

The Memorability of Supernatural Concepts: Effects of Minimal Counterintuitiveness, Moral
Valence, and Existential Anxiety on Recall

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Abstract

Within the cognitive science of religion, some scholars hypothesize (1) that minimally counterintuitive (MCI) concepts enjoy a transmission advantage over both intuitive and highly counterintuitive concepts, (2) that religions concern counterintuitive agents, objects, or events, and (3) that the transmission advantage of MCI concepts makes them more likely to be found in the world's religions than other kinds of concepts. We hypothesized that the memorability of many MCI supernatural concepts was due in large part to other characteristics they possess, such as their frequent and salient association with moral concerns and the alleviation of existential anxieties, and that without such characteristics they would fail to be memorable. We report the results of three experiments designed to test the relative contributions of minimal counterintuitiveness, moral valence, and existential anxiety to the memorability of supernatural ideas. We observed no main effects for minimal counterintuitiveness but did observe main effects for both moral valence and existential anxiety. We also found that these effects did not seem to stem from the greater visualizability of morally valenced concepts or concepts that concerned existential anxieties. These findings challenge important claims made by leading researchers regarding MCI concepts within the cognitive science of religion.

Keywords: minimal counterintuitiveness, cognitive science of religion, moral valence, existential anxiety, memory, recall, Knobe effect

The Memorability of Supernatural Concepts: Effects of Minimal Counterintuitiveness, Moral Valence, and Existential Anxiety on Recall

A central area of research within the cognitive science of religion has focused on ‘minimally counterintuitive concepts’—basic-level concepts that violate a small number of domain-level expectations. Examples include a dog that can talk or a statue that can weep. MCI concepts are to be contrasted with both intuitive concepts that include no domain-level expectation violations and highly counterintuitive concepts that involve multiple expectation violations—e.g., a dog that can talk, walk through walls, and be present in more than one place at the same time. Justin Barrett (2000, 2004b, 2008; Barrett & Nyhof, 2001) and Pascal Boyer (1994a, 1994b, 1995, 2000a, 2000b, 2001, 2002, 2003; Boyer & Ramble, 2001) have argued that the concepts most likely to be found in the world’s religions are MCI because (i) religions concern counterintuitive agents, objects, or events and (ii) MCI concepts enjoy a transmission advantage over both intuitive and highly counterintuitive concepts.

The notion of counterintuitiveness to which Barrett, Boyer, and others appeal is a technical one that is defined in terms of basic-level concepts and domain-level concepts (Hirschfeld & Gelman, 1994; Boyer & Ramble, 2001). Domain-level concepts are the most general ontological categories to which objects are psychologically represented as belonging. The number of domain concepts is thought to be rather small. Boyer (2001, p. 78; 2003, p. 119) suggests they may only include the concepts animal, person, living thing, natural object (including things like rivers or mountains), plant, and artifact.

Basic concepts can be illustrated by considering the level of abstraction at which it is most natural to think about one’s pets. Does most of your thinking about Fido proceed in terms of Fido

being (a) a Labrador Retriever–Poodle mix with a little bit of Beagle, (b) a dog, (c) a canine, (d) a mammal, (e) a vertebrate, (f) an animal, (g) a living thing, or (h) a material entity? You probably think of Fido primarily as a dog. According to Eleanor Rosch and her collaborators (1976), conceptually basic categories are never found at the most concrete or the most general levels of abstraction and possess a variety of cognitively important characteristics that distinguish them from other levels of categorization. Basic concepts possess higher category cue validity than more general and less general concepts and are the most inclusive categories “for which a concrete image of the category as a whole can be formed, [are] the first categorizations made during perception of the environment, [are] the earliest categories sorted and earliest named by children, and [are] the categories most codable, most coded, and most necessary in language” (Rosch et al. 1976, p. 382).

According to Barrett and Boyer, a counterintuitive concept is a basic concept that violates a domain-level expectation. Boyer (2003) explains:

Supernatural concepts are informed by very general assumptions from ‘domain concepts’ such as *person*, *living thing*, *man-made object*. A spirit is a special kind of *person*, a magic wand a special kind of *artefact*, a talking tree a special kind of *plant*. Such notions are salient and inferentially productive because they combine (i) specific features that violate some default expectations for the domain with (ii) expectations held by default as true of the entire domain. (p. 119)

Not everything that is bizarre will count as counterintuitive in the relevant sense. For example, a dog that meows and purrs would not be counterintuitive, since meowing and purring violate basic-level expectations rather than domain-level expectations. These behaviors would be unusual for Fido in virtue of the fact that Fido is a dog, not in virtue of the fact that Fido is an animal or a living thing. In contrast, a dog that never needs to eat would be counterintuitive.

A concept is minimally counterintuitive rather than highly counterintuitive if it includes only one or two breaches of domain-level expectations. A highly counterintuitive dog concept (i.e., one that departs from standard expectations in a number of ways) would be one that “passes through solid objects, is made of metal parts, gives birth to chickens, experiences time backwards, can read minds, and vanishes whenever you look at it” (Barrett, 2007, p. 771).¹

Barrett and Boyer contend that religion is typically defined in terms of belief in beings or entities with counterintuitive properties:

What separates supernatural concepts from natural concepts is a violation of intuitive expectations for a given ontological category. (Barrett, 2000, p. 31)

A cognitive science perspective offers a theoretically motivated working definition for a *god*: a counterintuitive agent that motivates actions—provided its existence is believed in. (Barrett, 2007, p. 772)

[‘Religion’] is a convenient label that we use to put together all the ideas, actions, rules and objects that have to do with the existence and properties of superhuman agents such as God. (Boyer, 2001, p. 9)

To sum up, *religious concepts invariably include information that is counterintuitive relative to the category activated.* (Boyer, 2001, p. 65)

Barrett and Boyer thus claim that counterintuitiveness is a necessary and not merely a prototypical feature of supernatural or religious ideas.²

¹ Barrett and Boyer acknowledge that many religious theologies attribute a large number of counterintuitive characteristics to divine beings. However, Barrett and Boyer draw an important distinction between theology and everyday religion, noting that highly counterintuitive concepts are found only “in the rarefied intellectual atmosphere of literate theology” yet are “all but absent in popular, culturally widespread forms of supernatural imagination” (Boyer, 2001, p. 85).

² Pyysiäinen, Lindeman, and Honkela (2003) echo this claim, contending that counterintuitiveness is “the hallmark of religiosity.” Atran and Norenzayan (2004, p. 714) concur, maintaining that religion involves “the culturally universal belief in beings who are imperceptible in principle, and who change the world via causes that are materially and logically inscrutable in principle.”

