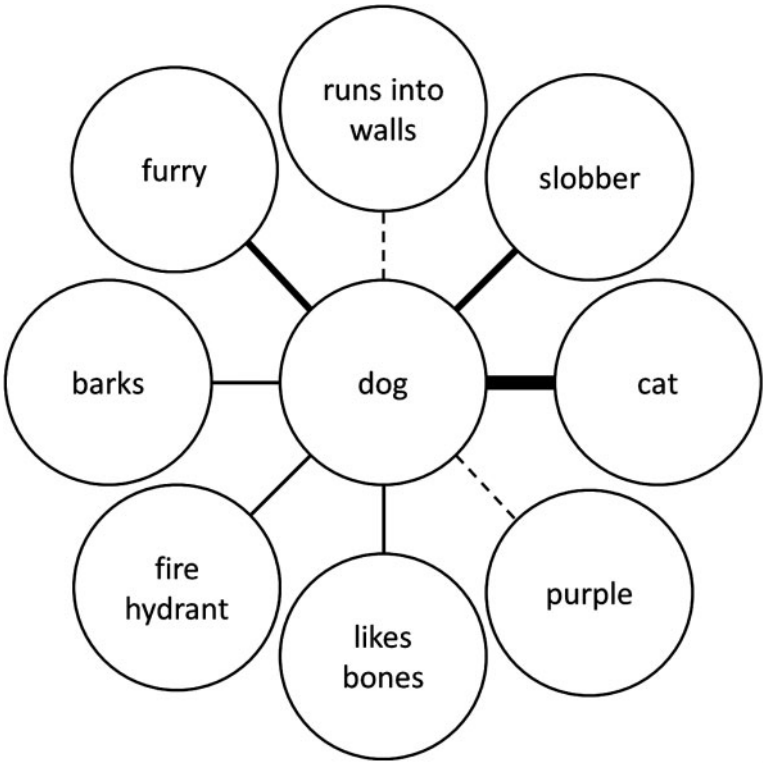

Figure 2. Hypothetical dog schema.

any given domain) of each item within a "cultural" domain. Conceptual proximity can be measured using free-lists, pile-sorts, taxonomic coding, and similarity ratings, among other methods that researchers have been using for quite some time for a variety of domains outside of religion (see Borgatti, 1998; Henley, 1969; Quinlan, 2005; Romney & D'Andrade, 1964; Ryan, Nolan, & Yoder, 2000; Shipman & Boster, 2008; Smith & Borgatti, 1997; Smith, Furbee, Maynard, Quick, & Ross, 1995; Thompson & Juan, 2006). Unfortunately, by and large this literature and its methods have been neglected in discussions of MCI theory and the cognitive science of religion generally. This is likely due in part to MCI theory's emphasis on *deep inferential* information rather than explicit, "cultural" models, their constituent units, or their tacit organizational principles.

Some researchers (McGraw, 2007; Purzycki, 2006, 2010; Upal, 2010), however, have examined schema theory and connectionism's relationship to MCI theory. For instance, by appealing to connectionism, Upal (2010) situates the "context view" (see section 3.2) within the deeper conflict between connectionism and modularity; the key issues are: (1) where the inferences come from; and (2) whether or not there are different kinds of inferences at work. According to MCI theory, "a dog that can walk through walls" violates core physics systems. The "context view" might suggest that "walking through walls" only has a tenuously related schematic relationship to "dogs," or perhaps violates the related unit of "runs into walls." Furthermore, by adding another conceptual unit to the stimulus – a *very thin* wall – the "same" idea becomes entirely mundane. To complicate matters even more, if we were to ask someone to list the properties of dogs

(or any animal), and he or she said "they can't pass through solid objects," *we* would be mildly surprised. We return to this point below.

2.4. Recapitulation

Figure 3 presents a snapshot synthetic model of the various cognitive structures to which researchers regularly appeal. Table 1 provides some examples of these structures' violations. To illustrate, when we see an object (in this case a dog), we have cognitive modules or core cognitive systems working rapidly that provide the inferences typically associated with animates, physical objects, and so forth. We might be compelled to figure out what the dog's disposition is by way of our mentalizing systems, and we might reach out to pet it with the inferences that it will enjoy it (a mental state), that our hand will not pass through the dog, and so forth. These inferences are made possible by *deep inferential* processes. These processes, according to MCI theory, correspond to the ANIMAL category and its attending inferential systems. Yet, we also have animal and dog schemas that provide us with the specific information that is, more or less, accessible. The information we already have about dogs, this particular dog, the context, and so on constitute just some of the reflective interpretive models and scripts that we can bring to the experience. Under specific constraints, our schemas are hierarchically structured (e.g., animal schema subsumes the dog schema, which subsumes the Labrador Retriever schema, etc.), but we can reflectively shift our conceptual pivot. This constrains the available sub-directories of information.

These cognitive structures help us navigate our social and natural worlds. While modules and core domains might be thought of as cognitive adaptations to ancestral environments, these and our schematic models acclimate to local conditions in the present. As already discussed, these structures can be violated in various ways with incoming stimuli. A "purple dog" brings together two otherwise tenuously connected concepts, and is thus *counter-schematic*. A "dog that vanishes" presumably violates a deep physical inference, but *also* brings together two tenuously connected concepts. However, while "a dog that runs into walls" might be consistent with physical inferences, it is a rarity in both reality and conception and we might easily say that it is *counter-schematic* by virtue of this rarity. A dog that transforms into a cat may violate *deep inferences* about species' essences, but the transformation may simply grab our attention because we cannot quite grasp what it entails, thus requiring a bit more processing and inference-making on our part. But, it may

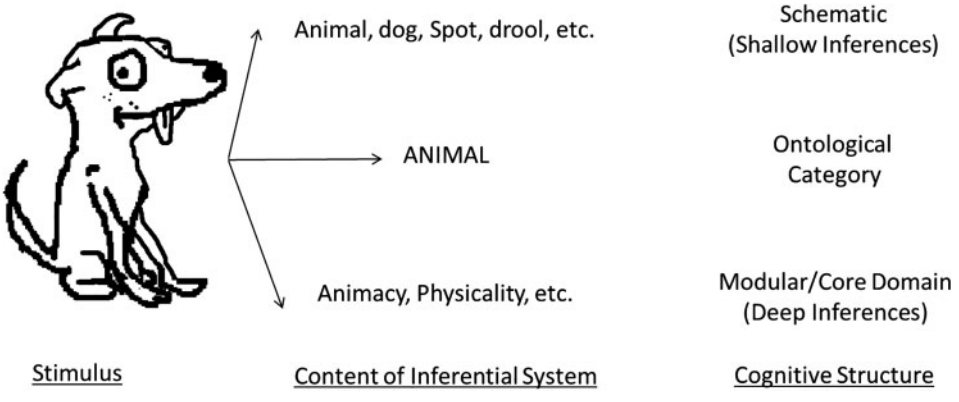

Figure 3. Synthetic model of cognitive structures.

Table 1. Types of incoming concepts by category.

Category	Example	Concept type
PLANT	A rose that grows	INT
	A rose that grows fur	CSCH
	A rose that grows when exposed to human thoughts	CSCH/MCI?
	A rose that vanishes	MCI (Br)
	A rose that thinks	MCI (Tr)
	A rose that buys humans for its wife	CSCH/MCI?
	A rose that likes to buy humans for its wife	CSCH + MCI
ANIMAL	A dog that runs	INT
	A dog that runs into walls	INT/CSCH?
	A dog that vanishes	MCI (Br)
	A dog that transforms into a fire hydrant	MCI (Br) + CSCH
ARTIFACT	A hammer that hits nails	INT
	A hammer made of balsa wood	CSCH
	A hammer that falls off of a table	INT/CSCH?
	A hammer that slides off of a table by itself	CSCH/MCI?
	A hammer that likes working hard	MCI (Tr)
	A hammer that floats above a table	MCI (Br)
	A hammer that enjoys the cries of nails	MCI (Tr) + CSCH?
NATURAL OBJECT	The wind blows leaves	INT
	The wind is made of molasses	CSCH
	The wind wants to blow me off the street	MCI (Tr)/INT?
	The wind thought it was a beautiful day	MCI (Tr)
	The wind teleported to another country	MCI (Br)
HUMAN	The man walks down the street	INT
	The man walks into walls	INT/CSCH
	The man walks on water	CSCH/MCI (Br)?
	The man breathes underwater	CSCH
	The man requires sunlight and water to grow	INT/CSCH?

Note: INT = intuitive; CSCH = *counter-schematic*; MCI = minimally counterintuitive; Br = breach; Tr = transfer; ? = unclearly defined.

also simultaneously grab our attention by virtue of the close conceptual proximity/higher connection weight between "dog" and "cat."[14]

MCI theory requires maintaining the distinction between *deep* and *shallow inferences*, but a close look reveals chronic confusion about them. Indeed, Barrett (2008a) acknowledges that there are significant

> differences in how "counterintuitive" was operationalized for the different experiments [in MCI research]. These empirical studies reflect only modest agreement concerning what does and does not constitute a public representation of a counterintuitive idea. Perhaps these differences alone account for the differences in results. (Barrett, 2008a, p. 309)

As we discuss below, these problems not only persist, but also run deeper and wider.

3. Counterintuitive versus *counter-schematic*

Some studies have explicitly examined the distinctions between *deep* and *shallow inferences*. On the empirical end of things, Johnson et al. (2010, p. 115) found that MCIs

are easier to retain than *counter-schematic* items. So, "A gargantuan orange hippopotamus with a friendly disposition, that regularly likes to wallow in the mud all day and gets startled very easily" and "A smelly, gold and black Siamese cat from the United States, that is a really good surfer and gets along well with children" constitute *counter-schematic* concepts and are less memorable than an item with one or more MCI features (e.g., "A beautiful glossy rose bush which whispers in Latin every day, grows rapidly in the summer and sheds its leaves in the winter"). Purzycki (2011a) found that while MCIs (e.g., "a goldfish that can completely disappear") were significantly "funnier" than intuitive statements (e.g., "a bee that makes a hive"), items containing *schematic* violations with MCIs (e.g., "a corn stalk that enjoys husking people") *and* without MCIs (e.g., "a goose that drinks really cheap whiskey") were rated as significantly funnier than MCIs without *counter-schematic* content. Elsewhere, Purzycki (2010) found that only items with parallel violations – MCIs *with* humorous *counter-schematic* content – were recalled more frequently than MCIs, INTs, and *counter-schematic* items. While they did not consider the emotional salience triggered by items like "illiterate teacher," "democratic skunk," or "vomiting birch," Porubanova et al. (2013, 2014) found that discrete *counter-schematic* concepts held a memory advantage *over* MCIs. These studies are difficult to compare given the variation of the items used (and differences in their availability). But, they do suggest that: (1) our minds indeed make sense of and retain different kinds of novelties in different ways; and (2) parallel violations can occur. However, the distinction between counterintuitive and *counter-schematic* has not been consistently or carefully considered in the literature. Indeed, there has been a considerable amount of variation and confusion between the two since MCI theory's inception.

3.1. Counter-schematic *content and the bizarreness bias*

MCI theory has not been the only theory to find a memory bias for unusual or unexpected content. What it added to the conversation was a nativism-savvy model of the human mind, the deep knowledge structures we have, how they correspond to relatively discrete conceptual categories, and how incoming information violates their relationships. However, MCI theory suffers from problems similar to those that have rendered other approaches of little utility. One theory in particular that gained much popularity in the 1980s and 1990s was the bizarreness bias. This empirical literature was well enough known to MCI theorists that they recognized "bizarreness" as something requiring differentiation. Barrett and Nyhof (2001) were the first to include bizarre-but-not-MCI items in their study in order to establish a unique place for MCI theory. They did manage to show a stronger memory bias for MCI items than for bizarre items. Still, in examining the literature on the bizarreness bias, it is difficult not to notice strong similarities to MCI research in both the structure and findings.

The bizarreness effect has been theoretically grounded in schema theory, and stimuli were most commonly created by pairing two nouns that were either distantly related or "incorrectly" placed in a sentence (e.g., The GRAPE burned the ARTIST with a CANDLE; see Hirshman et al., 1989). Although these sentences were not conceived of as MCIs, many of them seem to occupy the same schema/ontological category gray-area as MCI stimuli; for example, we interpret the grape to have agency. Further, if we decide that MCI content is based entirely on schematic associations and not really about *deep inferences* at all, then there is nothing to differentiate it from bizarre content.

With these similarities in mind, some of the effects found using bizarre content might also be found in MCI content. For example, the bizarreness effect only works for free

recall and not cued recall (Riefer & Rouder, 1992); it works for simple sentences but not complex ones (McDaniel & Einstein, 1989; Richman et al., 1990; Robinson-Riegler & McDaniel, 1994); it works in mixed lists, but not in lists of all bizarre items compared to lists of all common ones (Kroll & Tu, 1988; McDaniel & Einstein, 1986; for a similar MCI effect, see Norenzayan et al., 2006); and the effect disappears when participants are led to expect bizarre content (Hirshman et al., 1989; for a similar MCI effect, see Upal, Gonce, Tweney, & Slone, 2007). Research has also demonstrated that creating a mental image around bizarre items is not crucial (Anderson & Buyer, 1994), and is possibly even detrimental (Weir & Richman, 1996), to the memory bias. People do not need to invoke an image of a pyromaniac grape to produce a memory effect; it is enough to just notice that the two words are incorrectly ordered or paired.

The bizarreness bias as a useful mnemonic has largely been deemed a failure (Burns, 1996; Worthen, 2006). Under certain conditions, however, bizarre stimuli are more memorable than common stimuli and they fail to increase memory overall (e.g., Einstein, McDaniel, & Lackey, 1989; Kroll & Tu, 1988; Lang, 1995). When comparing pure and mixed lists, people remember more items in pure lists that do not include bizarre items than in mixed lists that do, even if bizarre items are more memorable than common concepts when presented together. These findings have led to a two-factor theory that claims that bizarre items are associated with easier memory retrieval, but common ones are more easily stored (Riefer & Lamay, 1998; Riefer & Rouder, 1992). This suggests that, in the long run, memory for common content should be more robust. Similarly, participants remember bizarre content with less detail and accuracy than common content (Kroll & Tu, 1988, Experiment 4 and 5; McDaniel & Einstein, 1986, Experiment 2), and with greater memory distortion (Worthen & Roark, 2002).

Whether MCI content is simply a more extreme form of bizarre content, or another type of content all together, remains an unresolved problem. For MCI content to persist over generations with enough consistency and fidelity to somehow turn into religious concepts, it needs to overcome some of the constraints and issues associated with the memorability of unusual content more generally.

3.2. Shifting focus: content versus context(s)

In an attempt to clarify the muddiness of what makes a concept minimally counter-intuitive, Barrett (2008a) reformulated MCI theory by abandoning appeals to cognitive architecture and nativism. He instead focuses on the content of inferential systems: "Spatiality, Physicality, Biology, Animacy, and Mentality … [that] *do not necessarily map onto genuine ontological distinctions*" (Barrett, 2008a, p. 317, emphasis added; Figure 2). While Barrett briefly discusses various ontological categories, he focuses primarily on basic-level concepts. His new coding scheme allows researchers to count up the counterintuitive properties of ideas in order to determine the degree to which they violate these inference systems. *Transfers* are indexed by a capitalized superscript to the left of a concept, while *breaches* are subscripts on the right side of a concept. So, "a statue that thinks" would be ^{M}STATUE, "a statue that vanishes" would be STATUE$_{P}$, and "a statue that listens to you while levitating" would be ^{M}STATUE$_{P}$. The little M's are for "Mentality" systems and the little P's are for "Physicality" systems. Such counterintuitive properties could be counted up and allow researchers to compare their storability. We return to this system below. For now, however, it is important to note that Barrett emphasizes that a concept like "a bright green ferret" does not fit into his coding scheme as it does not violate any of these core intuitive systems. Rather, he calls such concepts

"counter-schematic." While Barrett does not delve into the distinction too much, it harkens back to a defining feature of MCIs, namely, that MCI concepts violate *special kinds* of intuitions made possible by deeper cognitive faculties. This approach, however, is fraught with old problems while introducing a few new ones as well.

