MCI Theory: A Critical Discussion

Benjamin Grant Purzycki*
Centre for Human Evolution, Cognition, and Culture
University of British Columbia
1871 West Mall
Vancouver, BC V6T 1Z2
email: bgpurzycki@alumni.ubc.ca

Aiyana K. Willard
Department of Psychology
University of British Columbia
2136 West Mall
Vancouver, BC V6T 1Z4, Canada
email: aiyana@psych.ubc.ca

*corresponding author

Abstract: 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: MCI theory, memory, religious concepts, cognitive science of religion, cognitive anthropology

Acknowledgements: During the preparation of this manuscript, Purzycki and Willard were financially supported by the Cultural Evolution of Religion Research Consortium (CERC), which is funded by SSHRC and the John Templeton Foundation. The authors thank Natalie Emmons, Stewart Guthrie, Jordan Kiper, Eric Margolis, Michaela Porubanova, John Shaver, Wesley Wildman, and the anonymous reviewers and editor for their very helpful and valuable comments.

1. Introduction

In recent years, "minimal counterintuitiveness theory" (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 about our world.
2) Concepts and stories with content that minimally violate these inferences are easier to remember than ideas and narratives that are a) entirely consistent with this inferential knowledge or b) 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 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 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* religious concepts' persistence and ubiquity.

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 taken place that has caused the very notion of an MCI has become 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 of a long history of studies that found novel, bizarre, and/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, and/or genetically endowed faculties

[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; Samuels et al. 1999; Segal 1996; Sperber 1996, 2002; Pinker 2005a, 2005b). 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).

and information that function and vary when provided the right 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 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 and/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 keeping in mind 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 about (or saying) 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"), along 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 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 (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 maintain that such mechanisms 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), they can understand the basics of small numbers and amounts (McCrink, 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, Ferry, & Rips ,2009; Hespos, Dora, Rips, & Christie, 2011). 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, Cosmides, & Tooby, 1992; Barrett, Dunbar, & Lycett, 2002; Buss, 2004). These cognitive systems provide a

[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 and Richerson, 1985:2) or "the information capable of affecting individuals' phenotypes which they acquire from other conspecifics by teaching or imitation" (33). This is akin to ideational concepts of "culture" such as Goodenough's ([1957] 1964): "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" (36; 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* by exposure to incoming 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, 1995; Johnson, 2000; Johnson, 2003). Though we have intuitions 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.

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 membership (Boster, 2005; Carey, 2009; D'Andrade, 1995; Keil, 1996; Spelke & Kinzler, 2007; Wellman & Gelman, 1992). 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, ANIMAL, PLANT, ARTIFACT, and NATURAL OBJECT, though other and/or deeper categories are often listed as well.[4,5]

[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 (2002:96) and others (Sperber, 1996; Boyer, 1994) suggest that LIVING KIND and STUFF are "basic ontological categories" (Atran 2002:96). Elsewhere, Atran (2002) identifies the "conceptually primary ontological categories…[as] PERSON, ANIMAL, PLANT, ARTIFACT, SUBSTANCE" (98, emphasis added). 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 naïve 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) 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 (95). 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 which 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.

According to Boyer (1998), "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" (p. 878). According to Atran (2002), these "specific forms of inference" are "innate, modular expectations" (p. 96).[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 [*sic*] 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 (379; see too Boyer, 2001, pp. 112-120).

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,

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

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" (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.

[7] This model is purposely anachronistic; these "inference systems'" are from Barrett (2008) which we discuss in Section 3.2.

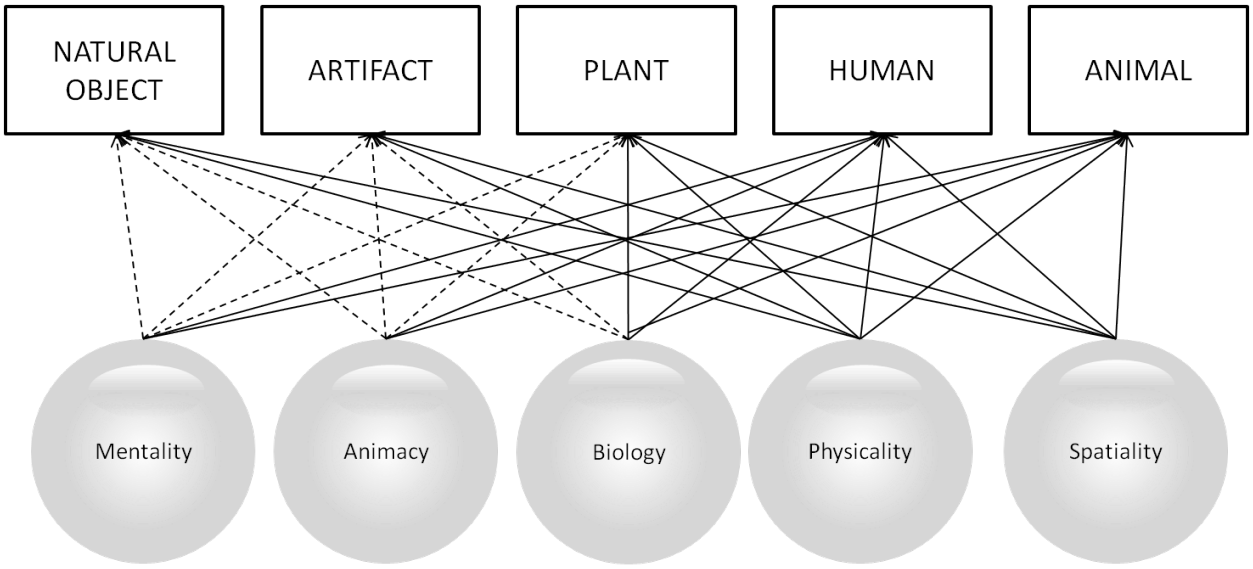

Figure 1. Deep inferential systems informing basic ontological categories[8]

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). So, 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

[8] An alternative way to illustrate this would be to hierarchically organize ANIMATEs and INANIMATEs, and have branches to ANIMALs, PERSONs, 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.

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, an:

> 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).

Barrett (2008) 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 (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 formally investigate the relationship between "basic parts of human nature" and how they interact with locally specific 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 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 non-random would be detected as having a mind. A *shallow inference* might be that upon seeing this objects' fur, drool, and forward-facing ears, you determine that it is a dog and it wants a bone.[9]

[9] 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).

2.2.2. Religion and the Epidemiology of Representations

Sperber (1996) 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" (p. 113). 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, he predicts that "beliefs which violate head-on module-based expectations…thereby gain a salience and relevance that contribute to their cultural robustness" (p. 140). Consistent with this view, Boyer (1994) popularized the argument for the "counterintuitiveness" of religious ideas insofar as they are "counterontological" (2001); such ideas are made possible by default conceptual domains and easier to retain because they violate the default, *deep inferences* informing these core categories (Boyer, 2000, 2001; Barrett, 2000).

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 which 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 (i.e., a concept that makes those dotted lines solid). Notice that transfers take place only by applying inferences typically granted to agents (ANIMALs and HUMANs) to non-agents (ARTIFACTs, PLANTs, and NATURAL OBJECTs). Breaches occur when incoming concepts contain elements consistent with when the solid lines become dotted.

Boyer and Ramble (2001) suggest that "culturally successful religious concepts belong to a small number of recurrent types or *templates*" which have the following features: a "pointer to a particular domain concept" (e.g., HUMAN, ANIMAL, etc.), "an explicit representation of a violation of intuitive expectations", and "a link to (nonviolated) default expectations for the category" (p. 537). Moreover, "Religious *concepts*," they state, "are more specific than *templates*, in that they add to the template two other entries" which are "a slot for additional encyclopedic information" and "a lexical label" (Boyer and Ramble, 2001, p. 537). Elsewhere (Boyer 2001), "template" refers to "recipes…that build religious concepts by producing inferences on the basis of some information provided by other people and by experience" (p. 54) *and* the aforementioned ontological categories (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.[10]

MCI theory continues to be a primary area in the field and "counterintuitive" continues to characterize religious concepts in the literature (e.g., Cohen, 2008; McCauley, 2011; Slone, 2004; Tremlin, 2006).[11] 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-Norquist, Shaw, & Xygalatas, 2013; Porubanova, Shaw, McKay, & Xygalatas, 2014; Purzycki, 2010, Willard, Henrich, & Norenzayan, n.d.). Among Boyer and Ramble's (2001) inaugural studies, they 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

[10] 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 "counterschematic" (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 counterschematic 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 folkphysical systems is just as intuitive as "a cat eating cat food", something that consists of a schematically consistent relationship.