The point of departure for research on the hypothesized transmission advantage of MCI concepts is Dan Sperber's (1985, 1990, 1996) approach to the study of culture that he calls 'the epidemiology of representations.' According to Sperber, we can explain why some cultural ideas are more widespread than others by considering how human minds might be more likely to generate, transmit, and absorb those ideas. Just as some organisms have characteristics that make them more likely to survive and reproduce, some concepts appear to have characteristics that make them more likely to be remembered and transmitted to others. We can explain why ideas that are widespread take the particular forms they do by considering how universally shared cognitive processes or conceptual structures inform and constrain these ideas. Several researchers in the cognitive science of religion (e.g., Atran, 2002; Atran & Norenzayan, 2004; Norenzayan & Atran, 2004; Norenzayan et al., 2006; Barrett, 2000; Barrett, 2004b, 2008; Barrett & Nyhof, 2001; Boyer, 1994a, 1994b, 1995, 2000a, 2000b, 2001, 2002, 2003; Boyer & Ramble, 2001) have used the framework proposed by Sperber to investigate the psychological constraints and dynamics of the spread of supernatural or religious ideas.³

Barrett and Boyer hypothesize that minimal counterintuitiveness constitutes a 'cognitive optimum,' since MCI concepts do not overburden conceptual systems like highly counterintuitive ones but (unlike ordinary concepts) are interesting and challenging enough to garner special attention. Barrett and Boyer have performed several studies that seem to support this hypothesis. For example, Boyer and Ramble (2001) found that MCI concepts were recalled better than intuitive concepts or bizarre concepts that involve basic-level expectation violations.⁴ Barrett and Nyhof

³ Cf. the supplementary materials document associated with this paper for additional details on the epidemiological approach to culture, including how it differs from memetics.

⁴ Barrett and Boyer thus claim that their work on MCI concepts goes beyond existing work demonstrating a mnemonic advantage for bizarre ideas (Hirshman, 1988; Hirshman, Whelley, & Palij, 1989; Waddill & McDaniel, 1998).

(2001) found that individuals recalled counterintuitive items from culturally unfamiliar folk stories better than intuitive items in the same stories and that MCI concepts were more likely to be present after three retellings of a story than either intuitive or bizarre concepts. They also observed that this recall advantage persisted after a three month delay.⁵ Banerjee, Haque, and Spelke (2013) report a similar finding with seven- to nine-year-old children, who recalled MCI concepts better than intuitive or highly counterintuitive story items (both immediately and after a one week delay).

A number of researchers, however, have reported experimental results that seem to challenge Barrett and Boyer's claims about the mnemonic advantage of MCI concepts. Some of these challenges focus on the purported mnemonic advantage of MCI concepts over intuitive ones, while others focus on the role that 'inferential potential'—the ability of a concept "to generate thoughts, predictions, memories, mental imagery and other personal inferences in the mind representing it" (Gregory & Barrett, 2009, 291)—to the memorability of MCI concepts. However, not all of these challenges hold up under careful scrutiny.

Scott Atran and Ara Norenzayan (Atran & Norenzayan, 2004; Norenzayan & Atran, 2004; Norenzayan et al., 2006), for example, report that two-word intuitive items were recalled better than two-word MCI items (both immediately and after a one week delay). Using many of the same test items as Atran and Norenzayan, Gonce et al. (2006) report that when MCI items were embedded in what they call 'a relevant context,' they were recalled better than intuitive concepts, but that when items were presented in a list format, intuitive items were recalled better. They conclude that MCI concepts enjoy a transmission advantage only in certain contexts. There are, however, a number of problems with these attempts by Atran and Norenzayan and Gonce et al. to

⁵ Atran and Norenzayan (2004) and Norenzayan et al. (2006) also report that belief sets or narratives with a few MCI elements were recalled better than belief sets or narratives that contained only intuitive items or a large number of MCI items. Although theoretically significant, our focus will not be on the question of what mix of intuitive vs. MCI elements is optimal for the memorability of entire belief sets.

challenge previous research on MCI concepts. As Barrett (2004a) has pointed out, Atran and Norenzayan often fail to categorize items in accord with MCI theory and conflate the notions of counterintuitiveness, counterfactuality, category mistake, and contradiction. Barrett (2004, p. 732) also suggests that many of the items used by Atran and Norenzayan either “provide insufficient information to illicit any concept formation (e.g., ‘Solidifying Lady’),” or “may read as obtuse metaphors (e.g., ‘Cursing Horse,’ ‘Sobbing Oak’).” Because Gonce et al. (2006) borrowed many of Atran and Norenzayan’s research items, these problems affect their findings as well. An additional problem with Gonce et al.’s (2006, p. 521) research is that their claim “[w]hen relevant context was present, minimally counterintuitive concepts were recalled significantly better than intuitive concepts” is unwarranted by their own research. In none of their studies was there a statistically significant difference between the recall rates of MCI and intuitive concepts when context was provided.⁶

Another team of researchers, Porubanova et al. (2014), report that concepts that were not MCI but that involved the violation of learned, culturally-based expectations were recalled better initially (and recognized better after a one month delay) than MCI concepts. However, a number of the MCI items used in this study are quite difficult to comprehend. These include ‘democratic skunk,’ ‘liquid butcher,’ ‘evaporating rabbit,’ and ‘stalking table.’ We ran a follow-up study in which we asked 100 workers from Amazon’s Mechanical Turk (average age = 37, 35% female, 74% Caucasian) to rate how difficult (1 = Very difficult, 2 = Somewhat difficult, 3 = Neither easy nor difficult, 4 = Somewhat easy, 5 = Very easy) it was for them to understand the meaning of the items used in Porubanova et al.’s (2014) study.⁷ Participants rated the MCI items as considerably

⁶ For additional details concerning our concerns about these studies, cf. the supplementary materials document.

⁷ Each participant had at least a 97% approval rate on at least 5000 MTurk tasks and was paid \$.50 for their time.

more difficult to understand ($M = 2.1$) than culturally-based expectation violations ($M = 3.6$) or intuitive items ($M = 4.6$). A one-way ANOVA revealed these differences to be significant ($F(2, 2387) = 874.38, p < .001, \text{partial eta squared} = .42$). Although the MCI test items found in any study might be thought to present interpretative difficulties due to their unusual nature, Boyer (1994b, 2001) and Barrett (2004b) have consistently characterized MCI concepts as ideas that violate only one or two domain-level expectations but maintain coherence with other default expectations. The fact that the items used by Porubanova et al. (2014) seem particularly difficult to comprehend leads us to be concerned that the differences in recall they report might be due in large measure to differences in the comprehensibility of their test items.