Barrett (2008a) acknowledges that one difficulty with this approach is that god concepts initially appear to be *maximally* counterintuitive insofar as their properties violate a lot of inferences:

> Similarly, God in the Abrahamic traditions has a mind (and so is a Person) with fully breached Biology, Physicality, and Spatiality expectations along with a smattering of Mentality breaches (e.g., mind reading ability, unrestricted perception, etc.). God might then be represented something like $HUMAN_{s+p+p+p+b+b+b+m+m+m}$ and have a counterintuitiveness score of 10 or more. (Barrett, 2008a, p. 326)

Is God actually and actively represented in or presented to our minds as having 10+ inference violations? There are at least three reasons why this is probably not the case.

First, Barrett notes that some of these properties may indeed have their foundations in intuitive reasoning (e.g., omniscience might be a default position with its intuitiveness explained by variation in false-belief attribution and cognitive load; see Schneider, Lam, Bayliss, & Dux, 2012).

Second, when we are exposed to the God concept, this may not necessarily activate all of the *schematically stored counterintuitive properties of God*. We are not necessarily exposed to God's counterintuitive properties all at once; rather, we have the accumulation of gods' features that may or may not be consistent with one another.[15]

Third, such a model ignores the variation in models of God across individuals and why one particular feature of God might be more prevalent than others. MCI theory predicts that MCIs are easier to retain than intuitive or maximally counterintuitive information. Yet, if a sample recalls "God knows everything" more than "God is everywhere" – two allegedly and equally counterintuitive concepts – MCI theory has nothing to say about why this would be the case (see section 4.3).

Barrett (2008a) continues:

> What a folk God concept commonly adds to this representation is breaches of the transferred Mentality (e.g. being able to hear or see anything, being able to read minds), $MIND_{m+m}$. Note, however, that if God is represented as omnipresent (a breach of Spatiality), then being able to hear or see anything is not a breach of Mentality. The omnipresent God may be represented with only a single breach of Mentality (mind reading), and a breach of Spatiality. The resulting coding would yield a counterintuitiveness score of 2 and look like this: $MIND_{s+m}$. If, on the other hand, God is not commonly (intuitively) represented as omnipresent, but is conceptualized as having a single location … that is well-distributed (such as an enormous cloud or unbounded substance), then perhaps God is better coded, $MIND_m$. (Barrett, 2008a, p. 328)

Here, Barrett equates "commonly represented" with "intuitive" and thus blurs the distinction between shared, semantically *stored* conceptual relationships and intuitive *processes*. Additionally, simply because all people in a tradition *collectively* have 10+ stored MCI features attached to their God concept does not mean that the concept does; inductively summing total MCIs in such a way presumes that individual *models* are synonymous with *shared* ones. Individuals may not share, or even be aware of, all of the representations of a group as a whole, and context changes what is salient and relevant.

If they are shared, explicit, and can be held in working memory, they are schemas and therefore not counterintuitive in the technical sense.[16]

Some have hinted at this problem by suggesting that religious ideas are therefore intuitive and have attempted to understand the role that "context" plays in the retention and recollection of MCIs by way of framing narratives using counterintuitive and intuitive frames. For instance, Tweney, Upal, Gonce, Slone, and Edwards (2006) and Upal et al. (2007) point to the difference between a flying cow lifted off of the ground by a twister and one that zips around of its own accord, free from the confines of gravity. They find that identifying MCIs requires understanding the prior context, namely, the other inputs and schematic information. Russell and Gobet (2013, p. 742) take this further and argue that "counterintutiveness" is really only "a subjective assessment" depending on the individual's judgment. Such positions are on to something, but from a cognitive architectural standpoint, the idea that context determines whether or not a concept is an MCI depends on whether or not context provides (in)sufficient information to violate *deep inferences* about physics. In other words, the two different floating cows are two different stimuli *as determined by the workings of the human mind*. The beauty of MCI theory was that it was ostensibly grounded in how our minds *interact* with incoming information, not whether or not the incoming information has inherent qualities (cf. Upal, 2007; Upal et al., 2007). As such, while understanding the role of schematic, social, and natural context is undoubtedly important to understanding memorability, examples and arguments like these strip MCI theory of its originally defining features by manipulating the shallower end of the cognitive pool at the expense of the deeper end and by interrogating what it means to be "counterintuitive."[17]

Empirically, if researchers ignore semantic framing effects and extant cultural knowledge, we risk exposing experimental subjects to a host of confounding factors. This is where the "context" view has a lot to say. However, the challenge lies in distinguishing *shallow* information (e.g., "the rose is bobbing in the wind") from its analogical, *deeper* equivalents (e.g., "this object classified as a non-agent is moving and therefore moving by virtue of an external force"), not by denying or minimizing the importance of deeper inferential systems. However, Barrett's new system counts just about *anything* that violates information *even hinting* at "Spatiality, Physicality, Biology, Animacy, and Mentality" as counterintuitive (see below; Figure 1).[18]

This is precisely where the riddle lies: we are an organism that can entertain shallow information and use it inferentially. This information can be qualitatively consistent with information derived from deep inferences. Concepts with violations of deep inferences can in turn become explicit representations. While MCI theory often assumes the distinction, researchers often conflate the two or deny the significance of deep inferences by emphasizing the shallow level of human cognition. We argue that not only is the distinction real, it is crucial for MCI theory and other cognitive research relying on or investigating the "explicit" or "cultural" as distinct from the "intuitive" and "natural." However, the relevance of this distinction in the present case appears to be limited only to initial exposure with little if anything to say about the persistence of representations.

A *new* concept that violates an individual's active, *deep inferential* systems should become part of his or her explicit, schematically represented, conceptual repertoire. The statement "a plant that vanishes" might violate a *deep inference*, but in order to recall and convey that concept to another person, it *must* be brought into working memory and therefore explicitly represented in semantic networks. Once incorporated into long-term memory stores, such concepts are by definition schematic information (and perhaps intuitive by virtue of context, but nevertheless *counter-schematic* relative to its target

object's schematic prototype). The question of whether or not it becomes "more intuitive" is a matter of *shallow* cognition; such concepts are schematic upon recall. Our *deep inferential* processes nevertheless remain at the ready to make sense of the world. At best, then, when people convey them, MCIs are explicit, schematically represented statements with content that is *consistent* with violations of *deep* inferences.[19]

But is not clear that hearing someone say "a plant that vanishes" violates the same *deep* systems discussed in the developmental literature (Baillargeon, 2008). Over time, we learn that helium balloons do not fall to the ground even though rocks do, that magnets can move across space without contact when another magnet is present, and that water will disappear if left out in the sun for too long. We learn to update our *shallow*, intuitive sense of the world with experience, yet we do not expect all objects to follow the same rules (for similar arguments about language, see Pinker, 1999; Pinker & Prince, 1988). Although young children intuitively use purpose-based explanations of objects (the rock is pointy so animals do not sit on it), we learn to overcome these core biases as we age (Kelemen, 1999). The biases themselves remain, which is apparent when adults are put under cognitive load (Kelemen & Rosset, 2009), or start to lose some mental abilities in cases of Alzheimer's (Lombrozo, Kelemen, & Zaitchik, 2007), but we are remarkably capable of fluently processing information that is counter to these immediate intuitions. Additionally, people do not develop obvious memory biases for violations of this type of intuition. For instance, the underlying mechanistic functions of evolution are remarkably hard to teach because it violates our intuitions (Kelemen, 2012; Sinatra, Brem, & Evans, 2008; cf. Kelemen, Emmons, Schillaci, & Ganea, 2014). Components of religious ideas, on the other hand, are frequently considered to be *deeply* intuitive. Incidentally, it is this deep intuitiveness that researchers also use to explain why religious ideas are ubiquitous (e.g., Barrett, 2004; Bering, 2011; Bloom, 2007; Gervais & Norenzayan, 2012; Guthrie, 1993; Kelemen, 2004; Shenhav, Rand, & Greene, 2012; Willard & Norenzayan, 2013).

3.3. Further equivocations of deep and shallow inferences

Cognitive modularity became quite popular and a cursory glance at the literature shows a considerable range of flexibility in its use (see Fodor, 2000, pp. 55–78, 2005; Sperber, 2002; Pinker, 2005a, 2005b; Samuels, Stich, & Tremoulet, 1999). In a position that Fodor (1987, p. 27) would characterize as "modularity theory gone mad," Sperber (1996, p. 131) suggests that there might be "an initial template module for living-kind concepts that gets initialized many times, producing each time a new micro-module corresponding to one living-kind concept (the DOG module, the CAT module, the GOLDFISH module, etc.)." Indeed, Atran (2002, p. 96) and Sperber (1996) also characterize ontological categories as modules. Atran and Medin (2008, pp. 63–119) qualify these as "conceptual modules," which is akin to Chomskyan modularity insofar as modules are representational databases (Chomsky, 2000, pp. 106–133; Fodor, 2000, pp. 55–78) rather than rigidly encapsulated computational perceptual devices. Setting aside this debate (cf. Russell & Gobet, 2013), we highlight that these notions have referred to distinct, analytically isolatable, *theoretical* models of the mind's functions and contents. Their conflation, we argue, diminishes the clarity, precision, and potential of MCI theory and other social cognitive research insofar as it has contributed to studies that are very difficult to interpret. When researchers were devoted to understanding how biology and "culture" are inextricably linked, some threads within MCI theory made a clear distinction between normal types of weird ideas and those that violate the functions of

deeper faculties. Without a consistent and fallible way of operationalizing "MCI" and distinguishing it as an explanatory theory of a specific subset of religious beliefs, studies may conflate statements that violate very different operations. A careful look at the available material suggests that the conflation between *deep* and *shallow inferences* is actually quite prevalent.

Barrett (2008a, p. 309) posits that: "For the MCI theory (as I call it) to continue to be fruitful in the study of religious concepts, this ambiguity regarding how to identify (or generate) public representations of counterintuitive concepts must be resolved." The central prediction of MCI theory is that a significant amount of what explains religious ideas is their catchiness, which is determined by their degree of counterintuitiveness. But if that counterintuitiveness is a special kind of novelty violating *deep inferences*, then considerable research has tested hypotheses drawn from the theory using items that are not by definition counterintuitive. Some studies (Atran & Norenzayan, 2004; Gonce, Upal, Slone, & Tweney, 2006; Norenzayan et al., 2006; Tweney et al., 2006) designate concepts as counterintuitive that – according to the model outlined above – are counter-schematic or intuitive concepts. For instance, these studies consider "swimming cow," "admiring frog," and "melting lady" (or "grandfather") to be just as counterintuitive as "giggling seaweed," "arguing car," and "limping newspaper." However, cows are able swimmers, white phosphorus melts ladies and grandfathers, and picturing frogs admiring each other is cognitively effortless. Which intuitive processes do these items violate?

In one study, "a virgin mother" counts as an MCI as it "violates one aspect of folk biology because she gives birth to a child without prior sexual contact with any man" (Banerjee et al., 2013, p. 1253). Presumably, "giggling seaweed" applies agency to a PLANT (^{M}SEAWEED), but giggling is a *behavior* that may only *imply* agency. Such concepts, however, do not necessarily directly or obviously "violate head-on module-based expectations" (Sperber, 1996, p. 140). They may *indirectly* violate these expectations, but only if "giggling" is a descriptor that can be applied exclusively to agents.[20] In other cases of indirect MCIs, Boyer (2000, p. 198) claims that "a table that breathes" is an MCI concept as it uses "biological information associated with the ANIMAL category." Barrett (2008a, p. 312) uses "a statue that cries" as an example of an MCI because "crying is a behavior in the domain of living things." Banerjee et al. (2013) include a "crying mailbox" among MCIs.[21]

We have no evidence that *breathing*, *crying*, or *sex makes babies* are default inferences of ANIMALs, "folk biology," or the "domain of living things." There is also no evidence to suggest that *breathing*, *crying,* or *sex makes babies* are "innate, modular expectations" or that that they become part of default reasoning about anything, let alone "living things." Rather, these assertions are assumed. Pre-verbal infants *know* that solid objects cannot pass through one another, but have as difficult a time understanding sexual reproduction as parents might have explaining it. A "rock with replicating cells" is biological, but this merely misapplies information from *our own* (i.e., researchers') schemas of biological information to nonbiological entities. Such information might be applied to the ANIMAL domain and its constituent concepts, but is having replicating cells a default inference about biological organisms? Does a "furry saucer" count as a *transfer* because it applies "biological information associated with the ANIMAL category" to an ARTIFACT? According to Barrett's (2008a) updated model, these concepts have the potential to be coded as ^{B}ROCK or ^{B}SAUCER. Perhaps such concepts as *breathing*, *having replicating cells*, *growing*, and *furry* "attach" themselves to innate, default inference systems. Yet, such concepts may merely "attach" themselves to our "animal" schema rather than the ANIMAL category. If we remove everything that

originally made MCI theory distinct, we are left with the false assumption that *any generally assumed conceptual relationship having anything to do with ANIMACY, BIOLOGY, and so on that gets "misapplied" or "breached" is an MCI.*

Take the following:

> Intuitive concepts are intuitive because built into them are implicit inferences about their properties. These intuitive inferences are rarely articulated explicitly. Rather, they are assumed, and make the concepts comprehensible and communicable. For example, the concept bird involves the implicit inference that birds fly, that they grow and die, that they drink when thirsty. These inferences are guided by intuitive ontology (Keil, 1989), or core assumptions about the basic categories of existence, such as intentional beings, animals, inanimate objects, and events. (Norenzayan et al., 2006, p. 532)

In Norenzayan et al.'s (2006) depiction of what counts as intuitive, they suggest that "the concept bird" is implicitly assumed to fly, grow and die, and drink when thirsty. This is probably true. However, when they suggest that such "inferences are guided by intuitive ontology," we are left wondering about the source of such inferences. Again, does "drink when thirsty" somehow become part of our "innate, modular expectations"? Does "a bird that *doesn't* need to drink water" constitute an MCI? It would if we appeal to folk-biological information. Does a penguin or ostrich count as an MCI since they do not fly? They would if we consider violations of conceptual prototypes (i.e., schemas) to be MCIs. If some concepts become "attached" to these systems, there is no end to the range of interpretive possibilities since we can conflate inferences drawn from *deep*, *shallow*, and folk sources.

We simply do not know if "giggling seaweed" or a "whispering rose bush" (Johnson et al., 2010, p. 115) transfers agency to PLANTs. We do know, however, that two atypically connected concepts have been brought together. If there is indeed a difference between counterintuitive and *counter-schematic* concepts, and if these differences indeed predict variation in cognitive load, retention, and transmission, then isolating them remains an unresolved problem for MCI (and other) research. Depending on how such dilemmas are resolved, there may very well be nothing that distinguishes MCI theory from any other theory of memory – especially those that memory researchers have rendered effectively moribund. The fact that MCI theory has yet to explain or characterize much of religion is another major problem to which we now turn.

4. Moving forward and outward

In its beginnings, MCI theory suggested that religious beliefs correspond to underlying, perpetually active inferential systems rooted in our evolved psychology. Our field is richer for this contribution. Still, there are problems with this theory, how it was conceived, and how it has developed. In this discussion, we have sought to bring to bring some of these deeper problems to light. We now turn to some precautionary measures for MCI research, and introduce alternatives to understanding the nature of religious concepts. Depending on what it is that MCI theory purports to explain, we question its value until further evidence exists that supports the points spelled out in section 1.

4.1. Toward consensus: a synthetic model

For those committed to pursue MCI research, we have offered a model by which one may incorporate the insights from various foci. Below, we offer some guidelines to raise the precision and standards required to test MCI hypotheses more convincingly. According to

some strains of MCI theory, deep inferential systems inform ontological categories. So, when we see something that fits into the ANIMAL category, we know that it moves by virtue of internal motivational states. We often have concepts that correspond to these categories (e.g., "animal"). We can readily think about conceptual associations we have at the schematic level. At this level of cognitive processing, certain inferences may lie dormant that do not correspond to deeper faculties (e.g., "breathes," "dies," etc.). MCIs, by their original definition, must be concepts that violate *deep inferences*, not merely conceptual relations that apply to all objects within a domain and may be cross-culturally universal (e.g., ANIMALs and "breathing"). As such, MCI research in this framework must be closely aligned and informed by developmental psychological research.