[11] Cohen (2007), for instance, explicitly acknowledges her use of MCI theory to *characterize* (p. 121) 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" (p. 117). On why this may not be the case, see note 24 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 Sperber (1996) resists interpretivism; namely "An *interpretation* is a representation of a representation with a similar content" (34); 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.

difference across these categories. Barrett and Nyhof (2001) read American Indian folktales 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 5 MCIs, the half counterintuitive or "equal" condition had 9, and the "maximally counterintuitive"—MAX-CIs—had 13 MCIs). 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 folktales had 2-3 MCI items in them. Slone et al. (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 which 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 > 1 and counterschematic 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 and Barrett et al. (2009) analyzed the counterintuitive content of European folktales finding that a majority of them 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 was 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 study (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, finding 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, 2012) finding that INTs were just as stable as MCIs throughout the evolution of a single folktale. Lisdorf (2004) found that MCI concepts are more common than "bizarre" or INTs in Roman prodigies recorded between 218 to 44 BCE. One study found that MCIs were considered to be more "religious" than INTs (Pyysiänen, Lindeman, & Honkela,

2003). One more recent study (Fondevila, Martín-Loeches, Jiménez-Ortega, Casado, Sel, Fernández-Hernández, & Sommer, 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 non-religious MCIs (e.g., "From his beard came out wardrobes"), suggesting that actual religious MCIs are *more* intuitive than non-religious 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 & 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).[12] 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"

[12] 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, p. 70-71), drawing from Atran (1990, p. 215) who drew from Kant (1928 [1790], §59), 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" (p. 222). 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 are, indeed, also schematic processes insofar as the cognitive requirements drawn upon to make sense of symbols are nevertheless schematic information. Boyer uses "schemas" differently, explicitly stating that "Counterintuitive assumptions, obviously, are nonschematic; they appear counterintuitive precisely because there is no causal nexus from which they could be inferred" (83). 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", etc. (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" (p. 73). MCI research has yet to consistently and satisfactorily address this. See note 13.

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're 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 us to infer that the word *rest* completes the fourth phrase, but readers who are unfamiliar with the song will lack the appropriate schematic content. The point is, cultural schemas are *shared* and socially transmitted inferential systems 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 cultural schema is familiar to us. Unlike the relative rigidity of modules, schemas are more flexible clusters of informational units which 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, folkpsychology, 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., not culturally correct and/or 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 *counterschematic* because they violate schemas (see Section 3.2). *Counterschematic* 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 & Abrahamasen, 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; Ramsey & Stich, 1990). 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) 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" (p. 101).[13]

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), "for a connectionist system, learning is accomplished not by adding or modifying propositions, but rather by changing the connection weights between the simple units" (p. 38). Connectionism focuses on learning, retention of, and the relationships between informational units whereas modularity purports that there are innate learning principles and computational systems already at work in processing input. While connectionism is analogous

[13] 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 and 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.

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) introduced.[14] 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.

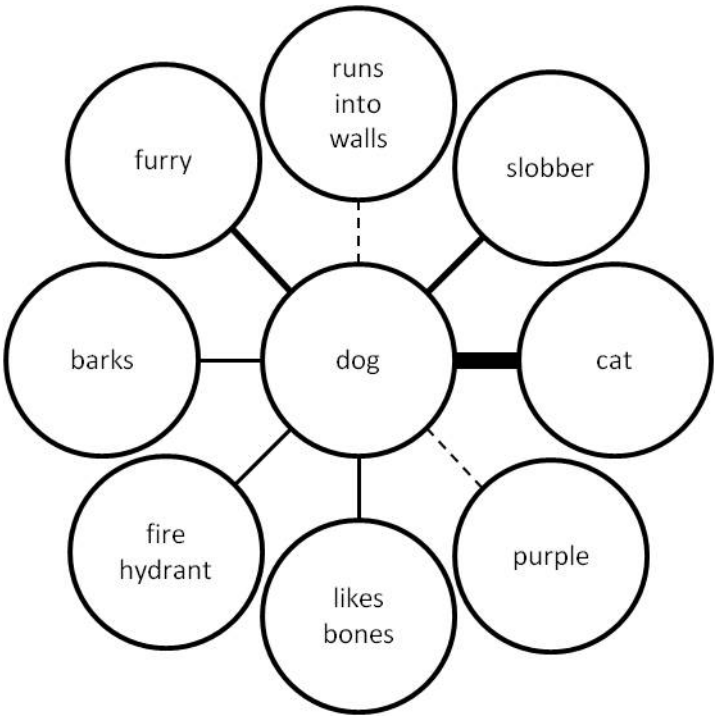

Figure 2. Hypothetical dog schema

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

[14] 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.

"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 renders more information to gain salience and accessibility.

As researchers, we can quantify 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 any given domain) of each item within a "cultural" domain. Conceptual proximity can be measured using free-lists, pile-sorts, taxonomic coding, 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, 1998; Smith, Furbee, Maynard, Quick, & Ross, 1995; Thomson & 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 its emphasis on *deep inferential* information rather than explicit, "cultural" models, their constituent units, and/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: a) where the inferences come from and b) 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 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 snap-shot 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/core cognitive systems rapidly at work 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, and the context 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, which constrains the available sub-directories of information.

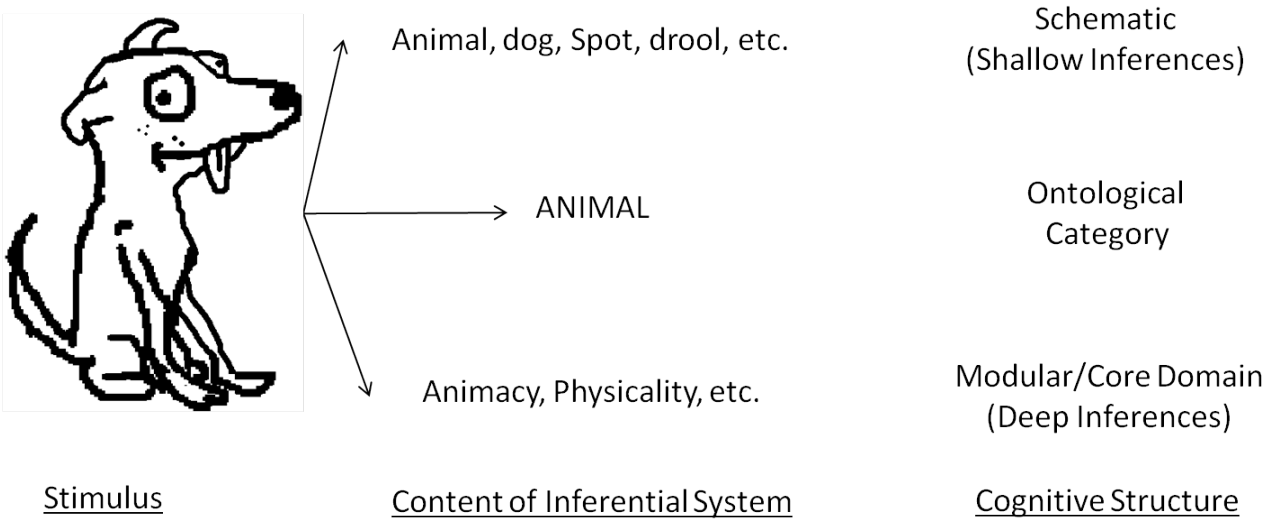

Figure 3. Synthetic Model of Cognitive Structures

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 = counterschematic; MCI = minimally counterintuitive; Br = Breach; Tr = Transfer; ? = unclearly defined

Table 1. Types of Incoming Concepts by Category

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 counterschematic. 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 counterschematic 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 parts. But, it may also simultaneously grab our attention by virtue of the close conceptual proximity/higher connection weight between "dog" and "cat".[15]

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

[15] 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" (74). This appears to be completely backwards 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 10.

concerning what does and does not constitute a public representation of a counterintuitive idea. Perhaps these differences alone account for the differences in results" (309). As we discuss below, these problems not only persist, but also run deeper and wider.