A second set of studies that have challenged the claims of MCI theory concern the role that inferential potential is supposed to play within the theory. Barrett, Boyer, and others who work on MCI theory introduce the idea of inferential potential by noting that simply being MCI is not enough for a concept to warrant any attention or to be of any religious concern. Consider the following items:

- (1) Invisible sofas (Barrett, 2000, p. 30)
- (2) Invisible rocks (Barrett, 2000, p. 32)
- (3) Animals that are made in factories (Barrett, 2004b, p. 25)
- (4) Rocks that vanish every time someone looks at them (Barrett, 2004b, p. 25)
- (5) Human limbs that are made of green cheese except when people examine them (Boyer, 2001, p. 29)
- (6) A statue that disappears whenever we think about it (Boyer, 2001, p. 78)
- (7) An all-knowing but powerless divinity who cannot have any effect on what goes on in the world. (Boyer, 2001, ch. 2)

- (8) The spirits of deceased ancestors who watch us, notice everything we do but forget everything they learn instantaneously (Boyer, 2001, ch. 2)
- (9) A shaman who can predict future events—but only about thirty seconds in advance (Boyer, 2001, ch. 2)
- (10) Giggling seaweed (Atran & Norenzayan, 2004)
- (11) Confused table (Norenzayan et al., 2006)
- (12) A potato with no spatial location (Gregory & Barrett, 2009)

Each of these items is MCI, yet you will not find anything like them in the world's religions. What are they missing?

Barrett and Boyer hypothesize that in order to be found in actual religious beliefs and practices, MCI concepts must also have what they call 'good inferential potential.' Barrett (2004b, p. 25) describes inferential potential as "the potential to explain, to predict, or to generate interesting stories surrounding them." Boyer (2001) explains:

Legends about Santa Claus or the Bogeyman are interesting, even arresting, but they do not seem to *matter* that much, while people's notions of God seem to have direct and important effects on their lives. We generally call supernatural concepts "religious" when they have such important social effects, when rituals are performed that include these concepts, when people define their group identity in connection with them, when strong emotional states are associated with them, and so on. (p. 90)

Even though proponents of MCI theory like Barrett and Boyer maintain that MCI concepts need to be coupled with other properties to have inferential potential, they contend that what gives MCI-plus-inferential-potential concepts their transmission advantage is the MCI component rather than the other, added components. However, in the initial recall experiments performed by Barrett,

Boyer, and others, the contributions of “good inferential potential” and having “important social effects” were not controlled for.

Justins Gregory and Barrett (2009, 292) tried to control for the possible mnemonic effects of inferential potential in a study of MCI concepts by attempting to select stimuli with “relatively uniform inferential potential.” They chose test items on the basis of a pre-test in which 10 participants were asked to indicate how thought-provoking the items were (on a five-point scale ranging from ‘very thought provoking’ to ‘not very thought provoking’), which Gregory and Barrett took to be a proxy measure for degree of inferential potential. Items from each category of interest (MCI, intuitive, true by definition, false by definition) whose mean inferential potential scores fell closest to the neutral midpoint were selected from a larger pool of items. Gregory and Barrett (2009) then observed that definitionally (or necessarily false) items such as ‘a triangle that is 4-sided’ were recalled better than MCI items and that stimuli with higher inferential potential were better recalled than stimuli with low inferential potential. They also observed no effect of minimal counterintuitiveness on immediate recall. These results appear to challenge claims made by proponents of MCI theory that the memorability of MCI items will in general be due to their minimal counterintuitiveness rather than to their inferential potential.

However, we have difficulty understanding how a procedure that aimed to control for inferential potential could result in nonsensical items such as ‘a triangle that is 4-sided,’ ‘a bachelor that is married,’ ‘a rainbow that is colourless,’ ‘a solid that is gaseous,’ ‘a vowel that is numerical,’ and ‘an infant that is elderly’ having roughly the same inferential potential—i.e., as much potential “to generate thoughts, predictions, memories, mental imagery and other personal inferences in the mind representing it” (Gregory & Barrett, 2009, 291)—as the MCI items ‘a fly that is immortal,’ ‘a camel that is invisible,’ ‘a cup that is thinking,’ and ‘a cactus that is jumping.’ The analytically

false items are uninterpretable nonsense. Nonetheless, we applaud their aim to examine inferential potential more carefully and to attempt to control for it in experiments on MCI concepts.

Sources of inferential potential that have been explored by other researchers working on MCI theory include humor, agency, and familiarity (Purzycki, 2010; Porubanova et al., 2014; Gregory & Greenway, 2017a, 2017b). Benjamin Purzycki (2010), for example, found (both initially and after a one week delay) that humorous MCI concepts were recalled better than humorless MCI concepts and that humorless MCI concepts were not recalled any better than humorless intuitive concepts. This study raise questions about the ability of minimal counterintuitiveness alone to confer a mnemonic advantage.

An additional finding reported by Porubanova et al. (2014) that we did not mention above is that expectation-violating concepts that pertain to agents were observed to be recalled better than expectation-violating concepts that do not. However, Porubanova et al. (2014) classified all eight of the MCI plant and “object” test items in their study as non-agential, even though all of them are arguably agential. Their reasoning was that grapes, maple trees, tulips, birch trees, kettles, tables, trains, and chairs are not agents. However, the MCI versions of these items—viz., ‘barking grape,’ ‘jumping maple,’ ‘racing tulip,’ ‘vomiting birch,’ ‘hungry kettle,’ ‘stalking table,’ ‘talking train,’ and ‘worried chair’—appear to be agential. Agency seems uncontroversially required for racing, stalking, talking, and worrying, and it is plausibly also required for barking and jumping. Barking involves directing a signal toward an intended hearer. Jumping does not occur every time something leaves the ground; it occurs only when there is an intention to leave the ground. And even if vomiting and feeling hungry do not intrinsically involve agency, they are things that only agents are ever observed to do. These worries about coding apparently agential items as non-

agential lead us to have concerns about what Porubanova et al.'s (2014) study tells us about the impact of agency (understood as a possible source of inferential potential) on memorability.

In a pair of studies performed in the UK and China, Justin Gregory and Tyler Greenway (2017a, 2017b) examined the effect of familiarity on the memorability of MCI concepts. While they failed to observe a main effect for counterintuitiveness on recall, they did observe a significant interaction effect between counterintuitiveness and familiarity.⁸ Across both samples in each study, they found that familiar MCI concepts were better recalled than unfamiliar MCI concepts. They also found that negative emotional valence, humor, and level of interest significantly predicted recall of test items. These findings raise questions about the claim that minimal counterintuitiveness is the central driver of memorability for religious or supernatural concepts, as compared to various sources of inferential potential.⁹

One cautionary note about Gregory and Greenway's (2017a, 2017b) studies is that, among the eight test items that they coded as both familiar and MCI, it is not clear how 'a wolf that is acting,' 'a balloon that is hovering,' and 'a Venus flytrap that is grabbing' are MCI. While wolves certainly cannot perform in theatrical plays, they can engage in goal-directed behavior and thus can act in one very real sense of the term. Moreover, balloons float, and according to the Merriam-Webster dictionary (<https://www.merriam-webster.com/dictionary/float>), 'hover' is a synonym of 'float.' Moreover, a recent article on Venus flytraps describes them non-metaphorically as grabbing their prey (Tucker, 2010). The fact that these allegedly MCI items do not appear to be

⁸ Gregory and Greenway (2017a, 2017b) also observed a significant interaction between counterintuitiveness and age, with younger participants recalling MCI items at higher rates than intuitive items. It is less clear whether and how this finding challenges the central claims of MCI theory.