At the schematic level of conceptual processing, certain inputs prime informational models of stored information. So, a "dog that likes to chew on bones" might trigger mentalizing systems, ANIMAL categories, and thus corresponding core systems, but also the specific information associated with dogs chewing on bones (e.g., drool, teeth, etc.). According to the original view, MCIs are incoming concepts that violate *deep inferences*. *Counter-schematic* concepts, in contrast, violate specific information about things or *shallow inferences*. So, without any other qualifiers, "a dog that can walk through walls" breaches *deep* physical inferences. But "a newt that likes to chew on bones" transfers information more typically associated (i.e., with a greater connection weight) with dogs to newts, and a "rainbow-colored dog" breaches standard schematic prototypes of dogs; these are therefore *counter-schematic*. The notion of "a breathing table" applies schematic biological information to a concept typically *informed* by the ARTIFACT expectation set, but "breathing" is not – as far as we know – a default inference of deeper cognitive systems.

However, things once again become problematic when we consider the aforementioned issue of transfers (section 2.2). Granting agency to a PLANT (e.g., "my jade plants know where the sun is"; Purzycki & Sosis, 2011), an ARTIFACT (e.g., "my car just doesn't want to start this morning"), or NATURAL OBJECT (e.g., "the wind keeps trying to knock me down") is counterintuitive by definition, but *particular domains* of mental states are perfectly intuitive to apply given the right schematically represented inputs (see section 2.3.2). We are suspicious of the counterargument that this is merely a linguistic convention. Rather, it is likely reflective of how often we adopt the intentional stance when perceiving the world, just as we perceive the sun rising and setting, but are capable of knowing that the sun does not, in reality, do either. We may have an innate procedure of mental state attribution without much restriction on the application of mental states to things outside of what we consider the correct domain, PERSON. We readily over-attribute mental states to pets (Epley, Akalis, Waytz, & Cacioppo, 2008), and to computers, cars, the weather, and the universe (Boyer, 1996; Dennett, 1971, 1987; Guthrie, 1980, 1993; Waytz, Cacioppo, & Epley, 2010). The application of mental states might be something that we do so readily and intuitively that it should not be considered a transfer at all.

4.2. Improving designs

If MCI theory is to be salvageable as a theory of specialized memory biases, it must rest on at least two things. First, it should closely attend to a particular view of the human mind that is fairly uncontroversial. Namely, we have knowledge and developmental trajectories that are at work long before we associate "dogs" with "fire hydrants." If there are no *deep inferences* and it is schemas all the way down – or there are no schemas and

it is *deep inferences* all the way up – then MCI theory is just another strange-idea-therefore-easier-to-remember theory and there is nothing to distinguish it from other such theories. Yes, religious ideas are often strange relative to their objects' secular equivalents, but not always in ways that violate *deep inferences*. Nevertheless, if we emphasize the nativistic elements of the theory, then MCI theorists need evidence to support that their target inferences are, in fact, coming from or at least consistent with deeper sources. In other words, counterintuitive statements should correspond to empirically demonstrated postulates (e.g., IF EYES ARE PRESENT + OBJECT MOVES ON ITS OWN → AGENT; IF TWO SOLID OBJECTS COME TOGETHER → OBJECTS WILL NOT PASS THROUGH EACH OTHER) that young children exhibit. Eventually we can articulate information that violates those inferences, but that is the best MCI research can do if it is to use adults – who already have relatively stable conceptual relationships – in experiments using phrases or stories. Given the discussion above, if we consider the original conception of MCIs as violations of *deep inferences*, they may be more precisely characterized as *counter-schematic* concepts with content that is consistent with violations of *deep inferences*, but not actually counterintuitive in the technical sense. But, researchers should not be too quick to assume that every string of strange information only violates schematic relationships or models; we are biologically endowed with a considerable amount of knowledge that develops in predictable ways and MCI theory ought to focus its efforts on this knowledge.

There are a few steps that future researchers can take to keep levels of cognitive processing distinct and control for likely confounds among adult participants in lab-based studies. We include citations for works that have used such or similar controls, and encourage the employment of *all* such measures in future studies:

- Carefully delineate between *deep* and *shallow inferences*, and rely on only well-established *deep inferences* discovered by developmental psychologists to violate in test materials (Barrett, 2008a; see section 2.1).
- Pretest and control for familiarity of schematic content, and for the average conceptual distance between objects and predicates of items (Norenzayan et al., 2006; Porubanova et al., 2014).
- Pretest and control for variation in visualization, metaphorical, and inferential potential (Gregory & Barrett, 2009; Hornbeck & Barrett, 2013; Slone et al., 2007; Upal, 2007).
- Pretest and control for affective responses (Purzycki, 2010, 2011a).
- Provide *all* test materials in studies for purposes of evaluation and replication.

Just as psychologists use standardized scales for operationalized measurements, MCI researchers might use a battery of standardized items in further experiments. Using standardized items, of course, requires consensus as to what constitutes an MCI concept. As illustrated above, there is no such consensus. Standardized items should be pretested for novel conditions, as familiarity and schematic content will shift from place to place. Measuring representational distances was the bread and butter of cognitive anthropologists for decades, but this rich literature, along with its insights and methods, continues to be overlooked by the bulk of the cognitive science of religion (see section 2.3.2; but also Atran & Medin, 2008 and volume 4 issue 3 of *Topics in Cognitive Science*). Likewise, given the importance of emotion in concept transmission and evolution (Nichols, 2002), affect should be considered and controlled for in future studies. In particular, pretests (e.g., ratings of separate samples) could help control for items that trigger differently valenced emotions, which likely impact retention.

In summary, we emphasize the need to know participants' explicit internal and external environments in order to understand how the *content* of religious concepts takes the form that it does. Even if these precautions are taken, however, it remains difficult to get around the persistent possibility that we can explain MCIs with appeals to schematic conceptual relations. Even with a study such as Hornbeck and Barrett's (2013) that innovatively used visual stimuli as test items (arguably the only study to have actually tested MCI theory grounded in perception), all *recalled* data are, by definition, indicative of schematic content. Thus, we may reasonably (re-)embrace cognitive anthropological methods. Rather than chase elusive kinds of inference violations, there are good reasons to refocus our efforts, especially if we are interested in understanding religion.

We now turn to an alternative view to enrich current cognitive theories of religious concepts and emphasize the importance of moving beyond the lab and into the field. Rather than salvage MCI theory or any other approach that views memory as central to understanding the distribution of religious concepts, we find a wider but more precise and testable view to be far more informative.

4.3. Beyond memory: the cognitive social ecology of religious concepts

MCI theorists have recognized that counterintuitiveness alone is insufficient to explain the distribution of religious concepts. The scope of MCI theory is primarily limited to the content of concepts, how they interact with cognitive faculties, and their subsequent retention rates. What about *commitment* to these concepts? The Mickey Mouse problem poses the question of why we do not commit to some MCI agents even though they have the same degree of counterintuitiveness as gods and other supernatural concepts (Atran, 1998, 2002, pp. 13–14, 260). A talking mouse is not a religious notion, even though it may be a counterintuitive concept (which, in our view, has not been established). This has been partially addressed by what might be called the strategic knowledge hypothesis (see Atran, 2002; Barrett, 2008b; Boyer, 2000, 2002; Purzycki, 2013a; Purzycki et al., 2012), which partially predicts that concepts of counterintuitive agents who are knowledgeable about important social affairs are *even easier* to retain and commit to than disinterested MCIs.

For example, a talking mouse who knows your every move is more likely to be retained than merely the notion of a talking mouse (MCI?) or a non-talking mouse (intuitive). Even though this has yet to be tested in a memory study, such schematically represented domains of attributed knowledge possibly correspond to intuitive social cognition and we therefore are more likely to retain and believe in talking mice who know if we have been bad or good.[22] Barrett (2008b) informally assessed Santa Claus' status as a potential god concept and found that he mildly approximates to a god by virtue of his inconsistent MCI properties, marginal access to socially strategic knowledge, and the motivational force behind people's behavior toward him. In response, Gervais and Henrich (2010) ask why people would commit to one god over another even though these beings fulfill all of Barrett's criteria for gods. Zeus, for instance, cared about how the Ancient Greeks behaved, but most people are not presently concerned about Zeus' wrath. Zeus is certainly a widespread concept, even though few make appeals to him. The Boogie Man is an actively widespread technique to get children to behave and fits all of Barrett's criteria for a god, perhaps even better than Santa Claus. Compare "Boogie Man" with "God" or "Zeus" and we indeed have variation in how effective such concepts are throughout an individual's life. Gervais and Henrich argue that *contextual* learning biases (e.g., who tells you about a god, how many people in your neighborhood believe in a

god, etc.) explain commitment to particular MCIs and how widespread they are better than the *content biases* of those ideas (Gervais & Henrich, 2010). However, such a view is not an alternative as it adds components to the MCI hypothesis by attending to the *social* context. We can easily add many more (e.g., emotion, social status, level of expertise). Evolved psychology, the content of beliefs, and their context of transmission give us a more enriched, dynamic view of the distribution of concepts (and we need it). However, none help in determining which concepts count as *religious* and why such concepts are ubiquitous. For this, we require understanding concepts' relationship to *ritual*.

4.3.1. The centrality of ritual

With respect to the question of what makes an MCI a religious concept, McCauley and Cohen (2010) consider the possibility that the cognitive science of religion may render the category "religion" less useful than it has been assumed to be in previous research (see too Atran, 2002, pp. 264–265). This may only be the case if we limit our inquiries to what happens *in* minds rather than *between* them (Purzycki, Haque, & Sosis, 2014). Assuming that MCI concepts have been clearly defined and are the optimal kind of concept for storage, we still need to show what makes MCIs *religious* concepts (and vice versa).[23] This demonstration becomes particularly important in light of the view that religion may be better viewed as a functional system (Alcorta & Sosis, 2005; Malley, 1995, 1997; Purzycki & Sosis, 2009, 2010, 2011, 2013; Sørensen, 2004). Religion at its core (or at least the essential *explanandum*) is the coupling of ritual and the supernatural agent concepts to which people make their appeals (McCauley & Lawson, 2002, pp. 1–37; Purzycki & Sosis, 2013). These supernatural agent concepts may or may not be counterintuitive in their conception (Bloch, 2002; Purzycki & Sosis, 2010, 2013). In this view, MCIs appear to be entirely peripheral to religion (as do myths and folk tales); what immediately renders any supernatural PERSON, ARTIFACT, PLANT, ANIMAL, or NATURAL OBJECT as distinct from any other is its association to ritual. These rituals may be directed toward the concept or object (e.g., praying to the gods) or implement the concept or object itself (e.g., using a special rattle). In contexts with abundant mnemonic devices for religion – such as ritual (Rappaport, 1999; Rossano, 2012; Whitehouse, 2004, pp. 29–48) – no MCI content is required to remind people about the appropriate form of action or that the gods are out there and care about what people do.

We still do not know how and why people *use* MCIs (outside of, perhaps, the advertising industry; Upal, 2007[24]). Assuming that people do use them, *when* do they use them? Do they actually motivate people to engage in ritual? Are they useful for manipulating others' behavior? Some evidence suggests that religious concepts sustain ritual practices over longer periods of time (Sosis & Bressler, 2003). What best explains this: religious concepts' unverifiability, their MCI content, or their ties to strategic information (see Whitehouse, 2004, p. 32)? We wish to avoid resorting to "mindblind" theories of religion (Atran, 2002), since we are presently interested in the mind, but any cognitive account of religion needs to account for the types of stimuli involved in religious cognition just as much as we need to unravel the computational processes involved in making sense of our world (see Gervais, Willard, Norenzayan, & Henrich, 2011). In fact, we have yet even to establish thoroughly the relationship between MCI content and religion at all. If ritual is an essential component to religion, and these rituals are devoted to supernatural agents, strange ideas may function as attractive but peripheral reminders and attention-grabbing oddities, but they are far from central.

Note that the majority of MCI studies have been *experimentally* conducted among *adult Westerners* in *memory* studies where participants are typically exposed to *prefabricated* MCI concepts and asked to *recall* them in labs, rather than demonstrating a bias by eliciting naturally occurring concepts or in any way tying concepts to expected ritual behaviors. It goes without saying that such samples are not representative of most people (see Henrich, Heine, & Norenzayan, 2010; Sears, 1986 for further discussion). Additionally, religious concepts are often introduced to children or spontaneously generated by them (Emmons & Kelemen, 2014; Kelemen, 2004; Wigger, Paxson, & Ryan, 2013) rather than adults.[25]

Researchers have used lists, quasi-narratives made from lists, and folk tales, but the leap from concept and story to *religion* has yet to be empirically addressed in the literature. Ecological validity does not simply mean taking the lab into the field and running further memory studies on prefabricated items that have been translated and back-translated. Rather, we need to see if our theories have any bearing on the real *religious* world. Perhaps we should reconsider memory as the primary currency of how we think of the persistence of religious concepts. Rather, we might ask how, when, and why people express religious concepts. If MCI theory ever satisfactorily *characterizes* religious concepts, we can then determine whether or not those concepts are indeed widespread and consistent by collecting data to that effect.

Of all of the studies testing hypotheses generated by MCI theory that use living people (see Lisdorf, 2004 for dead ones), only two, as far as we know, have actually analyzed *religious* narratives and concepts from people without exposing them to already-made concepts. Gibbon (2008) analyzed sermons from Turkish clerics and found confirmation of the prediction that narratives themselves are minimally counterintuitive (e.g., "If God is able to know people's thoughts and future actions by means *other than normal human communication*, this would be a breach of mentality and therefore a counterintuitive trait"; Gibbon, 2008, p. 395, emphasis added). Purzycki (2013b) analyzed stories that he collected in the Tyva Republic and also asked non-specialists there to list and describe local spirits and their locations. He found that MCI content largely had to be *inferred* from the data; people explicitly conveyed remarkably little counterintuitive content. However, Tyvans conveyed a considerable amount of *counter-schematic* content (e.g., a fish-scaled bull, a deer with really thick horns, exceptionally beautiful women). This suggests that religious concepts are indeed strange and atypical compared to their otherwise normally represented prototypes, but are not necessarily, clearly, consistently, or explicitly MCIs. Moreover, spirits' locations are grounded in ritual places marking territories and resources. Passing by a ritual place, one does not even need to know the spirit's form and features to reinforce religious commitment. If rituals prime concepts of supernatural agents, there is no obvious need to appeal to the "catchiness" of representational models of spirits to explain why people do this.

4.3.2. Representational models of the (super)natural

It is perfectly conceivable that if one were to ask people what makes particular spirits or other religious concepts different from their common, natural counterparts, MCI content would be readily conveyed. As far as we are aware, someone has yet to conduct a simple study having individuals list all of the properties of their god(s) (although see Barrett, 2008b). If no such study exists, this would be a very unfortunate indicator that our understanding of religious concepts' cross-cultural representation, retention, and transmission is profoundly impoverished. Such a study would have value in and of itself as it

would function as a naturalistic and immediately cross-culturally comparable study. With respect to testing the hypothesis of a memory bias for MCIs, however, researchers should not need to probe people to elicit MCI content; rather, MCIs need to be conveyed naturally across minds in order to support the theory (but again, this would make such concepts *counter-schematic*, relative to their normal counterparts).

Even if it were the case that people readily offered MCI features of their gods, eliciting such data would not necessarily demonstrate that such representations are catchier, however plausible the argument may appear. Rather, they may be spontaneously and consistently generated upon reflection (e.g., "I've never seen a spirit, but shamans must since they keep talking about them"). As some have, it is worth considering the possibility that religious concepts are actually more deeply intuitive than is usually assumed by scientists studying them.[26] Additionally, if, for example, "invisibility" were cross-culturally the most salient component of supernatural agents and "omniscience" was a runner-up, MCI theory cannot explain why this would be the case; it might characterize such concepts' catchiness by virtue of their alleged violation of *deep inferences,* but it does not explain variation in MCIs' catchiness. Rather, if we remain focused on memorability (rather than cognitive processes), appeals would likely shift to other obvious candidates to explain this variation (e.g., frequency and prestige learning biases; Boyd & Richerson, 1985, pp. 132–171, 2005, pp. 58–98; Henrich & Gil-White, 2001; Henrich & McElreath, 2003).