3. Counterintuitive vs. Counterschematic

Some have explicitly examined the distinctions between *deep* and *shallow inferences*. On the empirical end of things, Johnson et al. (2010) found that MCIs are easier to retain than counterschematic 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 *counterschematic* 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") (115). 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 (e.g., "a corn stalk that enjoys husking people") *and* without (e.g., "a goose that drinks really cheap whiskey") MCIs were rated as significantly funnier than MCIs without counterschematic content. Elsewhere (2010), he found that only items with parallel violations—MCIs *with* humorous counterschematic content—were recalled more frequently than MCIs, INTs, and counterschematic items. While they did not consider the emotional salience triggered by items like "illiterate teacher", "democratic skunk", or "vomiting birch", Porubanova-Norquist et al. (2013, 2014) found that discrete *counterschematic* 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 a) our minds indeed make sense of and retain different kinds of novelties in different ways and that b) parallel violations can occur. However, the distinction between counterintuitive and counterschematic 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. Counterschematic 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 90s 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 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, Whelley & Palij, 1989). Though these sentences were not conceived of as MCIs, many of them seem to occupy the same schema/ontological category grey-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, Dunn, Kahl, Sadler, & Simmons, 1990; Robinson-Riegler & McDaniel, 1994); it works in mixed lists, but not lists of all bizarre items compared to lists of all common ones (McDaniel & Einstein, 1986; Kroll & Tu, 1988; for a similar MCI effect see Norenzayan, Atran, Faulkner, & Schaller, 2006); and the effect disappears when participants are led to expect bizarre content (Hirshman, Whelley, & Palij, 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 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). Though under certain conditions, bizarre stimuli are more memorable than common stimuli, 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 and Einstein, 1986, Experiment 2), and 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, then it needs to overcome some of the constraints and issues associated with the memorability of unusual content more generally.

3.2. Shifting Focus: Content vs. Context(s)

In an attempt to clarify the muddiness of what makes a concept minimally counterintuitive, Barrett (2008) 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…*do not necessarily map onto genuine ontological distinctions*" (317, emphasis added; Fig. 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 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 "counterschematic". 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 (2008) 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 (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, 2013).

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, which may or may not be consistent with one another.[16] Third, such a model ignores the variation we find across individuals in their model of God 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 (2008) 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, $MIND_m$ (p. 328).

[16] 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 getting 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.

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 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.[17]

Some have hinted at this problem by suggesting that religious ideas are therefore intuitive and have attempted to understand the role "context" plays in the retention and recollection of MCIs by way of framing narratives using counterintuitive and intuitive frames. For instance, Tweney et al. (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 on 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) take this further and argue that "counterintutiveness" is really only "a subjective assessment" depending on the individual's judgment (p. 742). Such positions are on to something, but from

[17] This point relates to the notion of "theological" or "cultural correctness," which is doctrinal information that people are *supposed* to say or believe (Barrett, 1998; Barrett & Keil, 1996; Purzycki, 2013a; Purzycki, Finkel, Shaver, Wales, Cohen, & Sosis, 2012; Slone, 2004). The "correct" part of theology and other ideologies is a matter of explicit, schematic cognitive models that correspond to others'. They are "correct" when they correspond to the majority or 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* and/or *shallow* inferential processes running counter to authoritative and/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).

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 ostensibly was grounded in how our minds *interact* with incoming information, not whether or not the incoming information has inherent qualities (cf. Upal, 2007; Upal, Gonce, Tweney, & Slone, 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".[18]

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.

[18] Russell and Gobet (2013) "regard counterintuition as a highly semantic phenomenon" that is "unique to the individual" (743). 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 "counterintution" 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.

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; Fig. 1).[19]

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, but it is crucial for MCI theory and other cognitive research relying on or investigating the "explicit" or "cultural" as distinct from "intuitive" and "natural". However, this distinction might only be relevant in memory studies or to cultural transmission only upon *initial* exposure to concepts with little 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

[19] 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 counterschematic 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, 2008; 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" vs. "nonreflective" beliefs). At least in the case of determining the relative "naturalness" of religion and science, McCauley (2013) acknowledges that his typology is comparative and remains beyond our ability to measure (166). 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.

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 counterschematic relative to its objects' 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.[20]

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 (see Pinker, 1999; Pinker & Prince, 1988 for similar arguments for language). Though young children intuitively use purpose-based explanations of objects (the rock is pointy so animals don't 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

[20] There is variation in how these faculties operate with predictable effects on memory. In line with this idea, Willard, Henrich and Norenzayan (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, but, rather, that variation in *deep* inferential processes' functions do. 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.

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) 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.)" (p. 131). 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 and 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 (2008) 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" (p. 309). 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, Atran, Faulkner, & Schaller, 2006; Tweney, Upal, Gone, Slone, & Edwards, 2006) designate concepts as counterintuitive that—according to the model outlined above—constitute counterschematic or intuitive concepts. For instance, these studies consider "swimming cow", "admiring frog", and

"melting lady" (or "grandfather") 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, Haque, & Spelke, 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.[21] In other cases of indirect MCIs, Boyer (2000) claims that "a table that breathes" is an MCI concept as it uses "biological information associated with the ANIMAL category" (p. 198). Barrett (2008) uses "a statue that cries" as an

[21] 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).

example of an MCI because "crying is a behavior in the domain of living things" (p. 312). Banerjee et al. (2013) include a "crying mailbox" among MCIs.[22]

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 suggesting 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 cup" count as a *transfer* because is applies "biological information associated with the ANIMAL category" to an ARTIFACT? According to Barrett's (2008) updated model, these concepts have the potential to be coded as ^{B}ROCK or ^{B}CUP. 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're left with the false assumption that *any generally assumed conceptual relationship having anything to do with ANIMACY, BIOLOGY, etc. that gets "misapplied" or "breached" is an MCI*.

[22] 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).

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, Atran, Faulkner, & Schaller, 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 an MCI. 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, Kelly, & Bishop, 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 counterschematic 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 sought to bring to bring some of these deeper problems to light. We now turn to some precautionary measures if MCI theory is to continue 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 more convincingly test MCI hypotheses. The workings of the human mind are partly due to rule-based systems interacting with the world, and these rules are made possible by genetic endowments. 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*. Counterschematic 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. "A newt that likes to chew on bones" transfers information more typically associated (i.e., with a greater connection weight) with dogs to newts. A "rainbow-colored dog" breaches standard schematic prototypes of dogs and are therefore counterschematic. 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 counter-argument 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 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 et al., 2008), and to computers, cars, the weather, and the universe (Dennett 1971, 1987; Guthrie 1980, 1995; Waytz, Cacioppo, & Epley 2010). The application of mental states might be something 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's schemas all the way down—or there are no schemas and it's *deep inferences* all the way up—then MCI theory is just another strange-idea-therefore-easier-to-remember theory and therefore there is nothing to define it. Yes, religious ideas are often strange relative to their objects' secular equivalents, but not always in ways that are consistent with the various

models. 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 counterschematic 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 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 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, 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, pre-tests (e.g., ratings of separate samples) could help control for items that trigger differently valenced emotions, which likely impacts retention.

In summary, we emphasize the need to know your participants' explicit internal and external environments in order to understand how the *content* of religious concepts takes the form 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 actually have tested MCI theory grounded in perception), all *recalled* data is, 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 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've been bad or good.[23] Barrett (2008b) informally assessed Santa Claus' status as a potential god concept and found that Santa 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 towards him. In response, Gervais and Henrich (2010) ask why people would commit to one god over another even though they 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

[23] 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" (and/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).