⁹ Gregory and Greenway (2017a) contend that these results actually support the original formulations of Boyer's (2001) hypotheses about minimal counterintuitiveness because his claims there were focused on the memorability of familiar MCI concepts rather than MCI concepts in general.

MCI creates a difficulty in understanding the particular nature of the challenge that the results of Gregory and Greenway (2017a, 2017b) pose for MCI theory.

In addition to the experimental challenges described above that have been raised against MCI theory, Purzycki and Willard (2016) have articulated a number of more theoretical challenges to the research program. We do not have space to rehearse their challenges in detail here, but they include questions about MCI theory's lack of clarity concerning the ways that acquired information interacts with innate inferential systems to form mature representations of MCI concepts, the fact that MCI theory ignores much of the content of religious ideas because of its exclusive focus on counterintuitiveness, and the fact that MCI theory's narrow focus on one feature of conceptual content leads it to neglect the important role that rituals and other social religious practices play in the acquisition, persistence, and spread of religious ideas.¹⁰ Our research is in the same vein as the second set of experimental work described above (Gregory & Barrett, 2009; Purzycki, 2010; Porubanova et al., 2014; Gregory & Greenway, 2017a, 2017b), which seeks to examine the relative contributions that minimal counterintuitiveness and inferential potential make to the memorability of MCI concepts.

We hypothesized that much of the memorability of memorable MCI concepts stemmed from the fact that they “generate interesting stories surrounding them” or have potentially “important social effects” and that without such characteristics they would fail to be memorable. More specifically, we hypothesized that MCI concepts that featured salient moral components or that concerned what Atran and Norenzayan (2004, p. 713) call ‘existential anxieties’—viz., death,

¹⁰ Purzycki and Willard (2016) also criticize work on MCI theory for a lack of consistency in what minimal counterintuitiveness is taken to consist in. A primary way that Purzycki and Willard (2016, 226 et passim) make this point is by noting how differently MCI concepts are treated by Barrett and Boyer, on the one hand, and Atran and Norenzayan (Atran & Norenzayan, 2004; Norenzayan & Atran, 2004; Norenzayan et al., 2006) and Gonce et al. (2006), on the other. Instead of taking this to represent significant inconsistency within MCI theory, we view this as a situation where critics of MCI theory (Atran & Norenzayan and Gonce et al.) failed to aim their critiques as carefully as they should have.

deception, disease, catastrophe, pain, loneliness, want, and loss—would be more memorable than MCI concepts that did not. Moreover, we hypothesized that concepts that were morally valenced or concerned existential anxieties but were not MCI might be more memorable than MCI concepts that lacked these forms of inferential potential.

Our hypothesis concerning moral valence and memorability was based upon a number of considerations. First, we noticed that many of the MCI concepts used in existing studies that were serious candidates for religious or supernatural concern also had salient moral characteristics. For example, in research materials that feature a village statue that weeps, the statue is not described as weeping when the sun is high in the sky but when the people of the village have defiled themselves. Secondly, it seems that moral concerns are one of central kinds of thing that have the “important social effects” that Barrett and Boyer claim characterize memorable MCI concepts. Thirdly, religions often concern themselves with moral behavior. Boyer (2002) seems to assume that this is invariably the case when he writes:

Supernatural agents are also represented as ‘interested parties’ in moral choices. This means that the gods or the ancestors are not indifferent to what people do, and this is why we must act in particular ways or refrain from certain courses of action. (p. 82)

However, work in anthropology shows this claim to be too strong. While reviewing ethnographic research on small-scale societies, Norenzayan (2013) writes:

A startling fact about the spirits and deities of foraging and hunter-gatherer societies is that most of them do not have wide moral concern.... The gods of hunter-gatherer bands vary in the degree of their involvement in human affairs, but typically are morally indifferent.... This tendency to assume that religions are universally concerned with morality is another

blind spot that is the unintended result of seeing the world through a WEIRD lens. (pp. 7, 195, 205)

Nevertheless, religion and morality are often intertwined to such a degree that we hypothesized that the moral valence of both MCI and non-MCI items would contribute significantly toward their memorability. A fourth consideration stemmed from recent work in experimental philosophy that has shown that the moral valence of actions—i.e., whether they are good or whether bad or satisfy or violate salient norms—has a significant and pervasive impact on attributions of intentionality, belief, and knowledge (Alfano, Beebe & Robinson, 2012; Beebe, 2013; Beebe & Jensen, 2012; Knobe, 2003a, 2003b, 2010; Pettit & Knobe, 2009) and judgments about causation and probability (Hitchcock & Knobe, 2009; Dalbauer & Hergovich, 2013). If moral valence can affect these different kinds of judgments, we thought these considerations alone made it likely that moral valence would affect memorability as well. In light of all these considerations, we thus hypothesized that moral valence was a key driver of the memorability of a number cultural concepts in general and many memorable MCI or supernatural concepts in particular.

Our hypothesis concerning existential anxiety and memory was also based upon a number of considerations. One is simply that existential anxieties are matters of preeminent concern. A second consideration is that religions often depict supernatural agents as mastering or alleviating people's existential anxieties (Atran & Norenzayan, 2004, p. 713). In addition, there are numerous findings showing that fitness-related information imparts a mnemonic advantage to concepts (Nairne & Pandeirada, 2008; Nairne, 2010, 2015; Nairne & Pandeirada, 2010, 2016; Nairne, Pandeirada & Fernandes, 2017). Since the existential anxieties that are of concern to many religions also relate to fitness, we expected the mnemonic advantage of fitness-related information to underwrite much of the memorability of many supernatural or religious concepts. Furthermore,

we thought that existential anxiety and morality were not unrelated, inasmuch as many of the competitive and cooperative interactions of concern to morality are typically also related to fitness or survival.

In the following sections, we report three studies that test the hypotheses articulated above. Study 1 examined the contribution of moral valence to memorability on its own and found that negatively valenced items were recalled better than positively valenced or neutral items and that positively valenced items were recalled better than neutral ones. Study 2 compared the relative contributions of moral valence and minimal counterintuitiveness to memorability and found a main effect for moral valence but not for minimal counterintuitiveness. Study 3 compared the contributions of existential anxiety and minimal counterintuitiveness to memorability and found a main effect for existential anxiety but not for minimal counterintuitiveness. Study 4 examined the ease with which individuals can form vivid mental images of the research items used in Studies 1 through 3 and found that the observed differences in recall in these studies did not seem to be due to the greater visualizability of the more memorable items. Thus, we found that some of the characteristics of concepts that give them ‘good inferential potential’ predicted recall but that minimal counterintuitiveness alone did not. Our findings represent an important challenge to key theses regarding minimal counterintuitiveness that have been put forward by Barret, Boyer, and others in recent years within the cognitive science of religion, insofar as these scholars have claimed that it is minimal counterintuitiveness that is the central driver of the memorability of religious or supernatural concepts.