It is also possible that across social and ecological contexts, there may be no need for religious concepts to dig so close to the cognitive core; a "deer with really thick horns" might be enough to stick – or maintain the very intuitive idea that there is a strange agent out there (Purzycki, 2013b, p. 113). In other words, cognitive optimality may shift across contexts due to social and ecological variables (e.g., higher population density, for instance, might predict the likelihood that concepts increasingly become difficult to explain away by virtue of more available, skeptical minds). As such, MCIs might be fairly superficial indices of widely shared and deeply intuitive representations about the supernatural. Likewise, among specialist religious classes – when they exist – religious concepts might be maximally counterintuitive for a host of reasons (see Nicholson, 2014, on a comparison between the Christian concept of Trinity and the Buddhist concept of "No-Self"; Russell & Gobet, 2013). Still, religious concepts are often qualitatively distinct from their normal counterparts. If they are distinct because they violate information that is *consistent* with *deep inferences*, they remain *counter-schematic* insofar as they are distinct from prototypical, quotidian models and explicitly represented. This point extends beyond MCIs' relative weirdness, however.

What remains to be fully appreciated in cognitive and other accounts of religion is the fact that the *content* of religious models so often corresponds to features of our environments and that these relationships also correspond to clear and very practical concerns (Durkheim, 1915/2001; Wilson, 2002). In terms of retention, how the coupling of belief and ritual corresponds to any fitness-relevant effects of religion – perceived *or* real – might tell us far more about why we remember things. Recent evidence suggests a strong memory bias for information about challenges to fitness (see Broesch, Barrett, & Henrich, 2014; Nairne, Pandeirada, Gregory, & Van Arsdall, 2009; Sandry, Trafimow, Marks, & Rice, 2013; see volume 22, issue 1 of *Memory*) and this might provide a key insight in helping us explain the ubiquity of religious concepts. However, memory need not be a focus.

Consider Sir Keith Vivian Thomas's (1971) observations regarding hagiolatry in medieval England:

> The worship of saints was an integral part of the fabric of medieval society and was sustained by important social considerations. Individual churches had their own patron saints, and strong territorial associations could give hagiolatry an almost totemic character … Local loyalties could thus sustain an individual's allegiance to a particular saint. But the worship of saints in general depended upon the belief that the holy men and women of the past had not merely exemplified an ideal code of moral conduct, but could still employ supernatural power to relieve the adversities of their followers upon earth. Diseases, like occupations and localities, were assigned to the special care of an appropriate saint, for in the popular mind the saints were usually regarded as specialists rather than as general practitioners. (Thomas, 1971, pp. 27–28)

It is perfectly conceivable that an MCI concept is unnecessary for this system to function and persist. Rather, the fear of and persistence of diseases, their association to saints and churches (Arnold-Forster, 1899), the belief that worshipping saints mitigates suffering, and "seeing" the effects are enough to perpetuate the system through time. No MCI content is needed, as tempting as it may be to find MCIs in this description. What is required, however, is access to a cognitive map of saint-church-illness correspondences and their prescriptive behavioral corollaries, as well as widespread and persistent illnesses. In other words, once we attend to the content of religious thought, we see mental representations' content as interactions between internal and external environments. Change the environment – in this case, say, develop higher-quality healthcare – and you alter the cognitive religious landscape accordingly. This point is uncontroversial; when fitness-relevant factors of the social and natural environments change, we should also see corresponding changes in religious content.

Exquisite cross-cultural work suggests that this is precisely the case. To take but a few examples, social religious rituals and appeals to supernatural agents emerge: during just about every significant life stage of humans (Reynolds & Tanner, 1995); when life is seriously threatened with disaster (Rossano, 2013; Sosis, 2007; see too Sibley & Bulbulia, 2012); at borders of hunting (Jordan, 2003), herding (Purzycki & Arakchaa, 2013), and other territorial grounds with external ritual devices that prime religious cognition, before hunts (Donahoe, 2003, p. 116); during water distribution management (Lansing, 1987); when religious leaders and experts do strange things to demonstrate their power (e.g., Balikci, 1970, p. 235); and the list goes on. If MCIs are somewhere in these transactions, it remains to be demonstrated systematically, and memory studies will bring us no closer to understanding why. What has been demonstrated is that we employ religious concepts and engage in ritual behaviors when challenges and the need to formalize and reaffirm relationships arise. We meet these challenges with ritual behaviors shrouded in appeals to the supernatural with likely primes of agency cognition and a host of other activated systems. When these challenges shift, so does the content, distribution, and timing of religious thought and behavior. It follows that religious cognition and the underlying deeper faculties at work will vary along predictable lines (e.g., local spirits' knowledge of human behavior diminishes the farther away the behavior transpires from spirits' territories; Purzycki, 2013a). In other words, local contexts should prime, steer, and harness *deep inferences* in various ways.

As such, perhaps a better way of making sense of religious concepts is by first grounding them in representational models of our environments and how they correspond to ritual. We can then determine when and where MCI content is conveyed (if it is at all). Rather than rely on our own remarkably fluid interpretive abilities to characterize religious concepts, researchers may systematically elicit data to test key hypotheses using extant methods and models of conceptual relationship that have been otherwise ignored

(see section 2.3.2). Religious concepts can "attach" themselves to minds, but they also "attach" themselves to representations of places, events, people, artifacts, and so forth, objects that function as external reminders, feedback loops, and pressures (see Basso, 1996; Hutchins, 1995, 2010; Purzycki, 2013a). It may be the case that MCIs and other religious concepts become associated with external mnemonic devices and contexts by virtue of what they do *across* minds rather than merely within them. In other words, social and ecological problems may "attract" religious solutions and *this* predicts the persistence of religious concepts as tools to maintain systems that minimize the deleterious effects of social and ecological problems (Alcorta & Sosis, 2005; Bulbulia, 2008; Purzycki et al., 2014; Purzycki & Sosis, 2009, 2010, 2011, 2013; Shariff, Purzycki, & Sosis, 2014).

5. Conclusion

MCI theory's fate remains as unclear as its defining features. By delineating between *deep* and *shallow inferences* as defined by the specific cognitive resources at work, a sharper portrait comes into focus. If our assessment has merit, the conflation of counterintuitive and *counter-schematic* concepts should be easier to recognize in the extant and future literature of religious concept transmission. Teasing the two apart remains the biggest challenge for such research. We nevertheless offer a synthetic model that highlights the concern for *where* inference violations might take place and how we can make such distinctions useful for empirical pursuits.

We suspect that ignoring the subtleties of cognitive architecture or emphasizing one level of inference-making at the expense of another has rendered MCI theory less distinct from other strange-concept memory research. Additionally, we remain unconvinced that memory studies and the analysis of folk tales or advertisements will tell us much about religion without understanding how, when, and why people actually transmit – and generate – such ideas, how religious concepts are associated with ritual, and how this coupling functions in any given context. As such, we emphasize and encourage ethnographic work in order to examine the target of our inquiry. Given the ubiquity of attributing minds to the otherwise mindless parts of the world and its central place among religious traditions everywhere, MCIs may not be "hallmarks of religiosity" (Pyysiäinen et al., 2003), but, rather, peripheral – and perhaps useful – devices to further mobilize, motivate, and maintain the rest of what we have learned about religion.

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Notes

1. There has been considerable debate and revision regarding the degree to which modularity characterizes the workings of the mind (Anderson, 2007; Barrett & Kurzban, 2006; Callebaut, 2005; Callebaut & Rasskin-Gutman, 2005; Chomsky, 1980, 2000, pp. 117–119; Fodor, 1983, 2005; Karmiloff-Smith, 1992; Pinker, 2005a, 2005b; Samuels et al., 1999; Segal, 1996; Sperber, 1996, 2002). We restrict our discussion to the foundational works that informed the genesis of MCI theory and its current state, and therefore avoid discussion of more current views of the mind and the neurophysiological foundations of cognition. Also note that Fodor's views on the innateness of cognitive faculties are *not* the same as his argument for the innateness of concepts (see Carey, 2014; Fodor, 1981; Rey, 2014).
2. Cultural evolutionary modelers Boyd and Richerson variously define "culture" as "the information capable of affecting individuals' behavior that they acquire from other members of their species through teaching, imitation, and other forms of social transmission" (Richerson & Boyd, 2005, p. 5) and "the transmission from one generation to the next, via teaching and imitation, of knowledge, values, and other factors that influence behavior" (Boyd & Richerson, 1985, p. 2) or "the information capable of affecting individuals' phenotypes which they acquire from other conspecifics by teaching or imitation" (Boyd & Richerson, 1985, p. 33). These are akin to ideational concepts of "culture" such as Goodenough's (1957/1964, p. 36):

   > a society's culture consists of whatever it is one has to know or believe in order to operate in a manner acceptable to its members, and do so in any role that they accept for any one of themselves. Culture, being what people have to learn as distinct from their biological heritage, must consist of the end product of learning: knowledge, in a most general, if relative, sense of the term … It is the forms of things that people have in mind, their models for perceiving, relating, and otherwise interpreting them. (cited in Duranti, 1997, p. 27)

   In all such definitions, culture is *explicit* and socially transmitted information and its organization rather than *inferred* information generated from exposure to social stimuli.
3. Crucially, "minds" are in no way limited to humans but are readily applied to anything from geometric shapes to animal puppets that show mentalistic cues (Guthrie, 1993; Johnson, 2000, 2003). Although we have intuitions that we apply to all animals or people, our core cognitive functions may not have neatly defined ANIMAL and PEOPLE categories, but rather broader intuitions about biological function, animate movement, and minds.
4. The "corest" of domains remains unclear. Pyysiäinen (2004) details the inconsistencies in Boyer's use of basic, core categories, but a wider look at the literature reveals a few more. For instance, Atran (2002, p. 96) and others (Boyer, 1994; Sperber, 1996) suggest that LIVING KIND and STUFF are "basic ontological categories" (Atran, 2002, p. 96). Elsewhere, Atran (2002, p. 98) identifies the "conceptually primary ontological categories … [as] PERSON, ANIMAL, PLANT, ARTIFACT, SUBSTANCE." Nevertheless, in terms of MCI as originally conceived, ontological templates partly consist of the differential convergence of inferences provided by modules. For instance, things in the STUFF and ARTIFACT categories may have the same inferences provided by naive physics systems, ARTIFACTs have the additional inference of essentialized function, and so on. Barrett's updated model (see section 3.2) explicitly avoided this confusion by focusing on the inference systems, which – he acknowledges – are also debatable.
5. Note that we do not need lexical equivalents for concepts (e.g., "plant") or their categories (e.g., PLANT). For instance, Berlin (1981, p. 95) demonstrates that while the Aguaruna do not have a word for the category "plant," the conceptual category nevertheless exists as fungi are not "considered to fall within the domain" of related plants. This suggests that the *category* has associated attributes and a word for "plant" is not necessary to have a category. It also suggests that there can be ontological placeholders that do not have conscious representations attributed to them. In other words, conceptual clusters can form around domain concepts without a corresponding lexical marker for the domain.
6. Boyer (1998) states that intuitive ontologies:

> are part of the evolved cognitive equipment typical of the species. This does not entail that they are necessarily 'innate' or modular in terms of neural architecture. All that is necessary for the present argument is that intuitive ontologies are the normal outcome of early cognitive development. (Boyer, 1998, p. 879)

While it is unclear from the context of the source, the operative word here may be *neural* architecture rather than *mental* architecture.

7. This model is purposely anachronistic; these "inference systems'" are from Barrett (2008a), which we discuss in section 3.2.
8. A *middling inference* or assumption might be generalization sets such as dogs breathe, grow, and die by virtue of their being animals (see section 3.3).
9. A plethora of concept types were soon (re)introduced – intuitive statements (INT), minimally counterintuitive statements (MCI), maximally counterintuitive statements (MAX-CI), and bizarre (BIZ) – in order to search for the cognitively optimal type of concept, which, MCI theory predicts, are the minimally counterintuitive ones (Boyer, 1994, p. 287). BIZ statements are "counter-schematic" (Johnson et al., 2010). Depending on the source, "maximally counterintuitive concepts" are often defined as "concepts that violate two ontological expectations such as a squinting wilting brick" (Upal et al., 2007) or "a chattering nauseating cat" (Upal, 2005, p. 2224). While some claim that MCIs are those that violate one or two deep inferences, it is entirely unclear how such statements violate any "ontological expectations" at all, as defined above. Is "having eyes" a *deep inference* about anything? Does "wilting" actually violate "modular expectations" about ARTIFACTs? While Norenzayan and Atran (2004) suggest that "a giant gorilla in an opera house" is a "bizarre" concept, when appealing to cognitive architecture this counts as a *counter-schematic* concept (a rather enjoyable one, at that; see section 2.3.1). Intuitive statements – statements that are consistent with modular inferences – blend into statements that are merely conceptually consistent. So, "a cat that fell out of a tree" – one that explicitly follows inferences generated by folk-physical systems – is just as intuitive as "a cat eating cat food" – something that consists of a schematically consistent relationship.
10. Cohen (2007, p. 117), for instance, explicitly acknowledges her use of MCI theory to *characterize* spirit concepts in Afro-Brazilian spirit-possession cults: "The concept of spirit may be created by taking an ordinary concept, such as man, and adding one or two counterintuitive features, such as intangibility and invisibility." On why this may not be the case, see note 26 on intuitive dualism. While her ethnography does not focus on MCI theory, we question the theory's utility as an interpretive framework for the same reasons that Sperber (1996, p. 34) resists interpretivism; namely "An *interpretation* is a representation of a representation with a similar content"; it should be a far more useful theory if directly brought to bear on data to determine whether or not it sufficiently *explains* religious concepts and their ubiquity.
11. In contemporary parlance, schemas are typically the stuff of "reflective beliefs" as distinct from "intuitive beliefs" (Barrett, 2004, p. 7; McCauley, 2011; Slone, 2004; Sperber, 1996, 1997). Note that Boyer (1994, pp. 70–71), drawing from Atran (1990, p. 215) who drew from Kant (1790/1928, §59, p. 222), made the crucial distinction between "schemas" and "nonschematic" assumptions (Atran uses "quasi-schematized") to lay the groundwork for what became MCI theory. Kant characterizes *schemata* as "pure concepts of the understanding" as distinct from *symbols* insofar as "[schemata] contain direct, symbols indirect, presentations of the concept." In other words, we can draw upon schemas to make sense of incoming information, whereas symbols require a little more work. We greatly simplify things insofar as interpreting symbols is, indeed, also a schematic process; the cognitive requirements drawn upon to make sense of symbols access schematic information. Boyer (1994, p. 83) uses "schemas" differently, explicitly stating: "Counterintuitive assumptions, obviously, are nonschematic; they appear counterintuitive precisely because there is no causal nexus from which they could be inferred." Here Boyer emphasizes the *causal* and *explanatory* aspects of schemas; explaining or making sense of something is a schematic process when one may easily draw upon explicit information to explain it. He states that "nonschematic" information is along the lines of "congressmen from this or that party are particularly likely to be corrupt, or to be liberal in issues of private morality," and so on

(Boyer, 1994, p. 70). In our use of the term, this is schematic information too, just of a more specific character. Note too, that he foresees one problem discussed in the present paper:

> To provide a satisfactory account of any given concept, we must be able to give an answer to two series of questions. First, we must have a precise account of the mechanisms whereby nonschematic assumptions are added to the conceptual schemata, and of the processes whereby they are made intuitively plausible or natural. Second, we must evaluate the relative contributions of schematic and nonschematic assumptions in constraining inferences about a given domain of reality. (Boyer, 1994, p. 73)

MCI research has yet to consistently and satisfactorily address this. See note 12.

12. While important, this timeless debate is beyond our present concerns. Still, connectionism entails a greater emphasis on the gradual acquisition of "knowledge through exposure to a variety of specific examples and repeated correction of inferences about those instances" (Strauss & Quinn, 1997, p. 57). On the surface, this portrait bears a striking resemblance to Sperber's aforementioned view. Connectionists, however, largely argue that the *source* of such inferences is the interaction between the informational units *themselves* rather than innate, domain-specific modules. In other words, there are emergent patterns inherent in the units of the stimulus and these units do the processing work themselves. Nativists often hold that there are biologically endowed cognitive systems that differentially handle stimuli.
13. To be clear, we do not wish to equate "mental organs" with "innate information" or specific locations of the brain. Rather, they are functionally distinct properties of the brain that interact with incoming stimuli and ultimately stabilize to optimally function within local contexts.
14. Boyer (1994) states that:

> nonschematic assumptions can vary in *salience*, that is, in the probability that they will be activated, given a certain situation. Schematic assumptions, by contrast, are automatically activated whenever the conceptual structure is relevant to the situation at hand, whereas nonschematic assumptions are not invariably activated. (Boyer, 1994, p. 74, emphasis in original)

This appears to be completely backward from the present discussion, but again, Boyer uses "nonschematic" to characterize latent information, not just *deep* information. Nevertheless, we would suggest that the veracity of these claims about nonschematic information depend on the source of the information; schematic information does vary in salience depending on the domain activated. See note 9.