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. 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 and Henrich, 2010). However, such a view is not an alternative as much 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). While evolved psychology, content of beliefs, and their context of transmission together give us a more enriched, dynamic view of the distribution of concepts (and we need it), none help us make much sense of why such concepts are *religious* concepts, let alone their ubiquity. 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 previously held (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 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)[24]. 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, 2012; Purzycki & Sosis, 2010, 2013). In this view, MCIs appear to be entirely peripheral to religion (as do myths and folktales); 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 they do.

We still do not know how and why people *use* MCIs (outside of, perhaps, the advertising industry; Upal, 2007[25]). Assuming people use them, *when* do people use them? Do they actually

[24] Researchers have demonstrated that people view MCI content as more religious or supernatural than non-MCI content (Norenzayan et al., 2006; Pyysiänen, 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.

[25] 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, 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 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.

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, and/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 to even thoroughly establish 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 *pre-fabricated* MCI concepts and asked to *recall* them in laboratories, 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 et al., 2010; Sears, 1986 for further discussion). Additionally, religious concepts are often introduced to children and/or spontaneously generated by them (Emmons & Kelemen, 2014; Kelemen, 2004; Wigger, Paxon, and Ryan, 2013) rather than adults.[26]

[26] Perhaps it is the case that if 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.

Researchers have used lists, quasi-narratives made from lists, and analyzed folktales, 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. While 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"; p. 395, our emphasis), Purzycki (2013) analyzed stories 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 *counterschematic* 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 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) (though see Barrett, 2008b). If no such study exists, this would be a very unfortunate indicator that our understandings of religious concepts' cross-cultural representation, retention, and transmission is deeply 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 *counterschematic*, 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 not.[27] 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

[27] 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 et al., 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.

classes—when they exist—religious concepts might be maximally counterintuitive for a host of reasons (see, Nicholson, forthcoming, on a comparison between the Trinity and Buddhist concept of "No-Self"; Russell and 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 counterschematic 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, 2001 [1915]; 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 the nature of why we remember things. Recent evidence suggests a strong memory bias for information about challenges to fitness (see Broesch, Barrett, & Henrich, forthcoming; Nairne, Pandeirada, Gregory, & Van Arsdall, 2009; Sandry, Trafimow, Marks, & Rice, 2013; see volume 22, issue 1 of *Memory*) and this might provide a key point in helping us explain the ubiquity of religious concepts. However, memory need not be a focus.

Consider Sir Keith Vivian Thomas' (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 (p. 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), 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, researchers may systematically elicit data to test key hypotheses using extant methods and models of cognitive structures that have been otherwise ignored. Religious concepts can "attach" themselves to minds, but they also "attach" themselves to representations of places, events, people, artifacts, and so forth, objects of which function as external reminders, feedback loops, and pressures (see Basso, 1996; Hutchins, 2005, 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, Haque, & Sosis, 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 counterschematic 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 and/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 folktales 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" (Pyysiänen, 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.

References

Alba, J. W., & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin, 93*(2), 203-231.

Alcorta, C. S., & Sosis R. (2005). Ritual, emotion, and sacred symbols: The evolution of religion as an adaptive complex. *Human Nature, 16*(4), 323–359.

Anderson, J. R. (2007). *How can the human mind occur in the physical universe?* New York: Oxford University Press.

Anderson, D. C., & Buyer, L. S. (1994). Is imagery a functional component of the 'Bizarre Imagery' phenomenon? *The American Journal of Psychology, 107*(2), 207–222.

Apperly, I. A., & Butterfill, S. A. (2009). Do humans have two systems to track beliefs and belief-like states? *Psychological Review*, *116*(4), 953–970.

Atran, S. (1990). *Cognitive foundations of natural history: Towards an anthropology of science*. Cambridge: Cambridge University Press.

Atran, S. (1993). Whither "ethnoscience"? In P. Boyer (Ed.), *Cognitive Aspects of Religious Symbolism* (pp. 48-70). Cambridge: Cambridge University Press.

Atran, S. (1998). Folk biology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences, 21*(4), 547–609.

Atran, S. (2001a). The case for modularity: Sin or salvation? *Evolution and Cognition, 7*(1), 1-10.

Atran, S. (2001b). A cheater–detection module? Dubious interpretations of the Wason Selection Task and logic. *Evolution and Cognition, 7*(2), 187-193.

Atran, S. (2001c). The trouble with memes: Inference versus imitation in cultural creation. *Human Nature, 12*(4), 351-381.

Atran, S. (2002). *In gods we trust: The evolutionary landscape of religion*. New York: Oxford University Press.

Atran, S., & Medin, D. (2008). *The native mind and the cultural construction of nature.* Cambridge: MIT Press.

Baillargeon, R. (2008). Innate ideas revisited: For a principle of persistence in infants' physical reasoning. *Perspectives on Psychological Science*, *3*(1), 2–13.

Balikci, A. (1970). *The Netsilik Eskimo*. Prospect Heights: Waveland Press.

Banerjee, K., Haque, O. S., & Spelke, E. S. (2013). Melting lizards and crying mailboxes: Children's preferential recall of minimally counterintuitive concepts. *Cognitive Science, 37*(7), 1251–1289.

Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.). (1992). *The adapted mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge: The MIT Press.

Barrett, H. C., & Kurzban, R. (2006). Modularity in cognition: Framing the debate. *Psychological Review, 113*(3), 628-647.

Barrett, J. L. (2004). *Why would anyone believe in God?* New York: AltaMira Press.

Barrett, J. L. (2008a). Coding and quantifying counterintuitiveness in religious concepts: Theoretical and methodological reflections. *Method and Theory in the Study of Religion, 20*(4), 308–338.

Barrett, J. L. (2008b). Why Santa Claus is not a god. *Journal of Cognition and Culture*, *8*, 149–161.

Barrett, J. L., Burdett, E. R., & Porter, T. J. (2009). Counterintuitiveness in folktales: Finding the cognitive optimum. *Journal of Cognition and Culture, 9*(3), 271–287.

Barrett, J. L., & Lanman, J. A. (2008). The science of religious beliefs. *Religion*, *38*(2), 109–124.

Barrett, J. L., & Nyhof, M. A. (2001). Spreading non-natural concepts: The role of intuitive conceptual structures in memory and transmission of cultural materials. *Journal of Cognition and Culture, 1*(1), 69–100.

Barrett, L., with Dunbar, R., & Lycett, J. (2002). *Human evolutionary psychology*. Princeton: Princeton University Press.

Basso, K. H. (1996). *Wisdom sits in places: Landscape and language among the Western Apache*. Albuquerque: University of New Mexico Press.

Beakley, B., & Ludlow, P. eds. (1992). *The philosophy of mind: Classical problems, contemporary issues*. Cambridge: MIT Press.

Bechtel, W., & Abrahamsen, A. (2002). *Connectionism and the mind: Parallel processing, dynamics, and evolution in networks*. 2nd edition. Malden: Blackwell Publishing.

Bering, J. M. (2011). *The belief instinct: The psychology of souls, destiny, and the meaning of life*. New York: W. W. Norton and Company.

Berlin, B. (1981). The concept of rank in ethnobiological classification: Some evidence from Aguaruna folk botany. In R. W. Casson (Ed.), *Language, culture, and cognition: Anthropological perspectives* (pp. 92-113. New York: Macmillan Publishing Co., Inc.

Bloch, M. (2002). Are religious beliefs counter-intuitive? In N. K. Frankenberry (Ed.), *Radical interpretation in religion* (pp. 129–146). Cambridge: Cambridge University Press.

Bloom, P. (2005). *Descartes' baby: How the science of child development explains what makes us human*. New York: Basic Books.

Bloom, P. (2007). Religion is natural. *Developmental Science*, *10*(1), 147–151.

Boster, J. S. (2005). Categories and cognitive anthropology. In H. Cohen and C. Lefebvre (Eds.), *Handbook of categorization in cognitive science* (pp. 92-118). San Diego: Elsevier.