1. Study 1

Study 1 was a recall experiment that tested the hypothesis that moral valence can affect recall.

1.1. Methods

1.1.1. Participants

Participants were 54 students (average age = 19, 56% female, predominantly Caucasian) from a large, public university in the northeastern United States. They were given course credit for their participation.

1.1.2. Materials and procedure

Study 1 was patterned after one of the first experiments Barrett performed on MCI concepts (reported in Barrett & Nyhof, 2001). Barrett and Nyhof (2001) directed participants to read a story that described an ambassador's visit to a museum on another planet. The museum had 18 exhibits, 6 of which concerned various types of non-living physical objects, 6 that illustrated different kinds of plants and animals, and 6 that presented an assortment of intentional agents. The items in each exhibit were generally described with two sentences, the first containing information about the general ontological category under which each item fell, and a second sentence that described whether the item was MCI, bizarre, or intuitive. The stories that Barrett and Nyhof (2001) used had a very minimal narrative structure. There was a main character, a beginning, and an ending; but the various components of the story were not woven together in any traditional narrative fashion. This allowed items of one kind to be easily replaced by items of another kind and for them to appear in different orders.

Barrett and Nyhof (2001) asked one group of participants to read through one of the stories twice, and then after a two minute delay, to type out the story as best they could remember it. A second group of participants read the retellings of the first group of students, and then after a

similar delay, typed out everything they could remember from the retellings. A third generation of participants performed the same task using the second generation retellings. As noted above, Barrett and Nyhof (2001) found that MCI concepts were more likely to be present in the third generation retellings than either intuitive or highly counterintuitive concepts.

In Study 1, we followed the same procedures as Barrett and Nyhof (2001) but replaced their descriptions of bizarre and counterintuitive attributes with descriptions of morally good and morally bad attributes. The intuitive items for which Barrett and Nyhof provided descriptions in their article were left unchanged and were thus coded as morally neutral. Descriptions of 19 neutral items, 18 good items, and 17 bad items were distributed across 3 stories, each of which came in 3 different orders. There were supposed to be 18 items of each type, but due to a transcription error, one bad item was misprinted as a neutral one. As we will see below, this mistake enhanced rather than undermined the central finding of the study. Below are two of the item sets used in Study 1.

Item set 2:

Neutral: The next exhibit concerned a being that can only remember a limited number of events or pieces of information. It always tried to remember events or information that pertained to its daily activities.

Good: The next exhibit concerned a being that can only remember a limited number of events or pieces of information. It always tried to remember events or information that might help keep other beings safe.

Bad: The next exhibit concerned a being that can only remember a limited number of events or pieces of information. It always tried to remember events or information that it could use to manipulate and exploit other beings.

Item set 3:

Neutral: I continued through the dimly lit hall and came to an exhibit about a being that can see or hear things that are not too far away. For example, it could make out the letters on a page in a book if it is no more than eight feet away, provided its line of sight was not obstructed.

Good: I continued through the dimly lit hall and came to an exhibit about a being that can see or hear things that are not too far away. Whenever it wanted to help another being, it always made sure to stay within about eight feet of the being so that it could always see it clearly.

Bad: I continued through the dimly lit hall and came to an exhibit about a being that can see or hear things that are not too far away. Whenever it wanted to steal something, it always made sure to stay within about eight feet of the object so that it could see it clearly before stealing it.

A complete list of test items and details about the narrative frame can be found in the supplementary materials document that accompanies this article.

Participants were divided equally across three generations of story retellers. Participants sat at a computer workstation and read one of the three stories twice. They were not told in advance that they would be asked to perform a recall task. After a brief delay during which they filled out demographic information on the computer, participants were instructed to type out the story they read as best they remembered it. Second-generation participants came to the same computer lab at a later time, and each of them read two first-generation retellings of one of the stories. They were told that these were two versions of the same story. After a brief delay, these participants were also instructed to type out as much of the story as they remember. Each third-generation participant

read two second-generation retellings and performed the same task. Without telling participants that they would be contacted again, all participants were contacted via email two months after the experiment and were offered \$5 if they replied to the email indicating what they remembered from the story. Not enough participants replied after the two month delay to have sufficient data for analysis at this stage.

Two hypothesis-blind coders categorized participant retellings according to which original story items were recorded in some identifiable form and whether they were correctly described as neutral, good, or bad. Inter-rater reliability was greater than 95%. Disagreements were resolved through discussion.

1.2. Results

The numbers of neutral, good, and bad story items recalled by participants across three generations of retelling are represented in Figure 1.

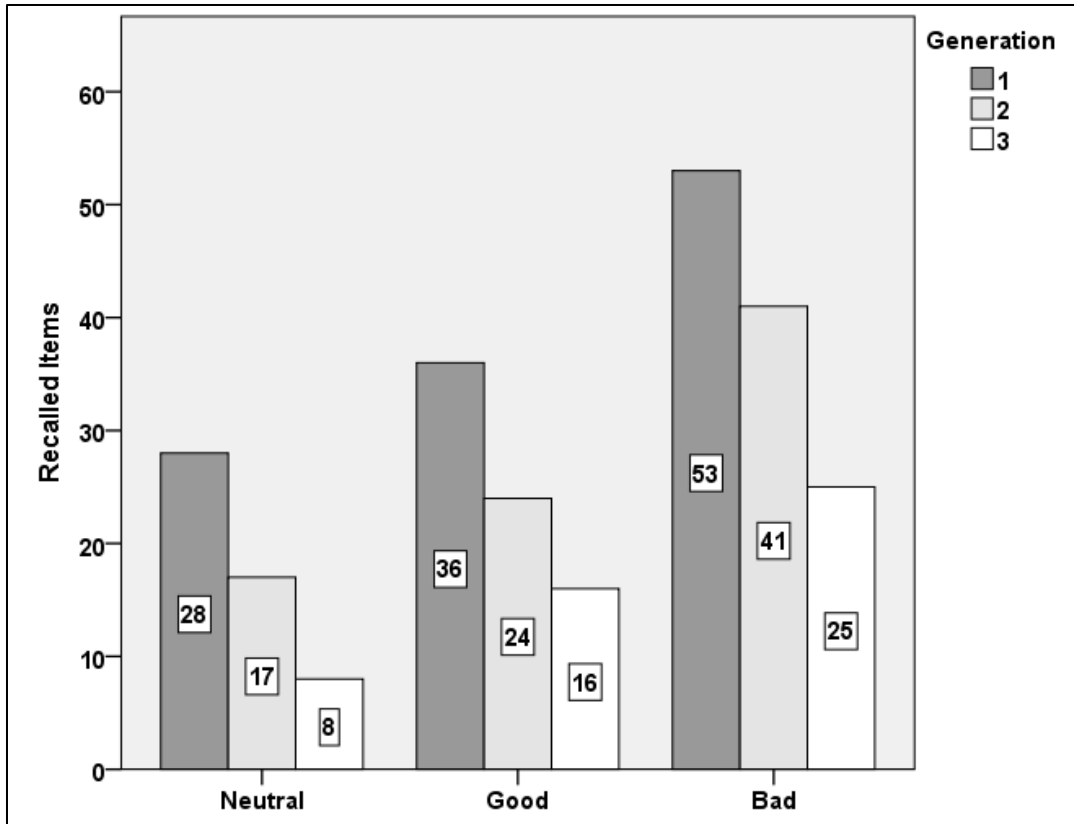


Figure 1. Neutral, good, and bad story items recalled by participants in Study 1 across three generations of retelling.