15. But the problem is more basic than this. So, "a statue that thinks" would be ^{M}STATUE. Why not "AGENT made of stone"? There is not any direct and obvious *deep* inferential system being violated here and therefore it is probably not an MCI. While it may be argued that agents made of stone are incapable of self-propulsion, we still do not know, beyond interpretation, if inferences of "self-propulsion" are violated by statues that think. Again, what is crucial here is the distinction between storage and active cognitive systems.
16. This point relates to the notion of "theological" or "cultural correctness," which is doctrinal information that people are *supposed* to say or believe (Barrett, 1999; Barrett & Keil, 1996; Purzycki, 2013a; Purzycki et al., 2012; Slone, 2004). The "correct" part of theology or other ideologies is a matter of how one's explicit, schematic cognitive models correspond to authoritative models; they are "correct" when they. They are "correct" when they correspond to the majority or to an authoritative source such as the Bible or a religious leader. Like political correctness, it is a matter of how we are supposed to talk (and presumably think; e.g., "God is everywhere"). Theological *in*correctness or inconsistency is often a matter of *deep* or *shallow* inferential processes running counter to authoritative or cultural consensus models of what people are supposed to say (e.g., saying "God came down from heaven" presumably suggests that deeper inferences about humans' localized physicality are at work, whereas "God doesn't like it when you chew gum" is applying novel schematic information to models of what God cares about).
17. Russell and Gobet (2013, p. 743) "regard counterintuition as a highly semantic phenomenon" that is "unique to the individual." This assessment stems from their problems with "innatist

assumptions" and their reluctance to embrace conceptual modularity. As we have discussed in the present work and elsewhere, we also emphasize the distinction between cognitive faculties' operations from the content of human thought. However, we question this alleged "uniqueness" as religious concepts are likely consistent across individuals. Russell and Gobet question this consistency's source. Two immediate challenges for defending claims that the "counterintuition" discussed by MCI theorists is "highly semantic" and "unique to the individual" are determining what "highly" means and determining whether or not only *shallow inferences* are at work upon initial exposure to MCIs. Even if religious concepts are entirely things of schematic content, in our view, the best MCI theory can do is characterize types of schematic concepts based on their deeper processual analogues. This would be an important contribution, but as we have detailed, the theory has yet to accomplish this.

18. Barrett also avoids the nature/nurture and cognitive architectural issues by appealing to McCauley's (2011) distinction between "maturational" and "practiced" naturalness. While this distinction serves to reformulate how we talk about cognitive processes, it does not solve the problem of the distinction between *counter-schematic* and counterintuitive, and as such tells us very little about how to sufficiently determine what constitutes an MCI. So, while we might use McCauley's distinction to point to MCIs and characterize the violated inferences' ontogenetic status (e.g., Barrett, 2008a; Barrett & Lanman, 2008), it neither tests nor solves the problem of what distinguishes an MCI from any other weird idea unless we determine a way of empirically delineating between *deep* and *shallow* inferences as well as "maturationally" natural or practiced habits (or "reflective" versus "nonreflective" beliefs). At least in the case of determining the relative "naturalness" of religion and science, McCauley (2013, p. 166) acknowledges that his typology is comparative and remains beyond our ability to measure. Likewise, with relative ease we might characterize *deep* inferences as "maturationally natural" and *shallow* inferences as "practically natural," but determining what kinds of stimuli violate these cognitive levels is an empirical question.
19. There is variation in how these faculties operate with predictable effects on memory. In line with this idea, Willard et al. (n.d.) find that the more people show a general tendency to apply human-like mental state reasoning to such things as nature, animals, and machines (i.e., anthropomorphize), the less likely they are to show a memory bias for MCI content that violates "mentality" systems. These results suggest that it is not necessarily variation in schematic content that predicts a concept's counterintuitiveness; it is rather the variation in the functions of *deep* inferential processes. Further, once these schematic concepts exist, they impact the memorability of that type of counterintuitive content. Simply put, anthropomorphic ideas are not as distinctive if you are on the higher end of agency attribution.
20. Take the case of metaphor. We use terms like "babbling brook" to describe intuitive states of the world, and it is often good to let wine "breathe" a little before you drink it. "Arguing cars" can clearly have metaphorical value, or be understood as arguing *about* cars (akin to "talking shop"), and for both authors, "limping newspaper" conjured up a wet newspaper rather than one with legs. In none of these cases, however, is an explicit violation of default inferences generated by the aforementioned intuitive systems. From a connectionist standpoint, one might say that the connection weights between "limping" and "newspaper" are low compared to, say "wet" and "newspaper." It also may be the case that such concepts might confound our language processing; we may have ignored the "-ing" to think of a "limp newspaper," which then conjured up a wet newspaper. We would suggest that metaphorical cognition requires at least the schematic representation of what the metaphor means, and the metarepresentational ability to know that one is thinking about something different from the actual input (see Atran, 1990, p. 219; Upal, 2007). How we make sense of and create metaphors is a complex mixture of deeper inferences and schematic models at work. Detecting speakers' intentions can be a part of the process, yet as Lakoff and Johnson (1980) argue, metaphor is so much a part of our thinking that it is not necessarily always or even mostly the case. Often, religious people do not appreciate the metaphorical value of religious postulates and likely "turn off" their metarepresentational ability, or at least explicitly deny that religious and mythical concepts are metaphors (see Steadman & Palmer, 2008).
21. Note here that even if "crying mailboxes" and "crying statues" are equally counterintuitive, the fact that the former seems weirder to us than the latter suggests that schemas are at work (i.e., we hear about the latter more often than the former). But it may also be the case that we assume the statue is of a person and people cry, so such a thing is less strange than a "crying

mailbox." "A crying stone" seems quite different altogether, even though it is technically supposed to be the intuitive equivalent of the other two (and practically the same as the latter).

22. Note, however, that a mouse that knows your every move is still not an MCI in the strict sense. According to this model, a flower that thinks is a less likely candidate for a religious idea than a flower that knows you stole someone's bike by virtue of salience and relevance to individuals. Referring back to mentalizing, consider that we have a mental schema of "socially strategic knowledge" (or modules devoted to detecting moral defectors and morality; Cosmides & Tooby, 1989; Sugiyama et al., 2002). Cross-culturally, whatever constitutes such a domain is likely to vary and also is likely to vary situationally (i.e., models of socially strategic information in a classroom might be different from those at a synagogue), particularly when it comes to behaviors about which gods care. This opens the question of why gods might vary in their concern of universally recognized socially strategic information and locally specific domains of socially strategic information or other domains (see Purzycki, 2011b, 2013a; Purzycki & Sosis, 2011).
23. Researchers have demonstrated that people view MCI content as more religious or supernatural than non-MCI content (Norenzayan et al., 2006; Pyysiäinen et al., 2003), but it has yet to be shown that the wide range of religious or supernatural concepts found in the world are consistently, or even frequently, transmitted and retained MCIs.
24. Note that when advertisers use things that approximate to MCIs, it is the *products* and their ultimate purchase that are more important to the message, not the dazzling and attractive imagery, jingles, jargon, and acronyms designed to manipulate consumers into buying these otherwise mundane things. The analogy might be quite informative here insofar as MCIs might be glittery devices useful for getting people to engage in religiously justified behaviors. So, "walking on water" is *not* the object of religious devotion and is likely quite peripheral to religious traditions devoted to Jesus. It might give people a justification for claiming Jesus' divinity, it might be easier to remember than the Sermon on the Mount, it might violate deep inferences of folk physics (even though the basilisk or "Jesus Lizard" can run across water), and it might have a lot of metaphorical value (e.g., with faith you can do the impossible), but it does not help us explain much at all about "religion," let alone Christian mythology.
25. Perhaps it is the case that because religious concepts are introduced early in a child's development, their initial salience increases the chances of further elaboration of religious thought. These are ontogenetic questions ripe for empirical attention.
26. It is often stated that many or most ostensible MCI violations involve psychology (Atran, 2002; Atran & Norenzayan, 2004; Boyer, 2001; Cohen, 2007). Gods, ghosts, and spirits are agents (Guthrie, 2008, pp. 241–244). They are minds that deal in socially strategic information. If this is the case, then what exactly constitutes an MCI "mind" needs to be addressed. Bloom's (2005) work on dualism suggests that the intuitive view of minds is separate and not reliant on the physical body. Evidence for the potential universality of this view comes from studies demonstrating this phenomenon cross-culturally (Chudek, McNamara, Birch, Bloom, & Henrich, n.d.) and in pre-221 BCE Chinese texts (Slingerland & Chudek, 2011). If we intuitively think that minds are not part of bodies, and are not necessarily attached to bodies, then ghosts and spirits are logically more consistent with our intuitions than the scientific belief that the love you feel for your family and friends is nothing more than hormones and electric signals in your brain.

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COMMENTARIES

The (modest) utility of MCI theory

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Suppose the following were the story of an existing people, an ancient village at the base of a knoll on which a solitary tree grew. One year, the usual summer rains did not come, leaving the crops imperiled. The people of the village became increasingly desperate. What could be done? One day, to talk about leading their people to another place, two of the elders climbed the knoll and sat beneath the tree. Sitting and talking, they noticed that some nearby soil was not covered by scorched grass but had been disturbed. One of the elders dug at the dirt with his walking stick and horrifically discovered the shallow grave of a woman from the village who had been missing. Indeed, it now occurred to the elders that the woman had been missing for what seemed like precisely how long the rains had ceased. The body showed evidence of a violent death and buried with the body was the bloodstained staff of the woman's husband. The elders swiftly carried out their people's form of justice and executed the husband for murder, burying him alongside his wife under the tree on the knoll. The next day, the rains came. Thereafter, the people of the village quickly adopted the belief that the tree on the knoll was special: it knew what happened underneath its branches and had power to punish the wrongdoing of the people.

This invented mythology probably does not strike you as an implausible origin tale of a supernatural agent concept, indeed a minimally counterintuitive (MCI) agent concept that one could reasonably call a religious concept. Other versions of the tale would be much less plausible. For instance, if the people concluded that the tree only found murder immoral (a concept that transfers mentality to a tree but then restricts its folk morality counterintutively), or only knew what went on under it on Thursdays (mentality that has a counterintuitive property), or knew what went on anywhere in the village (a transferred mentality that has counterintuitive scope), and so on. My point is that many other *more* counterintuitive concepts are conceivable that have some fit with the facts witnessed by the people, but it is extremely unlikely that they would be fixed upon by any of the people, let alone become widely shared. Concepts that are too counterintuitive are less likely to be generated, harder to communicate, and hence, unlikely to become cultural (i.e., shared) concepts or beliefs. In this scenario, an intuitive concept would not have easily played the inferential role of the counterintuitive tree. By virtue of being only modestly counterintuitive, and that counterintuitive feature having inferential power to explain a peculiar series of events, a religious concept was spawned.

MCI theory is primarily concerned with why, all else being equal,[1] some ideas are catchier than others. Its insight is that the catchiness does not lie in the concepts themselves, but in how well they match human conceptual systems. It is beyond doubt that human minds are better at thinking some things over other things – what McCauley (2011) has called maturationally natural cognition. These characteristic ways of processing information impact how ideas are remembered, communicated, and thus transmitted.

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That some concepts are too counterintuitive to be broadly successful cultural concepts without special cultural scaffolding is indisputable. Ask any teacher of science, advanced mathematics, philosophy, or theology. Some ideas are just too hard to be acquired or communicated readily and accurately. By appealing to early-developing pan-human conceptual systems that have been studied by developmental psychologists and cognitive anthropologists, however, we can better predict and understand which concepts will typically be too hard. Importantly, degree of counterintuitiveness is a function of the types of minds that humans typically develop, and not of the concepts themselves.

Failure of researchers to properly operationalize counterintuitiveness and, for instance, sometimes confuse it with counter-schematicity does not entail that the two are the same, or that counterintuitiveness cannot be operationalized reasonably well. That there are some concepts that we simply do not know yet whether they are properly categorized as MCI versus counter-schematic likewise does not count against the theory. As the supporting sciences mature, we will know better.

Beyond these more theoretical and methodological matters, the data appear to support a modest MCI effect. Very recently, using a tightly controlled presentation method that used both words and images to avoid metaphorical interpretations of the items, Justin Gregory (2014a, 2014b) has found that young adults and adolescents both generate and remember MCI items more readily than older adults and recall MCI items better than intuitive items even after controlling for familiarity and other factors known to impact recall. MCI agents were particularly well remembered and these findings were comparable across both Chinese and British populations. So MCI effects consistent with the theory have now been found using narrative embedding and list-like presentation, recall and transmission measures, textual and visual presentation, and across several importantly different cultural contexts (see Barrett & Nyhof, 2001; Boyer & Ramble, 2001; Gregory, 2014a, 2014b; Hornbeck & Barrett, 2013). Several of these studies controlled for schematic familiarity effects. But is MCI theory enough to explain religion? Hardly.

MCI theory's grounding in an epidemiological approach to cultural concepts (Sperber, 1996) means that, technically, it does not attempt to account for religious concepts as if they constituted a natural domain of concepts readily demarcated. Rather, MCI theory is an attempt to account for why slightly counterintuitive concepts emerge and persist within and between populations and, apparently, more commonly than more counterintuitive concepts. If concepts that scholars wished to identify as "religious" are among these MCI concepts, then MCI theory has something to say about their origin, transmission, and persistence. MCI theory does not require that religious concepts are mostly or largely counterintuitive, and so the MCI theorist need not empirically demonstrate that religions are full of counterintuitive concepts.

Rather, additional psychological dynamics must be added, particularly the inclusion of intentional agency of an extraordinary sort, because of its ability to broaden the inferential potential of the base concepts. Hence, Boyer (2001) and I (Barrett, 2004) wish to direct the cognitive science of religion's attention to MCI concepts that concern agency in particular, that is, gods. Then, if one thinks that these concepts explain, in part, "religion" (whatever that means), all the better.

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Note

1. The "all else being equal" should be taken as recognition that all else is not equal in the real world and, so, it does not modify MCI theory to add additional psychological dynamics to account more precisely for religious concepts (see, e.g., Boyer, 2001). Furthermore, methodologically, we must always set aside some factors that matter for the moment. The scholarly sin is to pretend that our resulting explanation is complete.

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Dead people and living spirits: lessons from developmental psychology on what is intuitive

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Purzycki and Willard argue that inconsistencies in how researchers use the terms "intuitive" and "counterintuitive" pose a significant challenge to minimally counter-intuitive (MCI) theory. In claiming that these terms should be informed by developmental psychology, Purzycki and Willard define counterintuitive concepts as those concepts inconsistent with deep ontological commitments about different kinds (e.g., agents, artifacts). As a cognitive developmentalist who studies knowledge acquisition, I will briefly review two theories that have shaped psychologists' understanding of intuitions. I will also present findings demonstrating that religious concepts are often grounded in early emerging intuitive beliefs, which means that MCI theory has limited potential to advance our understanding of religious transmission. A more direct approach involves examining the mechanisms by which intuitive beliefs become reflective religious beliefs and how they constrain the types of religious concepts observed across human cultures.

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Over the past 30 years, theory-theory has dominated developmental psychology. Theory-theory posits that conceptual change occurs as infants and children interact with their environments and encounter information that is inconsistent with their expectations (e.g., Carey, 1985, 2011; Gopnik & Wellman, 1994). Through recognizing and reconciling informational inconsistencies, children's theories are updated to reflect a more adult-like understanding of the world. Taking an example from biology, young children start out believing that people will live forever and, through testimony and experience, most eventually learn that all people die and that death is caused by the breakdown of the body (Slaughter, Jaakkola, & Carey, 1999). Thus, under theory-theory, intuitions are assumed to change over development and depend on individual experiences. While one child may grow up to believe that dead people become spirits that live in heaven, another may grow up to believe that personal existence ceases at death. Within this framework, findings from MCI research can tell us about the consistency in adults' conceptual representations within a given culture but not about the inherent memorability of counterintuitive concepts, which are not assumed to be stable over development.