Boyd, P. J., & Richerson, R. (1985). *Culture and the evolutionary process*. Chicago: University of Chicago Press.

Boyer, P. (1994). *The naturalness of religious ideas: A cognitive theory of religion*. Berkeley: University of California Press.

Boyer, P. (1996). What makes anthropomorphism natural: Intuitive ontology and cultural representations. *The Journal of Royal Anthropological Institute, 2*(1), 83-97.

Boyer, P. (1998). Cognitive tracks of cultural inheritance: How evolved intuitive ontology governs cultural transmission. *American Anthropologist, 100*(4), 876–889.

Boyer, P. (2000). Functional origins of religious concepts: Ontological and strategic selection in evolved minds. *Journal of the Royal Anthropological Institute, 6*(2), 195-214.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. New York: Basic Books.

Boyer, P. (2002). Why do gods and spirits matter at all? In I. Pyysiäinen and A. Veikko (Eds.), *Current approaches in the cognitive science of religion* (pp. 68-92). New York: Continnuum.

Boyer, P. (2003). Religious thought and behaviour as by-products of brain function. *Trends in Cognitive Sciences, 7*(3), 119-124.

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

Broesch, J., Barrett, H. C., & Henrich, J. (forthcoming). Adaptive content biases in learning about animals across the life course. *Human Nature*.

Bulbulia, J. (2008). Meme infection or religious niche construction?: An adaptationist alternative to the cultural maladaptationist hypothesis. *Method and Theory in the Study of Religion, 20*(1), 67–107.

Burns, D. J. (1996). The bizarre imagery effect and intention to learn. *Psychonomic Bulletin & Review, 3*(2), 254–257.

Buss, D. M. (2004). *Evolutionary psychology: The new science of the mind*. New York: Pearson Education, Inc.

Callebaut, W. (2005). The ubiquity of modularity. In W. Callebaut and D. Rasskin-Gutman (Eds.), *Modularity: understanding the development and evolution of natural complex systems*. (pp. 3-28). Cambridge: MIT Press.

Callebaut, W., & Rasskin-Gutman, D. (2005). *Modularity: Understanding the development and evolution of natural complex systems*. Cambridge: MIT Press.

Calabretta, R., & Parisi, D. (2005). Evolutionary connectionism and mind/brain modularity. In W. Callebaut and D. Rasskin-Gutman (Eds.), *Modularity: understanding the development and evolution of natural complex systems*. (pp. 309-330). Cambridge: MIT Press.

Carey, S. (2009). *The origin of concepts*. New York: Oxford University Press.

Carey, S. (2014). On learning new primitives in the language of thought: Reply to Rey. *Mind & Language, 29*(2): 133-166.

Chomsky, N. (1980). *Rules and representations*. New York: Columbia University Press.

Chomsky, N. (2000). *New horizons in the study of language and mind*. Cambridge: Cambridge University Press.

Chudek, M., McNamara, R., Birch, S. A. J., Bloom, P., & Henrich, J. (n. d.). Developmental and cross-cultural evidence for intuitive dualism. *Submitted for Publication*.

Clark, A. (1991). Systematicity, structure representations and cognitive architecture: A reply to Fodor and Pylyshyn. In T. Horgan and J. Tienson (Eds.), *Connectionism and the philosophy of mind* (pp. 198-218). Boston: Kluwer Academic Publishers.

Cohen, E. (2007). *The mind possessed: The cognition of spirit possession in an Afro-Brazilian religious tradition.* Oxford: Oxford University Press.

Collyer, S. C., Jonides, J. & Bevan, W. (1972). Images as memory aids: Is bizarreness helpful? *The American Journal of Psychology, 85*(1), 31–38.

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason Selection Task. *Cognition, 31*, 187-276.

D'Andrade, R. G. (1992). Schemas and motivation. In R. D'Andrade and C. Strauss (Eds.), *Human motives and cultural models* (pp. 23-44). Cambridge: Cambridge University Press.

D'Andrade, R. G. (1995). *The development of cognitive anthropology*. Cambridge: Cambridge University Press.

De Cruz, H. (2013). Religious concepts as structured imagination. *International Journal for the Psychology of Religion*, *23*(1), 63–74.

Dennett, D. C. (1971). Intentional systems. *The Journal of Philosophy, 68*(4), 87–106.

Dennett, D. C. (1987). *The intentional stance*. Cambridge: The MIT Press.

Donahoe, B. R. (2003). *A line in the Sayans: History and divergent perceptions of property among the Tozhu and Tofa of South Siberia*. (Unpublished doctoral dissertation). University of Indiana.

Duranti, A. (1997). *Linguistic anthropology*. Cambridge: Cambridge University Press.

Durkheim, É. (2001 [1915]). *The elementary forms of religious life*. Oxford: Oxford University Press.

Einstein, G. O., McDaniel, M. A., & Lackey, S. (1989). Bizarre imagery, interference, and distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*(1), 137–146.

Elman, J. L., Bates, E. A., Johnson, M. H., Karmiloff-Smith, A., Parisi, D., & Plunkett, K. (1996). *Rethinking innateness: A connectionist perspective on development*. Cambridge: The MIT Press.

Emmons, N. A., & Kelemen, D. (2014). The development of children's prelife reasoning: evidence from two cultures. *Child Development*.

Epley, N., Akalis, S., Waytz, A., & Cacioppo, J. T. (2008). Creating social connection through inferential reproduction: Loneliness and perceived agency in gadgets, gods, and

greyhounds. *Psychological Science, 19*, 114–120.

Fodor, J. A. (1981). *RePresentations: Philosophical essays on the foundations of cognitive science*. Cambridge: MIT Press.

Fodor, J. A. (1983). *The modularity of mind: An essay on faculty psychology*. Cambridge: The MIT Press.

Fodor, J. A. (1998). *In critical condition: Polemical essays on cognitive science and the philosophy of mind*. Cambridge: MIT Press.

Fodor, J. A. (2005). Reply to Steven Pinker 'So how does the mind work?' *Mind and Language, 21*(1), 25-32.

Fodor, J. A., & Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. *Cognition, 28*(1-2), 3-71.

Fondevila, S., Martín-Loeches, M., Jiménez-Ortega, L., Casado, P., Sel, A., Fernández-Hernández, A., & Sommer, W. (2012). The sacred and the absurd--an electrophysiological study of counterintuitive ideas (at sentence level). *Social Neuroscience*, *7*(5), 445–457.

Garro, L. C. (2000). Remembering what one knows and the construction of the past: A comparison of cultural consensus theory and cultural schema theory. *Ethos, 28*(3), 275–319.

Gelman, R., Spelke, E. S., & Meck, E. (1983). What preschoolers know about animate and inanimate objects. In D. R. Robers and J. A. Sloboda (Eds.), *The acquisition of symbolic skills* (pp. 297–326). New York: Springer.

Gelman, R., Durgin, F. & Kaufman, L. (1995). Distinguising between animates and inanimates: Not by motion alone. In D. Sperber, D. Premack, and A. J. Premack (Eds.), *Causal*

cognition: a multidisciplinary debate (pp. 150–184). Oxford: Clarendon Press.

Gervais, W. M., & Henrich, J. (2010). The Zeus problem: Why representational content biases cannot explain faith in gods. *Journal of Cognition and Culture, 10*, 383-389.

Gervais, W. M., & Norenzayan, A. (2012). Analytic thinking promotes religious disbelief. *Science*, *336*(6080), 493–496. doi:10.1126/science.1215647

Gervais, W. M., Willard, A. K., Norenzayan, A. & Henrich, J. (2011). The cultural transmission of faith: Why natural intuitions and memory biases are necessary, but insufficient, to explain religious belief. *Religion*, *41*(1), 389–400.

Gibbon, J. (2008). God is great, God is good: Teaching god concepts in Turkish Islamic sermons. *Poetics, 36*(5–6), 389–403.

Gonce, L., Upal, M. A., Slone, D. J., & Tweney, D. R. (2006). Role of context in the recall of counterintuitive concepts. *Journal of Cognition and Culture, 6*(3), 521–547.