Of the 248 recalled items, only 6 were recalled incorrectly in the sense that their valence was explicitly changed from what it was in the original story. The number of recalled items decreased from generation to generation, and the number of bad items that were recalled was greater than that of good or neutral items in each generation. Keep in mind that more bad items were remembered in spite of the fact that a typographical error led to there being fewer bad items and more neutral items to begin with.

In order to test for main effects for the generation and valence variables, two chi-squared goodness-of-fit tests were conducted. Both were significant, with medium effect sizes (generation: $\chi^2(2, N = 248) = 27.98, p < .001$, Cramér's $V = .34$; valence: $\chi^2(2, N = 248) = 27.15, p < .001$,

Cramér's $V = .34$).¹¹ In other words, the differences between the number of recalled items from generation to generation were significant; and the differences between the number of neutral, good, and bad items were also significant. A chi-squared test of independence, which tested for an interaction between generation and valence, failed to be significant ($\chi^2(4, N = 248) = 1.41, p = .84$). In other words, the effect of generation did not depend upon whether the items in question were neutral, good, or bad; and the effect of valence did not depend upon which generation we were dealing with.

1.3. Discussion

Study 1 demonstrates that the moral valence of concepts can significantly affect their memorability. Since the effect that the valence of actions has upon mental state attributions to those who perform those actions has been called 'the Knobe effect' (after the work of Knobe, 2003a, 2003b, 2010; Pettit & Knobe, 2009), we might consider the present finding to be a Knobe effect for memorability. Within the Knobe effect literature, badness has been observed to have a stronger and more pervasive influence than goodness on folk psychological judgments. Our findings are consistent with this pattern.

2. Study 2

Study 2 compared the relative contributions or influence of moral valence and minimal counterintuitiveness on recall. We found that the moral valence of test items but not their minimal counterintuitiveness predicted recall.

¹¹ The second goodness-of-fit test compared observed frequencies with equal expected frequencies, even though the numbers of original neutral, good, and bad items were unequal. The reason was that performing the chi-squared test on observed frequencies divided by their original numbers resulted in expected values of less than five, which violates an essential assumption of chi-squared tests. Because the test we report assumed equal original frequencies, it was thus more conservative than it needed to be and yet still returned a significant effect.

2.1. Methods

2.1.1. Participants

Participants were 105 undergraduates (average age = 19, 60% female, predominantly Caucasian) from a small, private university in the northeastern United States. They were neither paid nor given course credit for their participation.

2.1.2. Materials and procedure

Study 2 was patterned after another recall experiment conducted by Barrett and Nyhof (2001). Barrett and Nyhof noted that the study that serves as the pattern for our Study 1 did not employ basic level categories, although it did involve domain-level expectation violations. One reason for this was that the study was one of the first that Barrett performed on minimal counterintuitiveness, and he had not yet defined the concept as precisely as he did later. Therefore, in their next study, Barrett and Nyhof (2001) made sure to include basic categories. For our Study 2, we did the same.

Barrett and Nyhof (2001, pp. 83-84) also observed that the study that served as the template for Study 1 “used written stimuli while traditionally, stories and cultural concepts are transmitted orally” but that “[r]eal world transmission involves actual face to face interactions.” (Note that Barrett and Nyhof’s study was performed at the end of the twentieth century, before the age of social media domination.) Thus, for their next study, they used orally presented and transmitted stimuli. In Study 2, we did the same.

The narrative frame that was used for Study 2 described an anthropologist’s visit to a foreign culture. Ten sets of test items were used for Study 2. To simplify the variable of moral valence for this study, we only included items with a negative moral valence that involved the violation of a salient moral norm and items that did not involve the violation of any such norm. Within each set, there was one MCI item, one item that concerned the violation of a salient moral

norm, one that both was MCI and concerned norm violation, and one item that was neither MCI nor concerned norm violation. The aim was to have a total of 40 items, 10 in each of 4 categories. However, due to another transcription error, there were 10 MCI only items, 9 norm violation only items, 11 items that were both MCI and involved a norm violation, and 10 items that were neither MCI nor involved a norm violation. Fortunately, as we explain below, this error again only heightened rather than undermined the central finding of this study.

Below are two of the sets of test items that were used in Study 2:

Item set 1:

Neither MCI nor Norm violation: In the first village Smith visited, he met an old man that, it was rumored, owned more land than the king.

MCI: In the first village Smith visited, he met an old man who, it was rumored, was able to live without food.

Norm violation: In the first village Smith visited, he met an old man who, it was rumored, knew more about which tribal leaders were having affairs with other men's wives than the king.

MCI & Norm violation: In the first village Smith visited, he met an old man who, it was rumored, could see every immoral act being committed by someone on Vanafuto.

Item set 4:

Neither MCI nor Norm violation: In that same village Smith was introduced to the king who, during the great feast, gave food to the poor.

MCI: In that same village Smith was introduced to the king who, during a great feast, gave away a special fruit that could cure any disease.

Norm violation: In that same village Smith was introduced to the king who, during a great feast, forced many of the poorest villagers to give up their prized livestock in order to provide food for the feast.

MCI & Norm violation: In that same village Smith was introduced to the king who, during a great feast, forced many of the poorest villagers to give up their prized livestock in order to cook a special stew that could cure any disease.

A complete list of test items and details about the narrative frame can be found in the supplementary materials document that accompanies this article.

The principal investigator took one-third of each class of undergraduates out into a hallway and told them the story of the anthropologist. Students were then instructed to enter the room and retell the story to at least two of their classmates. After every participant had been told the story, they were asked to provide their demographic information on a sheet of paper. Then they were instructed to write down everything they could remember from the story. Without telling participants that they would be contacted again, all participants were contacted via email two months after the experiment and were offered \$5 if they replied to the email indicating what they remembered from the story. As in Study 1, not enough participants replied after the two month delay to have sufficient data for analysis at this stage.

Two hypothesis-blind coders categorized participant retellings of the story according to which original story items were recorded in some identifiable form and whether they were correctly described as neutral, MCI, norm violation, or both MCI and norm violation. Inter-rater reliability was greater than 95%, and disagreements were resolved through discussion.

2.2. Results

The numbers of MCI, norm violation, both MCI and norm violation, and neither MCI nor norm violation story elements that were recalled by participants are represented in Figure 2.