That said, recent studies challenge the notion that encountering informational inconsistencies results in a fundamental reorganization of knowledge and core assumptions. Specifically, intuitions observed among young children have been found not to disappear with age but instead persist into adulthood, albeit often masked by reflective beliefs (Eidson & Coley, 2014; Kelemen & Rosset, 2009; Kelemen, Rottman, & Seston, 2013; Lombrozo, Kelemen, & Zaitchik, 2007; Shtulman & Valcarcel, 2012). For example, Kelemen and Rosset (2009) found that when adults were forced to make judgments quickly and did not have time to reflect, they tended to accept scientifically unwarranted purpose-based explanations to explain natural events – much like young children have been found to do (Kelemen, 2003). Demonstrating that intuitions can be suppressed, adults who were given sufficient time to reflect before responding did not show the teleological bias. Such findings are best explained by dual process theory, which proposes that multiple, distinct cognitive processes are used in everyday reasoning: one process is fast, automatic, and unconscious, while the other is slow, effortful, and reflective (Evans & Frankish, 2009). Within this framework, explicit reasoning measures used by MCI researchers have probed memorability partially, if not entirely, based on reflective cognitive processes, and this issue needs to be addressed.

However, even if researchers take steps to improve empirical rigor, it seems unlikely that MCI theory will gain ground because it is rooted in the idea that most religious concepts are minimally counterintuitive. As Purzycki and Willard point out, this has not been established. In Figure 1 of the target article, I was struck by the human category being ontologically defined as equal parts biology, physicality, mentality, animacy, and spatiality. If, like Purzycki and Willard, I take "human" to mean "person," I find this categorization problematic. Research on children's and adults' afterlife reasoning has consistently shown that mentality is more central to conceptions of the dead than biology or physicality (e.g., Astuti & Harris, 2008; Bering & Bjorklund, 2004; Bering, Hernández Blasi, & Bjorklund, 2005; Harris & Giménez, 2005; see also Cohen, Burdett, Knight, & Barrett, 2011). Indeed, my own research on children's intuitions about their existence before biological conception (i.e., "prelife") supports that conceptualizing persons in terms of basic emotion and desire capacities is an early emerging cognitive bias that cannot be attributed to early exposure to religious testimony (Emmons & Kelemen, 2014; see also Emmons & Kelemen, 2015). Thus, while persons are often construed in terms of bodily and physical features, it is misguided to assume that these qualities are as central to conceptions of persons as mentality and potentially animacy (e.g., Emmons et al., 2013; Purzycki, 2013). Consequently, Figure 1

should perhaps be revised such that lines going to mentality and animacy are bold, while lines going to physicality and biology are dotted (spatiality requires additional study).

Based on the findings reviewed, I advocate that a more straightforward path to understanding religious transmission involves examining how intuitions become explicit religious beliefs and constrain the types of religious beliefs observed across cultures. For instance, the intuition that emotions and desires are eternal features of persons, while not itself a religious belief, provides a strong cognitive foundation for acquiring religious afterlife and prelife beliefs. Recognizing this, my colleagues and I are in the process of analyzing Mormon children's reasoning about their prelife capacities: Mormonism, unlike other Christian religions, formally supports the view that individuals had a spiritual premortal existence. In addition to examining broad developmental patterns, we will examine the effect of religious exposure and parental involvement with the Church on individual children's beliefs. We will also explore the content of children's justifications to evaluate the influence of specific doctrinal ideas on the development of their thinking. By examining individual variability, we aim to uncover which religious concepts map directly onto intuitions, as well as those that may not. In considering how intuitions potentially constrain the types of religious concepts that get transmitted, it is relevant to identify religious concepts that are scarce or nonexistent: for instance, typical conceptions of the afterlife do not consist of human bodies that lack mentality and agency. In sum, when studying religious concept transmission, it is critical to understand cognitive development and the mechanisms of human learning.

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On Purzycki and Willard's critique

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Purzycki and Willard identify serious problems in minimal counterintuitiveness (MCI) theory – a theory that for many writers is central to the cognitive science of religion. For example, the authors note (as have others including Guthrie, 2007; Näreaho, 2008 and most importantly Russell & Gobet, 2013) that the meaning of "counterintuitive," the principal concept of MCI theory, remains unclear. It varies widely even for individual writers, some of whom apply "counterintuitive" to such concepts as "swimming cow," "aggressive wind," and "omniscient person," while for others these are intuitive. The paper goes beyond earlier critiques of MCI theory in varied ways, by demonstrating in detail the above-mentioned disagreement; by examining studies that nominally concern MCI concepts but that often concern "counter-schematic" ones instead; and by analyzing the logical framework of the theory and its place among other theories of memory and cognition. Finally, the authors suggest measures to "salvage" MCI theory, although in the interim they have so undercut it that one wonders what is left to save.

The paper begins by usefully framing MCI theory as four related claims. First, human minds include innate systems that infer knowledge about the world. Second, MCI ideas – that somewhat contradict this inferred knowledge – are easiest to remember. Third, ideas central to religion are mostly MCI. Fourth, the main reason that religious ideas are widespread is that they are easily remembered.

The authors observe, however, that MCI researchers have hardly tested all four claims. Rather, they have tested primarily whether inference-violation aids memory, and have largely assumed both that religious thought *is* counterintuitive and that its wide distribution results from its being memorable. These two assumptions, Purzycki and Willard reasonably conclude, are therefore unjustified.

The paper holds that much confusion about what is counterintuitive and what is merely counter-schematic stems from conflating "deep inferences" (implicit, inferential

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knowledge provided by cognitive faculties, even in young children) and "shallow inferences" (accessible, reflective knowledge provided by experience). "Counterintuitive" concepts violate the deep inferences (e.g., the resistance of two solid objects to passing through each other), while "counter-schematic" concepts merely violate shallow ones (e.g., the supposed inability of a cow to swim). However, the authors note the absence of a clear line between deep and shallow inference, and indeed propose a third and intermediate form.

This reader was left doubting the intrinsic reliability of the deep–shallow typology, together with the specific innatism underlying deep inference. In comparison, Russell and Gobet's (2013) view appears more consistent with ordinary language and more parsimonious. For them, "counterintuitive" is simply a subjective assessment of a thing or event to which the assessor judges that category A applies, yet in which at least one property is incompatible with previous exemplars of A.

If the deep–shallow typology is unreliable, there may be – as Purzycki and Willard remark – little to distinguish MCI from standard accounts of memory. These accounts include (in my view) the information-theory observation that novel events are more informative and hence more memorable than familiar ones. But distinguishing one account of memory from another may not much matter for the cognitive science of religion, since it is unclear whether differences in memorizing concepts are key to explaining religion. Purzycki and Willard write that attention to concept memorization is recent in, and perhaps marginal to, theory of religion. Should we not, they ask, consider the role of *commitment to* concepts instead? And also (I would add) the role of the *genesis of* concepts? Because transmission cannot account for the worldwide distribution of religious ideas, we need to say why they arise.

In another blow to MCI theory, the authors note that one of its oft-repeated claims – that attributing mental states to inanimate things and events is counterintuitive – appears simply mistaken. Instead, such attribution is spontaneous, unavoidable, and deeply intuitive, as philosophers since Spinoza and Hume, and now cognitive psychologists, neuroscientists, and others (e.g., Beit-Hallahmi, 2009; Farah & Heberlein, 2007; Wegner, 2005), have said (Guthrie 1980, 1993, 2007, in press). We readily and involuntarily attribute volition to all manner of artifacts and natural forces: "This computer / car / stuck drawer is defying me," "This wind is after my hat," and "It wants to rain."

A related MCI theory claim is that persons who are not visible, or have no body, are counterintuitive. This claim is crucial to the MCI theory because such persons as gods and demons frequently are invisible or disembodied, and hence supposedly counterintuitive. But two decades of multidisciplinary work on mind–body dualism (Bering, 2002; Bloom, 2004; Cohen, Burdett, Knight, & Barrett, 2011; Leder, 1990; Lakoff & Johnson, 1999; Lohmann, 2003) have produced a different consensus. That is, such dualism is intuitive (in the sense of Sperber, 1996, p. 89) or even is (Bloom, 2004) innate. In this dualism, mind (or spirit, etc.) has priority and is both invisible and independent of body. Purzycki and Willard also write (although in a footnote) that this consensus contradicts MCI theory. As Russell and Gobet (2013, p. 741) write, "most investigators of [counterintuitivity use] their own personal concepts to design stimuli that they claim … are universal." That is, they pull them out of a hat.

Toward the end, the authors are gracious: "Our field is richer [for MCI theory's suggestion that] religious beliefs correspond to underlying, perpetually active inferential systems." However, this seems overly generous, because Hume, perhaps the preeminent philosopher of religion and a precursor of cognitive science (Morris, 2013), influentially said as much long ago. I would demur also at Purzycki and Willard's undefined use of the culture-bound notion "supernatural" (Klass, 1995; Saler, 1977) to identify another culture-bound notion, religion. Last, I would demur at their endorsement of functionalism, which I think (Guthrie, 1993) more attractive for its teleology than for its logic.

These few disagreements, however, scarcely temper my admiration for their powerful and productive assault on a dubious yet still-prominent hypothesis in the cognitive science of religion. To paraphrase the authors, it is a hypothesis we do not need.

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Toward an empirical approach to understanding counterintuitiveness, the supernatural, and the divine

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Purzycki and Willard (2015) provided a much-needed critique of the minimal counter-intuitiveness (MCI) hypothesis, survey the current state of the cognitive science of

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religion, and propose future directions for the field. I applaud their thorough treatment of the MCI hypothesis and its limits, and their challenge to scholars to consider other factors that may contribute to religious belief. In what follows I discuss an outstanding issue with the MCI hypothesis relating to the authors' definition of shallow and deep inferences and recent data that may illuminate the significance of counterintuitiveness in our understanding of the supernatural.

Purzycki and Willard provide a comprehensive description of the contrast between shallow and deep inferences and how the differences can be used to distinguish counter-schematic from counterintuitive concepts. However, that discussion fails to provide an improved definition of what constitutes counterintuitive, because the definition remains theoretical, and ironically is defined by intuitions rather than empirically validated measures. The failure to operationalize shallow and deep inferences presents two serious problems. First, without an objective measure of shallow and deep inferences, or counter-schematic and counterintuitive, the impossibility of distinguishing between the MCI effect and the distinctiveness effect persists. Second, our understanding of deep inferences will remain vacuous and even obstructive. The authors' definition of deep inferences hints that such inferences, by their very nature, hold a privileged status in memory. However, this assumption counters commonly accepted theories of knowledge representation coming from empirical work in cognitive psychology (McClelland & Rogers, 2003). Although such theories accept, as many cognitive psychologists do, that specific processes and variables, such as elaboration (O'Brien, Plewes, & Albrecht, 1990), distinctiveness (see Hunt & Worthen, 2006), and emotion (Pillemer, 1998), result in a memory advantage for target concepts; that the expression and accessibility of memory differs depending on whether the memory trace is implicit or explicit (see Tulving & Schacter, 1990); or that certain cognitive and environmental factors can result in an impoverished memory trace (Cook, Limber, & O'Brien, 2001; Fernandes & Moscovitch, 2000), the notion that certain types of knowledge is, in and of itself, special, has not been empirically established. While deep inferences may be unique, in the absence of an operational definition, it is unclear why or how they enjoy a privileged status. Therefore, operational definitions of shallow and deep inferences must be established for the sake of the empirical advancement of the field.

Perhaps the most salient and controversial question the authors raise is whether counterintuitiveness has any bearing on religious belief. To date there is no evidence that a memory advantage due to the counterintuitive nature of religious myths serves as a prerequisite for belief. Indeed, cognitive scientists of religion have recognized this as the Mickey Mouse problem – that many entities exist that are minimally counter-intuitive, such as Mickey Mouse, yet those entities are not incorporated into religion (Atran, 2002). Although this is not a new problem, few studies address the issue (however, see Barrett, 2008; Fondevila et al., 2011). Purzycki and Willard recommend that asking individuals about their understanding of sacred entities is a good starting point to examine the role of counterintuitiveness in belief. I recently conducted such a study in my lab. Participants were asked to list characteristics of both divine (specifically the Christian God) and non-divine (i.e., ghosts, fairies, superheroes, etc.) supernatural entities. The results from this study provide tremendous insight into how people understand the supernatural. The words used to describe God fell into seven categories: anthropomorphic (traits that suggest that God is human, i.e., God is a man); analogical (traits that God is "like" – "God is patience," "God is love," etc.); abstract (traits that represent the totality of God, such as "God is the beginning and the end," some of which are agentic "God is Judge," and some of which are supernatural,

i.e. "omnipotent"); psychological traits (those that indicate the type of deity God is, "God is loving," "God is homophobic"); psychological affects (feelings that God inspires such as fear, joy, admiration, etc.); psychological roles (the roles God plays in individuals' lives such as teacher, friend, healer, etc.); and relational traits (those that indicate a personal relationship with God such as interactive, experiential, living, etc.). Participants also listed a handful of supernatural traits such as "invisible," "immortal," "invincible," and so on. The words listed and the subsequent categories established suggest that the understanding of the Christian God involves much more than an anthropomorphic deity who occasionally violates deeply held intuitions. In another study, participants listed traits for non-divine supernatural entities (i.e., ghosts, witches, superheroes, etc.). Although there was some overlap between the divine and non-divine categories, significant differences emerged. The traits listed for non-divine entities included supernatural traits with subcategories of psychological (e.g., read minds, move objects with mind, etc.), physical (e.g., teleportation, invisibility, etc.), and biological (e.g., breathe underwater, super strength, super intelligence, etc.), psychological traits (i.e., helpful, vengeful, etc.), purpose-related (those relating to the cause of the entity's behavior, such as a traumatic past), and sociological roles (i.e., helps those in need, etc.). Overall, participants listed many more supernatural abilities for non-divine entities. In addition, words representing abstract traits, analogical traits, psychological roles, and relational traits were only identified for the Christian God. Clearly more data collection, including cross-cultural work, is needed to better understand how divine and non-divine supernatural entities are understood. However, the current data suggest that counter-intuitive concepts may play a more significant role in the understanding of non-divine supernatural entities. In contrast, the understanding of a divine entity, in this case the Christian God, is much more complex.

The possibility that counterintuitiveness has little bearing on religious belief as the previously mentioned data suggest, begs the question: does memory in general play any role in religious faith? Yes. It does. Belief simply cannot exist without memory. If we consider how individuals represent supernatural entities and the processes involved in the encoding and retrieval of information associated with those entities, including ritual experiences, emotions, stories, and personal experiences, we can only conclude that memory serves as a key operation to belief in the supernatural.

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On the necessity of "minimal" methodological standards and religious "butterfly" collecting

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Purzycki and Willard's timely critical evaluation of the minimal counterintuitiveness (MCI) research literature draws much-needed attention to some of the most pressing theoretical and empirical issues surrounding the theory. It is on this aspect of their paper, rather than their proposed alternative "synthetic" model, that this commentary will primarily focus. Particularly welcome among the host of issues discussed are the clarifications offered and concerns raised about the current state of MCI terminology. Developing collectively shared and consistently applied terminology is essential for enabling meaningful comparisons to be made across studies, and it is clear from the examples presented here and elsewhere (Barrett, 2008; Johnson, Kelly, & Bishop, 2010; Kavanagh, 2014b) that previous studies have largely constructed their stimuli inconsistently or incoherently, which jeopardizes their theoretical value.

Justin Barrett's (2008) counterintuitiveness coding scheme was designed to enable methodological consistency across studies, but Purzycki and Willard have rightly highlighted some of its deficiencies, particularly regarding its cognitive developmental assumptions. However, despite these limitations, it is still demonstrably a useful tool (e.g., Barrett, Burdett, & Porter, 2009; Gregory 2014a, 2014b, 2014c; Kavanagh, 2014a). To offer some first-hand experience, another coder and I recently applied the scheme to over 300 Japanese religious stories and, although certain difficulties were encountered (e.g., how to select ontological categories for characters with serial reincarnations), inter-rater reliability was high, and I was thus able to test a variety of hypotheses about the importance of *minimally* counterintuitive concepts in Japanese religious materials

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(Kavanagh, 2011). Rather than abandoning the counterintuitiveness coding scheme, and in lieu of an equally robust alternative coding method, it seems prudent to continue using Barrett's (2008) scheme, albeit with some modifications as implied by the target article. For example, some of Barrett's criteria may be amended or dropped in light of in-depth reviews of the cognitive developmental research, and heavier weightings could be added for more cognitively demanding breaches or transfers.