Goodenough, W. H. (1964 [1957]). Cultural anthropology and linguistics. In D. Hymes (ed.), *Language in culture and society: A reader in linguistics and anthropology* (pp. 36-39). New York: Harper & Row.

Gregory, J., & Barrett, J. (2009). Epistemology and counterintuitiveness: Role and relationship in epidemiology of cultural representations. *Journal of Cognition and Culture*, *9*(3), 289–314.

Guthrie, S. E. (1980). A cognitive theory of religion. *Current Anthropology, 21*(2), 181- 203.

Guthrie, S. E. (1993). *Faces in the clouds: A new theory of religion*. Oxford: Oxford University Press.

Guthrie, S. E. (2008). Spiritual beings: A Darwinian, cognitive account. In J. Bulbulia, R. Sosis, E. Harris, R. Genet, C. Genet, and K. Wyman (Eds.), *The evolution of religion: Studies, theories & critiques* (pp. 239-245). Santa Margarita: Collins Foundation Press.

Harmon-Vukić, M. E., & Slone, D. J. (2009). The effect of integration on recall of counterintuitive stories. *Journal of Cognition and Culture*, *9*(1), 57–68.

Harmon-Vukić, M., Upal, M. A., & Sheehan, K. J. (2012). Understanding the memory advantage of counterintuitive concepts. *Religion, Brain and Behavior, 2*(2), 121–139

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: Freely conferred status as a mechanism for enhancing the benefits of cultural transmission*. Evolution and Human Behavior, 22*, 165-196.

Henrich, J., & McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology, 12*, 123-135.

Henley, N. M. (1969). A psychological study of the semantics of animal terms. *Journal of Verbal Learning and Verbal Behavior*, *8*(2), 176–184.

Hespos, S. J., Ferry, A. L., & Rips, L. J. (2009). Five-month-old infants have different expectations for solids and liquids. *Psychological Science, 20*(5), 603–611.

Hespos, S. J, Dora, B., Rips, L. J., & Christie, S. (2011). Infants make quantity discriminations for substances. *Child Development, 83*(2), 554–567.

Hirschfeld, L. A., & Gelman, S. A. eds. (1994). *Mapping the mind: Domain specificity in cognition and culture*. New York: Cambridge University Press.

Hirshman, E. (1988). The Expectation-violation effect: Paradoxical effects of semantic relatedness. *Journal of Memory and Language, 27*, 40-58.

Hirshman, E., Whelley, M. M. & Palij, M. (1989). An investigation of paradoxical memory effects." *Journal of Memory and Language, 28*(5), 594–609.

Horgan, T., & Tienson, J., eds. (1991). *Connectionism and the philosophy of mind*. Boston: Kluwer Academic Publishers.

Hornbeck, R. G., & Barrett, J. L. (2013). Refining and testing "counterintuitiveness" in virtual reality: Cross-cultural evidence for recall of counterintuitive representations. *International Journal for the Psychology of Religion, 23*(1), 15–28.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge: MIT Press.

Hutchins, E. (2010). Cognitive ecology. *Topics in Cognitive Science, 2*(4), 705–715.

Johnson, C. V. M., Kelly, S. W., & Bishop, P. (2010). Measuring the mnemonic advantage of counter-intuitive and counter-schematic concepts. *Journal of Cognition and Culture, 10*(1), 109–121.

Johnson, S. C. (2000). The recognition of mentalistic agents in infancy. *Trends in Cognitive Sciences, 4*(1), 22–28.

Johnson, S. C. (2003). Detecting agents. *Philosophical Transactions of the Royal Society B: Biological Sciences, 358*(1431), 549–559.

Jordan, P. (2003). *Material culture and sacred landscape: The anthropology of the Siberian Khanty*. Walnut Creek: Rowman and Littlefield Publishers, Inc.

Kant, I. (1928[1790]. *The Critique of Judgment.* Translated by J. C. Meredith. Oxford: Oxford University Press.

Kaplan, R. M., & Pascoe, G. C. (1977). Humorous lectures and humorous examples: Some effects upon comprehension and retention. *Journal of Educational Psychology, 69*, 61-65.

Karmiloff-Smith, A. (1992). *Beyond modularity: A developmental perspective on cognitive science*. Cambridge: The MIT Press.

Keleman, D. (1999). The scope of teleological thinking in preschool children. *Cognition, 70* (3), 241–272.

Keleman, D. (2004). Are children "intuitive theists"? Reasoning about purpose and design in nature*. Psychological Science, 15*(5), 295-301

Keleman, D. (2012). Teleological minds: How natural intuitions about agency and purpose influence learning about evolution. In K. Rosengren, S. Brem, E. M. Evans, and G. M. Sinatra (Eds.). *Evolution challenges: Integrating research and practice in teaching and learning about evolution* (pp. 66-92)*.* Oxford: Oxford University Press.

Kelemen, D., & Rosset, E. (2009). The human function compunction: Teleological explanation in adults. *Cognition, 111*(1), : 138–143.

Kelemen, D., Emmons, N. A., Schillaci, R. S., & Ganea, P. A. (2014). Young children can be taught basic natural selection using a picture-storybook intervention. *Psychological Science*, *25*(4), 893–902.

Kleinsmith, L. J., & Kaplan, S. (1963). Paired associate learning as a function of arousal and interpolated interval. *Journal of Experimental Psychology, 65*(2), 190-193.

Kroll, N. E. A, & Tu, S-F. (1988). The bizarre mnemonic. *Psychological Research, 50*(1), 28–37.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

Lang, V. A. (1995). Relative association, interactiveness, and the bizarre imagery effect. *The American Journal of Psychology, 108*(1), 13–35.

Lansing, J. S. (1987). Balinese "water temples" and the management of irrigation. *American Anthropologist, 89*(2), 326–341.

Leslie, A. M. (1994). ToMM, ToBy, and agency: Core architecture and domain specificity. In L. A. Hirschfeld and S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 119-148). Cambridge: Cambridge University Press.

Lisdorf, A. (2004). The spread of non-natural concepts. *Journal of Cognition and Culture, 4*, 151–173.

Lombrozo, T., Kelemen, D., & Zaitchik, D. (2007). Inferring design evidence of a preference for teleological explanations in patients with Alzheimer's Disease. *Psychological Science, 18*(11), 999-1006.

Malley, B. E. (1995). Explaining order in religious systems. *Method and Theory in the Study of Religion, 7*(2), 5–22.

Malley, B. E. (1997). Causal holism in the evolution of religious ideas. *Method and Theory in the Study of Religion, 9*(4), 389–399.

Marcus, G. F. (1998). Rethinking eliminative connectionism. *Cognitive Psychology, 37*, 243-282.

Margolis, E., & Laurence, S. (2013). In defense of nativism. *Philosophical Studies*, *165*, 693–718.

McCauley, R. N. (2011). *Why religious is natural and science is not*. Oxford: Oxford University Press.

McCauley, R. N. (2013). Why science is exceptional and religion is not: A response to commentators on *Why Religion Is Natural and Science Is Not*. *Religion, Brain & Behavior*, *3*(2), 165–182.

McCauley, R. N., & Lawsom, E. T. (2002). *Bringing ritual to mind: Psychological foundations of cultural forms.* Cambridge: Cambridge University Press.

McClelland, J. L., Rumelhart, D. E., & Hinton, G. E. (1992). The appeal of parallel distributed processing. In B. Beakley and P. Ludlow (Eds.), *The philosophy of mind: Classical problems, contemporary issues* (pp. 269-288). Cambridge: MIT Press.

McCrink, K., & Spelke, E. S. (2010). Core multiplication in childhood. *Cognition, 116*(2), 204-216.

McDaniel, M. A., & Einstein, G. O. (1986). Bizarre imagery as an effective memory aid: the importance of distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12* (1), 54.

McDaniel, M. A., & Einstein, G. O. (1989). Sentence complexity eliminates the mnemonic advantage of bizarre imagery. *Bulletin of the Psychonomic Society, 27*(2), 117–120.