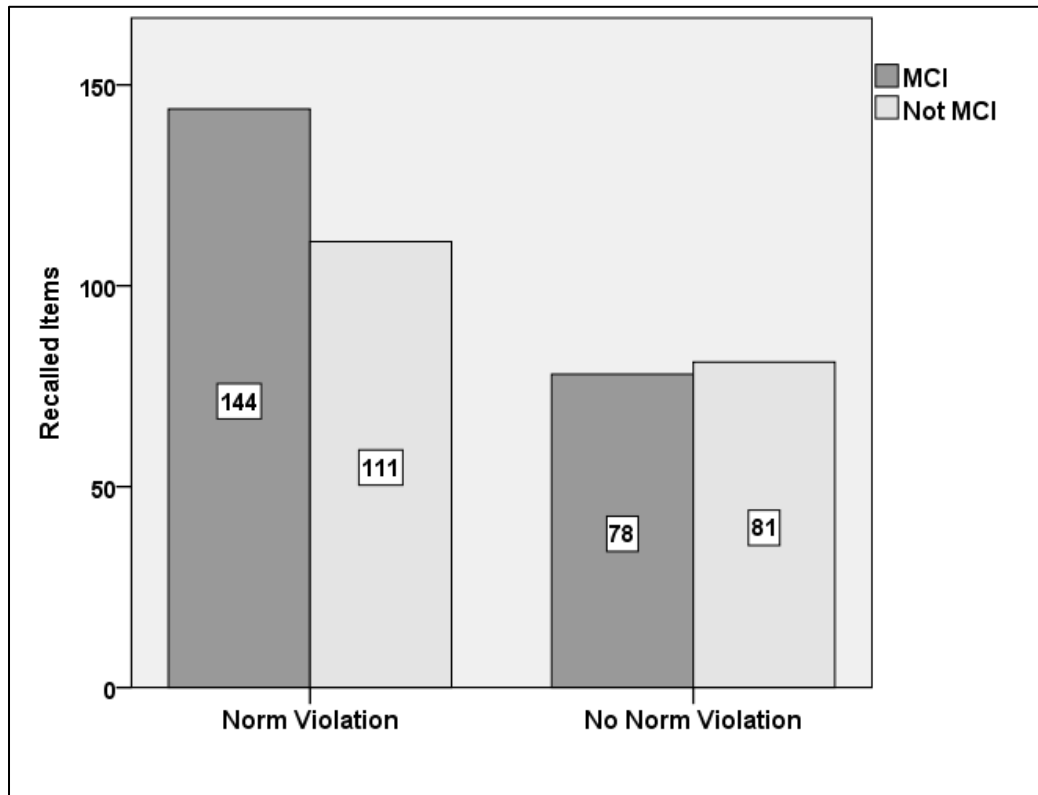


Figure 2. Test items recalled by participants in Study 2, organized according to whether or not they included an MCI component or a norm violation.

Although story elements that included both minimal counterintuitiveness and norm violation were remembered best of all, we failed to observe a statistically significant contribution from minimal counterintuitiveness to recall. As can be seen in Figure 2, the largest effect on recall came from the norm violation variable. In order to test for main effects for minimal counterintuitiveness and norm violation, two chi-squared goodness-of-fit tests were conducted. There was no significant main effect for minimal counterintuitiveness ($\chi^2(1, N = 414) = 2.17, p = .14$), but there was for norm

violation, with a medium effect size ($\chi^2(1, N = 414) = 22.26, p < .001, \text{Cramér's } V = .23$).¹² In other words, whether or not a test item was MCI had no significant effect on whether that item was remembered, but whether or not the item violated a salient moral norm did have such an effect. Keep in mind that while there were an even number of norm violation and non-norm violation items (20 each), there were by accident more MCI items (21) than non-MCI items (19)—yet an effect for minimal counterintuitiveness was still not observed.¹³ A chi-squared test of independence, which tested for an interaction between minimal counterintuitiveness and norm violation, failed to be significant ($\chi^2(1, N = 414) = 2.17, p = .14$). In other words, the effect that moral valence had upon recall did not depend upon whether or not the test items were MCI.

2.3. Discussion

The results of Study 2 run contrary to what the theories of Barrett and Boyer would predict and support our hypothesis that the inferential potential of cultural concepts used in the MCI research program is a central driver of their memorability and that without inferential potential MCI concepts would not be memorable. Furthermore, the fact that MCI items that did not involve norm violation were not recalled at higher rates than items that did not involve either minimal counterintuitiveness or norm violation can be seen as a failure to replicate some previous findings that purported to show a transmission advantage for MCI concepts over intuitive concepts.

¹² The second test remains significant after controlling for multiple comparisons. The second goodness-of-fit test compared observed frequencies with equal expected frequencies, even though the numbers of original neutral, good, and bad items were unequal. The reason was that performing the chi-squared test on observed frequencies divided by their original numbers resulted in expected values of less than five, which violates an essential assumption of chi-squared tests. Because the test we report assumed equal original frequencies, it was thus more conservative than it needed to be and yet still returned a significant effect.

¹³ As in Study 1, the goodness-of-fit tests we performed compared observed frequencies with equal expected frequencies. Thus, the test for a main effect for minimal counterintuitiveness was again more forgiving than it needed to be, and yet we did not observe what Barrett and Boyer's theorizing would lead us to expect.

3. Study 3

After finding in Study 2 that one kind of inferential potential predicted recall better than minimal counterintuitiveness and because existential anxieties represent another important source of inferential potential that is commonly associated with supernatural concepts (Atran & Norenzayan, 2004, p. 721), in Study 3 we compared the relative contributions of existential anxiety and minimal counterintuitiveness to recall.

3.1. Methods

3.1.1. Participants

Participants were 83 undergraduates (average age = 19, 52% female, predominantly Caucasian) from a small, private university in the northeastern United States. They were neither paid nor given course credit for their participation.

3.1.2. Materials and procedure

Study 3 followed the same procedures as Study 2 but used materials that featured items that were either neutral, MCI, associated with existential anxieties, or both MCI and associated with existential anxieties. The following are two of the sets of test items from Study 3:

Item set 1:

Neutral: In the first village Smith visited he met an old man named Cluang who wept while Smith told him a sad story.

MCI: In the first village Smith visited he encountered the wooden statue of Bonong that wept when Smith told it a sad story.

Existential anxiety: In the first village Smith visited he met an old man named Cluang, who smiled while listening to Smith's story about his narrow escape from death in a swamp filled with alligators.

MCI + Existential anxiety: In the first village Smith visited there was a wooden statue that smiled while listening to Smith's story of his narrow escape from death in a swamp filled with alligators.

Item set 2:

Neutral: While Smith was walking to another village, he approached a bridge over a deep ravine when the chief who had been accompanying Smith said: "Don't walk too slowly across the bridge. I'm hungry." After Smith and the chief crossed the ravine, they entered the village and enjoyed a great feast.