The specific issue of clarifying the distinction between counter-schematic and counterintuitive properties – certainly one of the most pressing issues for the field – is also, commendably, given due attention in the target article. Purzycki and Willard express ambivalence about whether the distinction can be meaningfully applied at all, due to imprecise definitions, fuzzy boundaries, and conceptual overlap. Their suggestion of turning to the cognitive developmental literature and its distinction between "deep" and "shallow" inferences is a reasonable one and, coupled with the pretesting of experimental stimuli and publication of stimulus lists – which should be considered obligatory – will help to increase rigor in the field. It is also a positive sign that a number of recent and forthcoming studies (Banerjee, Haque, & Spelke, 2013; Gregory, 2014a, 2014b, 2014c; Gregory & Barrett, 2009; Porubanova, Shaw, McKay, & Xygalatas, 2014) have already demonstrated greater care with stimuli construction and have begun to implement such measures.

Aside from the recommended terminology refinements and methodological improvements, Purzycki and Willard also lament the lack of MCI research on actual religious material and religious communities, despite virtually universal acceptance in the field of the importance of MCI items in religion (Barrett, 2004; Boyer, 1994, 2001; Pyysiäinen & Anttonen, 2002; Pyysiäinen, Lindeman, & Honkela, 2003). This is perhaps a legacy of Boyer's (2001, p. 78) early dismissal of any attempts to catalog cultural and religious material as having "all the attractions of butterfly collecting." However, "butterfly collecting" efforts are a necessary and worthwhile endeavor if researchers want to claim to have developed a comprehensive taxonomy for all worldwide butterfly breeds, and to present a series of predictions concerning the relative distribution of specific butterfly breeds. My own analyses do suggest that MCI agents are prevalent in religious material (Kavanagh, 2011), but there is certainly still a paucity of other relevant evidence in the peer-reviewed research literature. The MCI theory of religion is thus severely underdetermined by data. It is also clear that the Western Educated Industrialised Rich Democratic sampling bias in both coded materials and experimental studies, with approximately 90% of experimental participants to date being from the USA or Europe (Kavanagh, 2014b), urgently needs to be rectified (but see Gregory, 2014a, 2014b, 2014c). This unfortunate trend is counter to the admirable cross-cultural focus of earlier research (Boyer & Ramble, 2001) and is also why the target article's call for more ethnographic engagement should be heeded.

Finally, to conclude, I offer two short comments in reaction to the alternative "synthetic" approach presented. First, the portrayal of existing MCI accounts of religion as being naive about the wider constellation of factors that contribute to inspire religious belief and devotion seems to be something of a phantom position. This claim that MCI items are just one part of the story is already widely recognized in the literature, including by the very scholars who champion the relevance of MCI agents to religious traditions (Barrett, 2004; Boyer, 2001). Second, a lot of the interest that MCI theory has generated

is due to the relatively straightforward, falsifiable predictions that the approach presents, even when, admittedly, the operationalization of key terms and many subsequent tests of the hypothesis have been lacking. For the "synthetic" approach to offer a more profitable alternative, which is also capable of orientating wider research efforts, it would seem necessary to generate similarly clear predictions. However, the target article avoids such clear predictions and instead offers broad claims and generalities. This may be due to the sheer breadth of work required, but if that is the case, then identifying priority topics and generating central core falsifiable hypothesis would seem to be the next crucial step.

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MCI theory: can MCI theory alone explain the abundance of religious ideas?

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The target article, "MCI theory: a critical discussion," highlights many important issues with minimal counterintuitiveness (MCI) theory and questions its explanatory and predictive power. Specifically, it targets the notion of MCI as the sole factor in the transmission of religious ideas and the only factor in their attractiveness to human cognitive architecture. I agree with the authors' proposal that statements claiming that religious ideas consist primarily of MCI concepts and that the transmission of religious ideas can be attributed to the memory retention of MCI concepts are to a certain extent empirically unsubstantiated and might be based on biases (confirmation bias). They take legitimate issue with the vague definition of MCI concepts that permeates research testing the validity of MCI theory. Concretely, Purzycki and Willard make a crucial point about the conflation between deep and shallow inferences used in many experimental studies. I wholeheartedly agree that for the discussion about MCI to be more fruitful, those differences must be explicitly addressed and delineated when constructing concepts.

In terms of representational content and its potential role in cultural transmission, MCI concepts seem to be particularly salient. However, studies (Porubanova, Shaw, McKay, & Xygalatas, 2014; Porubanova-Norquist, Shaw, & Xygalatas, 2013) show that the MCI-ness of ideas alone does not account for their memorability. Not all violations of deep inferences enjoy a memory advantage; additional factors such as agency, emotional evocativeness, or cultural familiarity must be taken into account when looking at what mechanisms underlie the cognitive attractiveness of religious concepts. The propensity toward agency detection might explain the preferential existence and beliefs in gods being human or animal rather than object or plant. Agents are more easily recalled regardless of their MCI properties (Porubanova et al., 2014), perhaps due to the potential threat that they present. The emotional content and emotional response that many MCI (and religious) concepts activate might also partially explain the cognitive attraction toward those ideas. In particular, supernatural agents allow for a palliation of death, anxiety, and fear (Atran, 2002).

I believe, however, that although MCI needs to be delineated more precisely, the memory advantage of those concepts does not explain their transmission. This commentary suggests that the research addressing the transmission of religious ideas should not overlook context biases driving their transmission. Therefore, if MCI theory were to be more robust, it would abstain from referring to MCI as an underlying mechanism of idea transmission. Transmission of information might be attributed to other factors than representational content alone (possession of strategic information, verifiable information, prestige biases, conformist bias, and other social learning strategies) (Chudek, Heller, Birch, & Heinrich, 2012; Rendell et al., 2011). Many of the above-mentioned contextual factors are only marginally mentioned in the article and might be even more relevant to the dissemination of religious ideas (and belief in them) than their representational content (Gervais & Heinrich, 2010). The memorability of an idea alone,

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that is, its deep-inference violating content, cannot account for the profound, persistent, and abundant existence of religious concepts. For instance, religious authorities might utilize their power to attract followers through content that cannot be directly, empirically verifiable (a god can punish you; an angel can listen to your prayers) (see Supernatural Punishment Hypothesis, Sosis & Kiper, 2014).

As suggested by the authors, an honest aspiration for the standardization of MCI concepts for use across various studies should be pursued. Many studies not only use different methods of presenting MCI material (lists, concepts, stories), but use MCI material in combination with other concept categories simultaneously competing for cognitive resources (maximally counterintuitive information, deep versus shallow inference violation, emotional content, bizarre content, etc.). However, I am uncertain that the suggested implementations (a delineation between shallow and deep inferences, control for familiarity, visualization, and emotional evocativeness of ideas) will add anything to the ultimate goal that MCI theory pursues, that is, why religious ideas are abundant. While improving the internal validity of the experimental designs, it will not explain the motivation to transmit those concepts. For instance, even though one might believe in a particular religious ideas, the motivational forces leading to their potential dissemination are contingent on the extent to which other individuals might find those ideas potent, or on the probability that the veracity of those ideas are verifiable. A powerful theory on the abundance of religious ideas would concentrate not only on their cognitive effects and their inherent distinctiveness, but on the motivation to retain information imparted by an important authority figure.

In addition to the authors' call to include developmental science/psychology research to gain an understanding of how breaches of deep inferences inform us about core beliefs, I believe that an excursion into cognitive psychology and social psychology (particularly that related to context biases) might make the discussion of memorability and transmission of religious ideas even more fruitful. For instance, claiming that MCI concepts are more attention-grabbing is not completely accurate. If something is attention-grabbing, it refers to cognitive conspicuity operationalized through faster recognition of the object and easier (but not necessarily distinct) processing (e.g., Ohman, Flykt, & Esteves, 2001; Pratto & John, 1991). However, MCI studies only examined memorability, rather than attentional capture by MCI information.

I congratulate the authors on creating this long-awaited, extensive, interdisciplinary, and critical overview of MCI literature. The authors outlined a myriad of cognitive factors that might account for the memorability of MCI. In conclusion, I would like to applaud Purzycki and Willard for their convincing investigation into MCI theory and their emphasis on the need for its profound and careful revision. The authors successfully outlined concerns about MCI concepts not being necessarily representative of religious ideas and how they potentially lack appropriate ecological validity. The target article discusses many original and provocative ideas that, with additional, more compelling ethnographic and experimental evidence, might become a hallmark of MCI research.

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On finding the keys to MCI theory: a critical appraisal of Purzycki and Willard

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Purzycki and Willard's argument about the limits of present-day minimal counter-intuitiveness (MCI) theory reminds one of the drunkard searching for lost keys near a lamp post "because that's where the light is better." The "light" in this case is a theory of memory derived from recent cognitive science, and the "lost keys" are explanations of certain aspects of religious belief. The critique of MCI theory is timely; we now have dozens of empirical studies showing that MCI items do have some kind of special memorability (and more limited evidence that they are more easily transmitted socially).

But what does it mean to say that a concept is "MCI"? Purzycki and Willard adroitly show the many inconsistencies and the vagueness associated with the theory, both within and across individual studies. Future studies of this topic will necessarily involve close attention to the considerations raised in this article, if they are to avoid similar inconsistency and vagueness. At the heart of the critique are two distinctions that have been inadequately treated: that between counter-schematic concepts vs. counterintuitive ones, and that between deep vs. shallow processing.

The first distinction is shown to be important because, if a concept is counter-schematic, then it could have been learned (rather than being based upon universal tendencies of human thinking, whether innate or maturationally natural). It further matters whether or not deep or shallow processing is involved, although, here, I was a bit concerned that the distinction was perhaps conflated with that between automatic vs. controlled processing. In any case, the prescriptive advice offered (e.g., the admonition to MCI researchers to pay more attention to the measurability of "counterintuitiveness") is well taken; improving the lamp post lighting cannot hurt.

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Of course, the real challenge is to move away from the lamp post, the subject of the second main argument advanced by Purzycki and Willard. They are sharply critical of the notion that identifying religious concepts as minimally counterintuitive is sufficient as an explanation of the ubiquity of religion, and they are even skeptical about whether it is a necessary condition for such explanation. The point is well taken, but I want to suggest that the solution lies in a different direction – merely refining the notion of the counterintuitive, or replacing it with the counter-schematic, will fail. The real challenge is to come to grips with the systemic character of religion and religious belief.

Religion and religious belief each constitute complex systems containing dynamically interacting parts. From a cognitive point of view, both religion (as a social institution with a stake in particular representations) and religious belief (as a cognitive system anchored within an individual) are grounded upon representational *models* of things taken to be true. Each is a model in the sense that each involves claims about multiple entities (persons, gods, rituals, etc.) that interact in complex ways. Thus, beyond the question of whether the gods might sanction a particular behavior, or favor a ritual participant, it is the relationships between the god, the action, and the believing person that matter. Offering a sacrificial lamb appeases the god, comforts the sacrificer, and sanctions the action, but it also plays a functional role in binding a community, educating the young, and so on. Purzycki and Willard are thus correct in pointing to studies of ritual as needing emphasis, but it also needs to be emphasized that the claim that MCI theory alone can explain such events is clearly false – even if we do clarify what exactly an MCI concept is, why it acts on memory the way it does, and what role (if any) it plays in ritual.

The problem, in short, is that no account of the nature of static or singular concepts can possibly do more than add a footnote to the explanation of religion and religious belief – and such broader explanations are still lacking. This is the implied force of recent findings that the effect on memory of an MCI item depends upon the context in which it is placed. Purzycki and Willard reflect a similar view, but here their prescriptions for how to do better can be extended.

Knowing that the effect of an MCI concept depends upon its context has strong implications for how such concepts can be construed in the larger contexts of dynamic systems of religious belief. If these can be construed as models, then it follows that *model-based reasoning*, that is, the way in which such models are generated, modified, and function, becomes a central issue. To approach this issue, one needs to investigate from the "bottom up" (from fundamental cognitive processes), but also from the "top down" (from the complex richness of the whole, to an understanding of its parts and its dynamics). Studies of model-based reasoning have enjoyed great success in understanding scientific and technological thinking, and the same can be true in this domain (e.g., Gorman, Tweney, Gooding, & Kincannon, 2005; Nersessian, 2008; Tweney, 2014).

Sperber (1982/1985) discussed the kinds of interpretation of ethnographic field studies that are and are not appropriate, and advocated the increased use of cognitive psychological frameworks as interpretive aids to understanding anthropological data. We do need to escape from the laboratory. But we also need to extend theoretical work *into* the field, and that means using cognitive psychological ideas in the interpretation of ethnographic data.

Similar analysis can be seen in studies of cognitive artifacts (e.g., by Hutchins, 2010), in the huge body of work on expertise and its acquisition (e.g., Ericsson, Charness, Feltovich, & Hoffman, 2006), and, as noted, in the growing number of studies on model-based reasoning as a tool for the understanding of scientific thinking. In all of these cases, theoretical notions derived from cognitive psychology were adapted to richer contexts in the "real world," with great success. The same can be true in the psychology of religion and religious belief. We need better lamp posts – and more of them.

Disclosure statement

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RESPONSE

Accounting for variation and stability in religious cognition

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1. Introduction

We are genuinely appreciative of the commentators for their input. While the majority of them admitted that there are serious problems with the theory, there are still some disagreements as to whether or not they are worth trying to solve. Our response first details and discusses the calls for reform. We contend that the proposed reforms are misleading and fail to adequately address many of the problems we raised. Even if the reforms were to take place, MCI theory would still lack explanatory power. We conclude our discussion by emphasizing an approach that maintains and emphasizes variation and stability in religious cognition and representational models.

2. Calls for reform

There were several calls to reform – rather than abandon – MCI theory. These calls suggest that with improved methods along with findings from the "supporting fields" (Barrett, Kavanagh), MCI theory will only become clearer. Calls for making such concepts "better," "more refined," and "empirically useful" imply a vision or goal of how these refinements can improve the theory and what the theory will explain after being refined. Yet, without such a vision expressed, we wager that no amount of "operationalization" or assistance from other fields will help until we figure out exactly what an MCI is supposed to be or what is getting operationalized.

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2.1. Operationalization of … ?

As we detailed, newer strains of MCI theory abandon strict cognitive modularity and intuitive ontologies as starting points for how to talk about "counterintuitiveness." Given current research on cognitive architecture (Anderson, 2007; Barrett, 2012; McCauley, 2011), this is an understandable move, although it remains mysterious to us why the hierarchical, but flexible structures of schemas and the insights of cognitive anthropology remain largely ignored by the cognitive science of religion (CSR). This is quite likely due to its regular appeal to purported cognitive universals to explain religious universals (e.g., mentalizing systems, intuitive ontologies, memory systems). Also, we suspected that the replacement of the theoretical precision of Boyer's (1994, 2001) original conception with McCauley's appropriately vague distinction of "maturationally" and "practically natural" only increases the temptation to determine what is "counterintuitive" by fiat or by accident. Some of the commentaries confirmed this.

Curiously, responses did not address McCauley's recognition that "naturalness" is not empirically distinguishable from "unnaturalness" (see note 19). Determining just what kind of "natural" something is does "not turn on some precise metric by which we can measure … Claims about the naturalness of various elements of cognition are only estimates, sometimes rough estimates, that arise from weighing numerous considerations simultaneously" (McCauley, 2011, p. 13). McCauley does state, however, that "The distinction" between "practiced" and "maturational" naturalness "permits scientists, *on the basis of evidence from the social, cognitive, and neurosciences*, to inquire about the relative contributions of natural and cultural variables to both human development and cultural forms" (p. 72, emphasis added). In other words, we can look at any belief or behavior and seek to examine just how early, effortless, and ubiquitous it is to get a sense of the *relative* naturalness of its constituent parts (also see Norenzayan & Heine, 2005). MCI theory merely appeals to this effortlessness and ubiquity. However, by virtue of the poor assumptions about the inferential systems we discussed, the research fails to provide any reason why anyone should reach the same conclusion.

Harmon-Vukic identifies two core problems with our *deep* and *shallow* distinction. First, our discussion "fails to provide an improved definition of what constitutes counterintuitive, because the definition remains theoretical, and ironically is defined by intuitions rather than empirically validated measures" (see Cho, 2013; McCauley, 2013). However, our goal was to point out that MCI theory *requires* this distinction and researchers can only appeal to it, assume it, or declare it (or try to replace it as in the case of the "context" view). We introduced this model to point to these problems using analytically useful distinctions drawn from disparate fields, not to introduce an "improved" definition of MCIs. Like us, Tweney predicts that refining or replacing one with the other will ultimately fail.