McDaniel, M. A., Einstein, G. O., DeLosh, E. L., May, C. P. & Brady, P. (1995). The bizarreness effect: It's not surprising, it's complex. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(2), 422–435.

McGraw, J. J. (2007). *Religion as representations: Towards a reconciliation of schema theory and the cognitive science of religion*. University of California, San Diego, Unpublished MA Thesis.

Nairne, J. S., Pandeirada, J. N. S., Gregory, K. J., & Van Arsdall, J. E. (2009). Adaptive memory: fitness relevance and the hunter-gatherer mind. *Psychological Science*, *20*(6), 740–746.

Nichols, S. (2002). On the genealogy of norms: A case for the role of emotion in cultural evolution. *Philosophy of Science, 69*, 234-255.

Nicholson, H. (forthcoming). Social identity processes in the development of maximally counterintuitive theological concepts: Consubstantiality and no-self. *Journal of the American Academy of Religion*.

Norenzayan, A., & Atran, S. (2004). Cognitive and emotional processes in the cultural transmission of natural and nonnatural beliefs. In M. Schaller and C. S. Crandall (Eds.), *The psychological foundations of culture* (pp. 149-169). Mahwah: Lawrence Erlbaum Associates, Publishers.

Norenzayan, A., Atran, S., Faulkner, J., & Schaller, M. (2006). Memory and mystery: The cultural selection of minimally counterintuitive narratives. *Cognitive Science, 30*, 1-30.

Pinker, S. (1999). *Words and rules: The ingredients of language*. New York: Basic Books.

Pinker, S. (2002). *The blank slate: The modern denial of human nature*. New York: Penguin Books.

Pinker, S. (2000). *The language instinct: How the mind creates language*. New York: Harper Perennial.

Pinker, S. (2005a). So how does the mind work? *Mind and Language, 21*(1), 1-24.

Pinker, S. (2005b). A reply to Jerry Fodor on how the mind works. *Mind and Language, 21*(1), 33-38.

Pinker, S., & Prince, A. (1988). On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. *Cognition, 28*(1-2), 73-193.

Porubanova-Norquist, M., Shaw, D., & Xygalatas, D. (2013). Minimal-Counterintuitiveness Revisited: Effects of cultural and ontological violations on concept memorability. *Journal for the Cognitive Science of Religion, 1*(2), 181-192.

Porubanova, M., Shaw, D. J., McKay, R., & Xygalatas, D. (2014). Memory for expectation-violating concepts: The effects of agents and cultural familiarity. *PLoS ONE*, *9*(4), e90684. doi:10.1371/journal.pone.0090684.

Premack, D. G., & Premack, A. (2003). *Original intelligence: Unlocking the mystery of who we are*. New York: McGraw Hill.

Premack D. G., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences, 1*, 515-526

Purzycki, B. G. (2006). *Myth, humor, and ontological templates: A study of the retention and transmission of mythical-religious ideas* (Unpublished M. A. thesis). University of Nebraska-Lincoln.

Purzycki, B. G. (2010). Cognitive architecture, humor and counterintuitiveness: Retention and recall of MCIs. *Journal of Cognition and Culture, 10*(1-2), 189–204.

Purzycki, B. G. (2011a). Humor as violation and deprecation: A cognitive anthropological account. *Journal of Cognition and Culture, 11*(1-2), 217-230.

Purzycki, B. G. (2011b). Tyvan cher eezi and the socioecological constraints of supernatural agents' minds*. Religion, Brain and Behavior, 1*(1), 31-45.

Purzycki, B. G. (2013a). The minds of gods: A comparative study of supernatural agency. *Cognition, 129*(1), 163-179.

Purzycki, B. G. (2013b). Toward a cognitive ecology of religious concepts: An example from the Tyva Republic. *Journal for the Cognitive Science of Religion, 1*(1), 99-120.

Purzycki, B. G., & Arakchaa, T. (2013). Ritual behavior and trust in the Tyva Republic. *Current Anthropology, 54*(3), 381-388.

Purzycki, B. G., & Sosis, R. (2009). The religious system as adaptive: Cognitive flexibility, public displays, and acceptance. In E. Voland and W. Schiefenhövel (Eds.), *The biological evolution of religious mind and behavior* (pp. 243-256). New York: Springer-Verlag.

Purzycki, B. G., & Sosis, R. (2010). Religious concepts as necessary components of the adaptive religious system. In U. Frey (Ed.), *The nature of God: Evolution and religion*, (pp. 37-59). Marburg: Tectum Verlag.

Purzycki, B. G., & Sosis, R. (2011). Our gods: Variation in supernatural minds. In U. Frey (Ed.), *Essential building blocks of human nature* (pp. 77-93). New York: Springer-Verlag.

Purzycki, B. G., & Sosis, R. (2013). The extended religious phenotype and the adaptive coupling of ritual and belief. *Israel Journal for Ecology and Evolution, 59*(2), 99-108.

Purzycki, B. G., Haque, O., & Sosis, R. (2014). Extending evolutionary accounts of religion beyond the mind: Religions as adaptive systems. In F. Watts and L. Turner (Eds.), *Evolution, religion, and cognitive science: Critical and constructive essays* (pp. 74-91). Oxford: Oxford University Press.

Purzycki, B. G., Finkel, D. N., Shaver, J., Wales, N., Cohen, A. B., and Sosis, R. (2012). What does God know? Supernatural agents' access to socially strategic and nonstrategic information. *Cognitive Science, 36*(5), 846-869.

Pyysiäinen, I. (2004). *Magic, miracles, and religion: A scientist's perspective*. Walnut Creek: AltaMira Press.

Pyysiäinen, I., Lindeman, M., & Honkela, T. (2003). Counterintuitiveness as the hallmark of religiosity. *Religion, 33*(4), 341–355.

Ramsey, W., & Stich, S. (1990). Connectionism and three levels of nativism. *Synthese, 82*, 177-205.

Rappaport, R. A. (1999). *Ritual and religion in the making of humanity*. Cambridge: Cambridge University Press.

Rey, G. (2014). Innate *and* learned: Carey, Mad Dog Nativism, and the Poverty of the Stimuli and Analogies (Yet Again). *Mind & Language, 29*(2), 109-132.

Reynolds, V., & Tanner, R. (1995). *The social ecology of religion* (2nd ed.). New York: Oxford University Press.

Richerson, R., & Boyd, P. J. (2005). *Not by genes alone: How culture transformed human evolution*. Chicago: The University of Chicago Press.

Richman, C.L., Dunn, J., Kahl, G., Sadler, L., & Simmons, K. 1990. The bizarre sentence effect as a function of list length and complexity. *Bulletin of the Psychonomic Society, 28*(3), 185–187.

Riefer, D., & Rouder, J. (1992). A multinomial modeling analysis of the mnemonic benefits of bizarre imagery. *Memory & Cognition, 20*(6), 601–611.

Riefer, D., & Lamay, M. (1998). Memory for common and bizarre stimuli: A storage-retrieval analysis. *Psychonomic Bulletin & Review, 5*(2), 312–317.

Robinson-Riegler, B., & McDaniel, M. A. (1994). Further constraints on the bizarreness effect:

Elaboration at encoding. *Memory & Cognition, 22*(6), 702–712.

Romney, A. K., & D'Andrade, R. G. (1964). Cognitive aspects of English kin terms. *American Anthropologist, 66*(3, Part 2), 146-170.

Rossano, M.J. (2012). The essential role of ritual in the transmission and reinforcement of social norms. *Psychological Bulletin*, *138*(3), 529-549.

Rossano, M.J. (2013). *Mortal rituals: What the story of the Andes survivors tells us about human evolution*. New York: Columbia University Press.

Russell, Y. I., & Gobet, F. (2013). What is counterintuitive? Religious cognition and natural expectation. *Review of Philosophy and Psychology, 4*(4), 715–749.

Samuels, R. (2002). Nativism in cognitive science. *Mind and Language, 17*(3), 233-265.

Samuels, R. (2004). Innateness in cognitive science. *Trends in Cognitive Sciences, 8*(3), 136-141.

Samuels, R., Stich, S., & Tremoulet, P. D. (1999). Rethinking rationality: From bleak implications to Darwinian modules. In E. LePore and Z. W. Pylyshyn (Eds.), *What is cognitive science?* (pp. 74-120). Malden: Wiley-Blackwell.

Sandry, J., Trafimow, D., Marks, M. J., & Rice, S. (2013). Adaptive memory: evaluating alternative forms of fitness-relevant processing in the survival processing paradigm. *PloS One*, *8*(4).

Schmidt, S. R. (1994). Effects of humor on sentence memory. *Journal of Experimental Psychology*, *20*(4), 953-967.

Schneider, D., Lam, R., Bayliss, A. P., & Dux, P. E. (2012). Cognitive load disrupts implicit theory-of-mind processing. *Psychological Science*, *23*(8), 842–847.

Scholl, B. J., & Leslie, A. M. (2001). Minds, modules, and meta-analysis. *Child Development*, *72*(3), 696–701.

Segal, G. (1996). The modularity of theory of mind. In *Theories of theories of mind*. P. Carruthers, and P. Smith, eds. Pp. 141-157. Cambridge: Cambridge University Press.

Seidenberg, M. S. (1994). Language and connectionism: The developing interface. *Cognition, 50*, 385-401.

Shariff, A., Purzycki, B. G., & Sosis, R. (2014). Religions as cultural solutions to social living. In A.B. Cohen (Ed.). *Culture reexamined: Broadening our understanding of social and evolutionary influences* (pp. 217-238). Washington D.C.: American Psychological Association.

Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: Cognitive style influences belief in God. *Journal of Experimental Psychology: General*, *141*(3), 423-428.

Shipman, A. C. S, & Boster, J. S. (2008). Recall, similarity judgment, and identification of trees: A comparison of experts and novices. *Ethos, 36*(2), 171–193.

Shore, B. (1996). *Culture in mind: Cognition, culture, and the problem of meaning*. New York: Oxford University Press.

Sibley, C. G., & Bulbulia, J. (2012). Faith after an earthquake: A longitudinal study of religion and perceived health before and after the 2011 Christchurch New Zealand Earthquake. *PLoS ONE, 7*(12), e49648. doi:10.1371/journal.pone.0049648.

Sinatra, G. M., Brem, S. K., & Evans, E. M. (2008). Changing minds? Implications of conceptual change for teaching and learning about biological evolution. *Evolution: Education and Outreach*, *1*(2), 189–195

Slingerland, E., & Chudek, M. (2011). The prevalence of mind–body dualism in Early China. *Cognitive Science, 35* (5), 997–1007.

Slone, D. J. (2004). *Theological incorrectness: Why religious people believe what they shouldn't*. New York: Oxford University Press.

Slone, D. J., Gonce, L., Upal, A., Edwards, K., & Tweney, R. (2007). Imagery effects on recall of minimally counterintuitive concepts. *Journal of Cognition and Culture, 7*(3), 355-367.

Smith, J. J., Furbee, L., Maynard, K., Quick, S., & Ross, L. (1995). Salience counts: A domain analysis of English color terms. *Journal of Linguistic Anthropology*, *5*(2), 203–216.

Sosis, R. (2007). Psalms for safety: Magico-religious responses to threats of terror. *Current Anthropology 48*(6), 903-911.

Sosis R., & Bressler, E. R. (2003) Cooperation and commune longevity: A test of the costly signaling theory of religion. *Cross-Cultural Research, 37*(2), 211–239.

Sørensen, J. (2004). Religion, evolution, and an immunology of cultural systems. *Evolution and Cognition, 10* (1), 61–73.

Spelke, E. S., Breinlinger, K., Macomber, J., & Jacobson, K. (1992). Origins of knowledge. *Psychological Review, 99*(4), 605-632.

Spelke, E. S., & Kinzler, K. D. (2007). Core knowledge. *Developmental Science, 10*(1), 89–96.

Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Malden: Wiley-Blackwell.

Sperber, D. (1997). Intuitive and reflective beliefs. *Mind and Language, 12*(1), 67-83.

Sperber, D. (2002). In defense of massive modularity. In E. Dupous (Ed.), *Language, brain and cognitive development: Essays in honor of Jacques Mehler* (pp. 47-57). Cambridge: MIT Press.

Strauss, C., & Quinn, N. (1997). *A cognitive theory of cultural meaning*. Cambridge: Cambridge University Press.

Steadman, L. B., & Palmer, C. T. (2008). *The supernatural and natural selection: Religion and evolutionary success*. Boulder: Paradigm Publishers.

Stubbersfield, J., & Tehrani, J. (2013). Expect the unexpected? Testing for minimally counterintuitive (MCI) bias in the transmission of contemporary legends: A computational phylogenetic approach. *Social Science Computer Review, 31*(1), 90–102.

Sugiyama, L. S., Tooby, J., & Cosmides, L. (2002). Cross-cultural evidence of cognitive adaptations forf social exchange among the Shiwiar of Ecuadorian Amazonia. *Proceedings of the National Academy of Sciences of the United States of America, 99*(17), 11537-11542.

Tremlin, T. (2006). *Minds and gods: The cognitive foundations of religion*. Oxford: Oxford University Press.

Tweney, R. D., Upal, M. A., Gonce, L. O., Slone, D. J., & Edwards, K. (2006). The creative structuring of counterintuitive worlds. *Journal of Cognition and Culture, 6*(3), 483-498.

Upal, A. (2005). Role of context in memorability of intuitive and counterintuitive concepts (pp. 2224–2229). *Presented at the Proceedings of the 27th Annual Meeting of the Cognitive Science Society*.

Upal, A. (2007). What is more memorable counterintuitive concepts interpreted metaphorically or literally?, in *Proceedings of the 29th Annual Meeting of the Cognitive Science Society*, pages 1581-1586, Lawrence Erlbaum Press.

Upal, M. A. (2010). An alternative account of the minimal counterintuitiveness effect. *Cognitive Systems Research, 11*(2), 194–203.

Upal, M. A., Gonce, L. O., Tweney, R. D., & Slone, D. J. (2007). Contextualizing counterintuitiveness: How context affects comprehension and memorability of counterintuitive concepts. *Cognitive Science, 31*(3), 415–439.

Waddill, P., & McDaniel, M. (1998). Distinctiveness effects in recall. *Memory & Cognition, 26*(1), 108–120.

Waytz, A., Cacioppo, J., & Epley, N. (2010). Who sees human?: The stability and importance of individual differences in anthropomorphism. *Perspectives on Psychological Science, 5*(3), 219–232.

Weir, D., & Richman, C. L. (1996). Subject-generated bizarreness: Imagery or semantic processing. *The American Journal of Psychology*: 173–185.

Wellman, H. M., & Gelman, S. A. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology, 43*(1), 337-375.

Whitehouse, H. (2004). *Modes of religiosity: A cognitive theory of religious transmission*. Walnut Creek: AltaMira Press.

Wigger, J. B., Paxson, K., & Ryan, L. (2013). What do invisible friends know? Imaginary companions, God, and theory of mind. *International Journal for the Psychology of Religion, 23*(1), 2–14.

Willard, A. K., Henrich, J., & Norenzayan, A. (n. d.). Memorability and believability of MCI content.

Willard, A. K., & Norenzayan, A. (2013). Cognitive biases explain religious belief, paranormal

belief, and belief in life's purpose. *Cognition*, *129*(2), 379–391.

Wilson, D. S. (2002). *Darwin's cathedral: Evolution, religion, and the nature of society*. Chicago: The University of Chicago Press

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*(1): 103–128.

Worthen, J. B. (2006). Resolution of discrepant memory strengths: An explanation of the effects of bizarreness on memory. In R. R. Hunt and J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 133–156). New York: Oxford University Press.

Worthen, J. B, & Roark, B. (2002). Free recall accuracy for common and bizarre verbal Information. *The American Journal of Psychology, 115*(3), 377–394.

Xu, F., Spelke, E. S., & Goddard, S. (2005). Number sense in human infants. *Developmental Science, 8*(1), 88–101.