Second, Harmon-Vukic claims that our "definition of deep inferences hints that such inferences, by their very nature, hold a privileged status in memory." In actuality, we said that such inferences are "at the ready" all the time not by virtue of memory, but by virtue of their foundation in core, biologically grounded inferential systems "discovered by developmental psychologists" (Section 4.2), *not* schematic relationships. Stored, generalized concepts might be the stored conceptual equivalents of *deep* inferential systems' outputs, but again, the problem with MCI research is that it can never tell whether or not the stimuli being tested recruits these systems. This would remain the case even if the stimuli were based on collected religious concepts. Testing the memorability of these concepts will not give us insight into whether or not they are tapping *deep inferences*.

Most of the studies claim a handle on domain-specific inferential systems in research that only analyzes data culled from domain-general repositories.

Barrett claims that: "Failures of researchers to properly operationalize[1] counter-intuitiveness and, for instance, sometimes confuse it with counterschematicity does not entail that the two are the same or that counterintuitiveness cannot be operationalized reasonably well." This is true. However, assuming that this comment was directed at our arguments, we never claimed that the two are the same. In fact, drawing from the evidence, we explicitly endorsed the distinction, and recognized that the theory *relies* on it (Section 3). We also argued that since *recalled* data are schematic, researchers should at the very least consider the nature of schematic mental representations, a vast literature of which CSR has largely bypassed. Also, we are in perfect agreement with the claim that the "failures of researchers … does not entail that … counterintuitiveness cannot be operationalized reasonably well" (Barrett). However, what we argued repeatedly was that counterintuitiveness cannot be operationalized "reasonably well" if it relies on an unoperationalizable distinction.

Research in different fields does, in fact, suggest that our model – however broad – reflects discrete sets of cognitive processes; when people study the content and structure of representations, they are not studying the same things as inferential systems that are present at an early age.[2] As Emmons points out, the intuitions of infants are updated with knowledge and experience as they grow. Both the content of religious beliefs and the stimuli used in MCI research are based on knowledge structures created through social learning, life experience, and inference, but how these representations relate to or reflect the inferential systems of infants is not well understood. While researchers typically employ different methods to handle these different processes, MCI theorists emphasize one kind of process or the other, yet perpetually muddle the two. We suggested that, at best, researchers can control for conceptual distance in pretests. But even this fails to isolate *deep* vs. *shallow* inferences given the fact that our reflective conceptual relationships can often be consistent with *deeper* inferential processes.

2.2. Economy of emphasis: theory vs. method

Of course, we and McCauley might be wrong and, at some point, perhaps this distinction will be clearer. In the meantime, what else do we have? Since we cannot delineate between violations of conceptual relationships that might be consistent with *deeper* inferences, one option is simply to abandon the pursuit until we can. If MCIs violate *deep*, "maturationally natural" inferences rather than extant *shallow*, "practically natural" ones, MCI research needs to manipulate and control for engagement with these kinds of inferences. We are skeptical that this is possible. If MCI research focuses on *conceptual* relationships, however, then at the very least it ought to be clear that schematic information can be qualitatively consistent with *deeper* processes. If MCIs are whatever we say they are (see below), then no amount of operationalization is going to help. This is why theoretical precision – rather than rhetorical appeals – matters. Indeed, this theoretical imprecision allows researchers to consider "Venus flytraps," "caterpillars turning into butterflies" (Kavanagh, 2010), "invisible microorganisms [that] can kill large mammals," and "the earth revolves around the sun" (Barrett, 2004, p. 731) as the same as "trees that like lollipops," "manatees that can teleport to other continents," and "hammers that philosophize."

Yet, the commentaries make no indication that things have improved on the theoretical front in any way. Barrett and Kavanagh suggest that we will know better at some point and posit that further *empirical refinements* will save the theory. At a time when the new generation of researchers have – much to their credit – increased methodological rigor in significant ways (e.g., Kavanagh, Porubanova), the theory's theoretical precision has only gotten worse. Most studies simply beg the question that "MCI" is (or will be) an analytically useful construct.

According to Barrett, the fact that "there are some concepts that we simply do not know yet whether they are properly categorized as MCI versus counterschematic … does not count against the theory. As the supporting sciences mature, we will know better." While it certainly "counts against" the theory in terms of its clarity, precision, characterization, and explanatory power, if "count against" means falsification, Barrett is correct. What does "count against" the theory on empirical grounds is the evidence of religious ideas being textbook cases of counterschematic concepts. Again, we point to Purzycki's (2013b) work that collected orally transmitted folk tales and had people freely list and describe *actual* religious concepts from *actual* people without exposing them to prefabricated concepts that are MCIs by decree. These turned out to be largely counterschematic rather than having anything to do with *deeper* inferential systems. That such concepts could simply be incongruent with extant conceptual prototypes is a blow to any theory claiming to tap into maturationally natural systems without even operationalizing the distinction.

3. More precautionary measures for skeptics

3.1. Rhetorical magic

While the arbitrariness invoked in Guthrie's paraphrasing of Russell and Gobet's (2013) charge of "subjectivity" may come off as a little too strong, the metaphor of MCIs as "pulled from a hat" is apt upon close inspection of the literature. The sleight of hand goes as follows. First, appeal to developmental psychology and cite uncontroversial examples of native inferences (e.g., "the understanding that physical objects will fall unless supported"; Barrett, 2004, p. 731). Then, use examples – however specious – as though they are of the same inferential ilk (see above) without providing any evidence that these cases in any way reflect violations of "culturally independent implicit reasoning systems." We recommended that researchers point to *evidence* that each and every one of the so-called MCI concepts in studies have some empirical support that they are consistent with *deep inferences* drawn from developmental psychology for precisely this reason. Given the extant literature and these responses, this is not an unreasonable requirement.

3.2. Controlling for meaningfulness

Despite the claims of some commentators, we never said that MCI theory needs to account for "most" or "all" religious concepts. In fact, we explicitly pointed to the inadequacy of this argument in our comment on Gervais and Henrich's (2010) piece. Rather than an alternative, looking at other factors in learning or commitment is just that: looking at other factors. We also recognize that MCI theory was never conceived of as a way of describing religious ritual, practitioners, or institutions. Still, researchers claim (or used to claim) that MCI theory explains many types of religious concepts. It is not necessary for MCI theory to explain all supernatural[3] agents, for instance, but for it to be a useful theory that accounts for some of the persistence and spread of religious ideas, it

does have to account for some portion of these ideas. The fewer religious concepts that MCI theory can explain within religion, the less *potential* utility the theory has.

Barrett claims that the "theory is primarily concerned with why, all else being equal, some ideas are catchier than others" and – as we acknowledged – "catchiness … [lies] in how well they match human conceptual systems." In practice, however, saying "all else being equal" entails at least a little handle on other factors that are involved. But, the basic values of social science include ecological validity; even if tightly controlled memory experiments show an effect, the theory must still work in the real world to be of any significance, after the necessary changes have been considered (Section 4.3.1). But what are the things that require controls in order to detect something that, admittedly, has such a negligible effect? The answer appears to be: *everything else*.

Also consider the fact that the available memory studies do not report recall rates per item. If studies have the proper controls, then items' retention should be random across item types. If, however, specific items are responsible for the bulk of the recall rates, something otherwise not controlled for is driving the effect. As we discussed, it is for these reasons that other theories of memory failed; they only work in the comforts and controls of the lab. We raised the question: what is it about socioecological context X that might contribute to variation in concepts' relationship to various inference types? However, such a question is utterly backward if it presupposes that MCIs are the default, "all things being equal."

If our recommendations become basic requirements for MCI research and its evaluation, how useful would the theory be then? It still needs to explain *something*. What are MCI researchers trying to explain (or characterize)? Interestingly, Barrett states that "if one thinks these concepts explain, in part, 'religion' (whatever that means), all the better." In light of the otherwise ubiquitous claim in the literature that the theory is meant to, at least partially, *explain religion* and its ontogeny, this casual divorce of the theory from religion may hasten its demise as an even potentially useful theory as there is little left for it to explain.

4. Toward a cognitive science of religious variation

4.1. Goals of social sciences of religion

There are at least two major goals of the social science of religion relevant to the present discussion. First, it seeks intelligible ways to understand the universals and variation involved in that thing we call "religion."[4] Second, it seeks explanations and accurate models of religion's constituent parts. If we consider religion – or at least the interesting, universal aspects of that thing that people refer to when they say "religion" – to be the coupling of ritual and appeals to unseen, nonhuman, but human-like agents with greater ascribed powers than humans (Darwin, 1871; Guthrie, 1995; McCauley & Lawson, 2002; Purzycki & Sosis, 2013; Pyysiäinen, 2009), then our toes are already touching some empirically tractable ground.

As we discussed, MCI theory does not purport to address the first goal. Rather, it is a theory seeking to explain the catchiness of *concepts* (not the naturalness of percepts or modes of reasoning). Finding a universal but flexible constellation of features of "supernatural agents" or the "otherworldly" targets of our religious devotions is a valuable – if not *the most important* – enterprise among the myriad foci of CSR. As Kavanagh suggests, if "butterfly collecting" can tell us about something as important as, for example, adaptive radiation, then collecting systematic data about religious beliefs might tell us something interesting as well. In our view, CSR ought to consider

prioritizing explaining variation. We can excuse MCI theory from the first goal due to lack of relevance. With respect to the second goal, however, it deserves expulsion.

Tweney recognizes that if our *explanandum* is religion, then we must think systemically (see Section 4.3.1). Within this view, for the cognitive science *of religion* to be helpful, it should focus its efforts on how the human nervous system encodes information, functions within and acclimates to various conditions, and creates outputs relevant to the coupling of ritual and spiritual agents (Purzycki, Haque, & Sosis, 2014; Sosis & Bulbulia, 2011). When we look at religious systems' components, MCI theory's utility is so "modest" as to be rendered nil. Even if the focus becomes one of "CI agents," this redirection will only be as useful as the "CI" part is. As Emmons and Guthrie emphasize, many components of such agents heralded as "CI" exhibit themselves quite early[5] (Bloom, 2004; Emmons & Kelemen, 2014; Knight, Sousa, Barrett, & Atran, 2004; Lane, Wellman, & Evans, 2014; Wigger, Paxson, & Ryan, 2013), but the relevance to conceptual "catchiness" – the central aspect of the theory – remains shrouded in mystery. These significant studies focus on the cognitive foundations of some of the things that we see in religious thought and behavior rather than conceptual distance or "catchiness". Indeed, the "catchiness" of beliefs has little to do with unravelling the calculus involved in these studies' findings. We are delighted to hear that Harmon-Vukic and Kavanagh are examining actual claims; such studies' significance lies beyond concerns of retention.

4.2. The cognitive part of religious variation

Cultural epidemiology (Atran, et al., 2002; Claidière, Scott-Phillips, & Sperber, 2014; Sperber, 1996) utilizes an *attractor* model of "culture"; cultural representations and behaviors gravitate toward specific features of our mental, social, and natural environments. In his rendering of the approach, Sperber (1996, pp. 113–118) explicitly characterized attractors as psychological *and* ecological, the latter of which CSR largely ignores. Also ignored in MCI accounts is the *stability* and *ubiquity* of representations. Our proposal was an attempt to rectify this "eco-blindness" by appealing to the evidence suggesting that many problems "attract" religious solutions. When those solutions entail the strengthening of social relationships, managing resources, and manipulating others, religion is ready to mobilize people around the problem. While Guthrie might be reluctant to endorse this view (although we would point to ours as distinct from the traditional forms of functionalism to which he alludes; Shariff, Purzycki, & Sosis, 2014; Smith & Winterhalder, 1992), there is plenty of evidence that this is the case. It follows that human cognition – *deep* and *shallow* – should conform to such problems in ways that alter their effects. In other words, we ought to be able to pinpoint variation in the proximate systems at work that contribute to religion's ultimate effects.

With all due respect to Kavanagh and Harmon-Vukic, we did offer general predictions drawn from our model to help guide the assumptions of the field toward productive, ecologically valid cognitive research that is consistent with burgeoning evidence in other fields (Section 4.3.2): shared, explicit mental models should both point to fitness-relevant problems and indicate the predictable range of thought that an incoming society member or child will encode and likely act upon. *Deeper* inferential and reasoning systems should also conform to such problems. So, if spirits correspond to ecological problems associated with a specific territory, this might exhibit itself in reasoning about the breadth of spirits' knowledge and the priming of spirits in specific locations (Purzycki, 2013a). According to some studies using cross-cultural databases, gods are likely to be *explicitly* and *reflectively* "moralistic" under certain ecological conditions (Botero et al.,

2014; Peoples & Marlowe, 2012; Snarey, 1996). Yet, in cases where *shallow* representational models of gods' concerns do not consist of morality, moral content nevertheless modulates reasoning about what the gods know and care about (Purzycki, 2013a). How this reasoning stems from *deep* and/or *shallow* sources is an important question. In terms of the epidemiology of beliefs, however, the question is not whether moralistic gods are inherently "catchier" than non-moralistic gods, but whether or not the "catchiness" of gods' moralism fluctuates across conditions, and if so, what cognitive system or systems contribute to this modulation.

As research continues to find evidence of how key aspects of religion point to adaptive consequences or fitness-relevant features of socioecological contexts (Bird, Tayor, Codding, & Bird, 2013; Coe, Aiken, & Palmer, 2006; Matthews, Edmonds, Wildman, & Nunn, 2013; Shaver & Sosis, 2014; Strassmann et al., 2012), the question arises: *what is it about the mind that explains the variation and effects we find in religious systems?* Many things point to the perceived fitness-relevance of religious claims as powerful, alternative attractors and feedback loops in mobilization and consensus building. The sciences have a lot to gain by examining such questions, and everyone has a lot to gain by learning the answers. We remain unconvinced that representational "catchiness" based on the alleged violation of *deep*, maturationally natural cognition will contribute to that advance.

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Notes

1. "Operationalization" refers to a process of reducing a complex variable to a set of measurable traits (Bernard, 2011, pp. 23–35). Creating psychological scales, for instance, requires that the construct is measured in some currency. So, one might operationalize "happiness" on a Likert scale of 1–7, but those incremental units might vary in "intensity," "frequency," "polarity," "value," and so on. Barrett's coding scheme "operationalizes" MCI-ness not by delineating between "counterintuitive" and "intuitive," but by counting up how many MCI bits concepts have (so here, his scale is "frequency of occurrence per single idea"). Although this is a perfectly acceptable way to measure a construct, for it to be meaningful it requires a clear conception of the construct being measured. The ability to create a set of questions with a high alpha or high inter-rater reliability (Kavanagh, Porubanova) does not mean that the construct being measured is valuable or even "real" in its ability to explain anything about the world (what inter-rater indices often really calculate is inter-rater biases, so this may be a strength of the approach here, but also a weakness).
2. As Emmons suggests, if we are to take the relationship between *deep* inferences and ontological categories seriously (however vague they might be), then arrows and connections ought to vary in width (perhaps based on frequency, response time, conceptual salience, or some other measure). Arrow width ought to vary throughout development, across situations (i.e., varying inputs), and stabilize differently across social contexts. The general model might be appropriate as universalizable. If so, the burden of proof rests on those promoting such a view. However, there should be some flexibility there as well; this is precisely the kind of nervous system that has made us so successful.
3. Guthrie was correct to point out our too-casual use of the term. We use it largely to avoid redundancy, but acknowledge and agree that pinpointing what exactly demarcates natural agents and gods is not as simple as is often assumed.
4. The often-called-upon nonreligious example of folk tales faces similar issues as religion, which we will not get into here. Still, Upala, Gonce, Tweney, and Slone (2007) empirically demonstrated that the memory effects of MCI disappear when the presence of MCI content is

expected, such as in science fiction or a description of a dream. As suggested by Harmon-Vukic's ongoing work, we suspect that fairy tales fall into this same category of expected violations.

5. Emmons also adds a developmental dimension to the riddle that we identified: drawing from very explicit models, children can grow to mirror, mask, and play with uncontroversially *deep* systems' operations. This riddle is central to any of the age-old debates of the supremacy of nature or nurture, learned or innate information, or inferences *deep* and *shallow*, in questions revolving around adult traits. These are questions of ontogeny, however, and presupposing one or the other with adult samples.

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