MCI: While Smith was walking to another village, he approached a bridge over a deep ravine when a voice from the sky said: "A great feast awaits you on the other side." After Smith crossed the ravine, he entered the village and enjoyed a great feast.

Existential anxiety: While Smith was walking to another village, he approached a bridge over a deep ravine and heard a voice in his heart say: "Don't cross that bridge!" Two hours later, after Smith had crossed the ravine by another route, he discovered that the bridge had just collapsed, killing two travelers.

MCI + Existential anxiety: While Smith was walking to another village, he approached a bridge over a deep ravine when a voice from the sky said: "Don't cross that bridge!" Two hours later, after Smith had crossed the ravine by another route, he discovered that the bridge had just collapsed, killing two travelers.

The set of test items included 9 common items, 12 MCI items, 13 existential anxiety items, and 9 items that featured both MCI and existential anxiety. A complete list of test items can be found in the supplementary materials document that accompanies this article.

As in Study 2, the principal investigator took one-third of each class of undergraduates out into a hallway to tell them a story about an anthropologist. These students then retold the story to at least two of their classmates, and all participants were instructed to write down everything they could remember from the story after a brief delay.

3.2. Results

Neutral items were recalled 52 times, MCI items 105 times, existential anxiety items 144 times, and items that involved both MCI and existential anxiety were recalled 111 times. Because the numbers of original items were uneven, ratios of the number of recalled items to the number of original items (rather than total items) in each category are plotted in Figure 3.

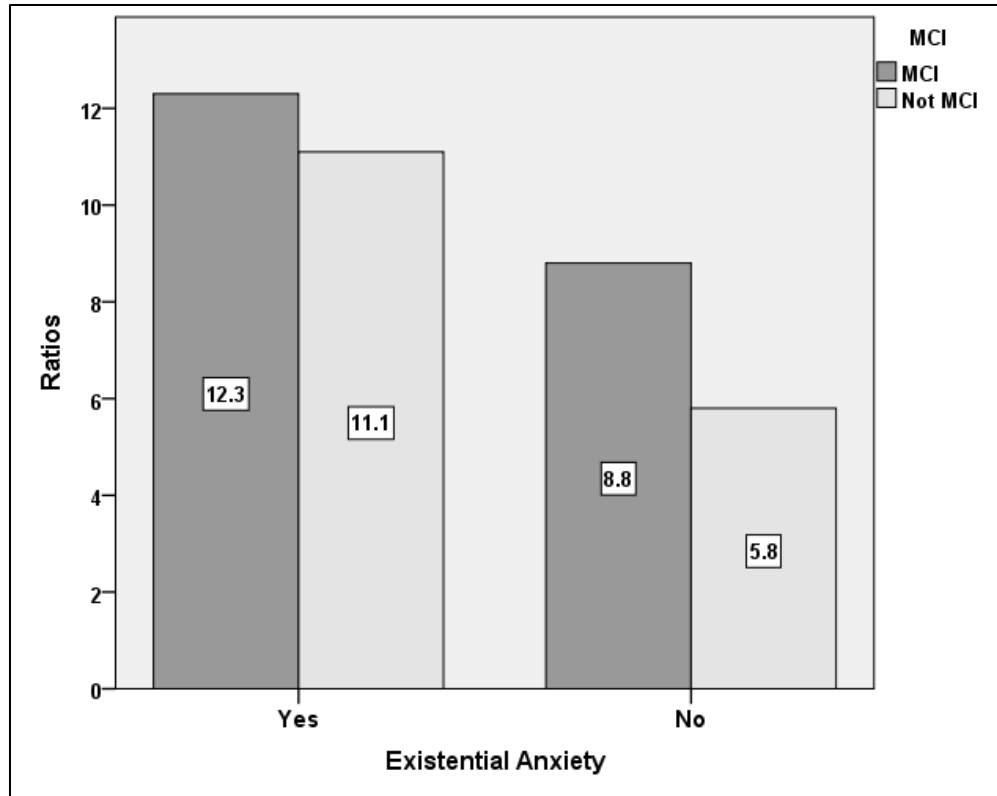


Figure 3. Ratios of number of recalled test items to number of original items in Study 3, organized according to whether or not they involved minimal counterintuitiveness or existential anxiety.

In order to test for main effects for the MCI and existential anxiety variables, two chi-squared goodness-of-fit tests were conducted. No main effect for minimal counterintuitiveness was observed ($\chi^2(1, N = 412) = .97, p = .32$), but there was a main effect for existential anxiety, with a small effect size ($\chi^2(1, N = 412) = 23.31, p < .001$, Cramér's $V = .24$). In other words, whether or not a test item was MCI had no significant effect on whether that item was remembered, but whether or not the item concerned existential anxieties did have such an effect. A chi-squared test of independence, which tested for an interaction between MCI and existential anxiety was significant, with a small effect size ($\chi^2(1, N = 412) = 21.24, p < .001$, Cramér's $V = .23$). In other

words, the effect that existential anxiety had upon recall depended in part upon whether or not the test items were MCI.

3.3. Discussion

As in Study 2, MCI items were recalled at slightly higher rates than non-MCI items, but this difference failed to be statistically significant. Also as in Study 2, one kind of inferential potential (existential anxiety) identified by researchers working on minimal counterintuitiveness did have such an effect and was the primary driver of observed differences in recall. Again, these results do not comport well with the claims of Barrett and Boyer that minimal counterintuitiveness alone is responsible for the memorability of supernatural or religious concepts.

4. Study 4

Because existing research has shown that concepts that are higher in imagery are recalled at higher rates than concepts that are lower in imagery (Paivio, 1990), and because many of the test items used in Studies 1 through 3 differed in their visualizability, one might wonder whether the results of Studies 1 through 3 could be due in part to these differences in visualizability. Study 4 addressed this question.

4.1. Methods

4.1.1. Participants

Participants were 420 workers from Amazon's Mechanical Turk (average age = 40, 48% female, predominantly Caucasian, all of whom had at least a 97% approval rate on at least 5,000 tasks), who were paid between \$.35 and \$.45 for providing ratings of a subset of the test items used in Studies 1 through 3.

4.1.2. Materials and procedure

180 participants were each asked to assess the ease with which they can form vivid mental images of 9 of the test items used in Study 1. An additional 120 participants were each asked to complete the same task for 10 items from Study 2; and another 120 participants each evaluated 12 items from Study 3. Participants were asked to select one of the following five answer choices: Very difficult, Somewhat difficult, Neither easy nor difficult, Somewhat easy, and Very easy. For purposes of analysis, Very difficult was scored as 1, Somewhat difficult scored as 2, and so on.

4.2. Results

Mean vivid image ratings for the neutral, good, and bad items from Study 1 are represented in Figure 4. A one-way ANOVA revealed a significant difference in vivid image ratings across the three valence categories ($F(2, 1607) = 42.39, p < .001, \text{partial eta squared} = .05$). Participants indicated that it was easiest to form vivid mental images of neutral items and most difficult to form images of bad items.

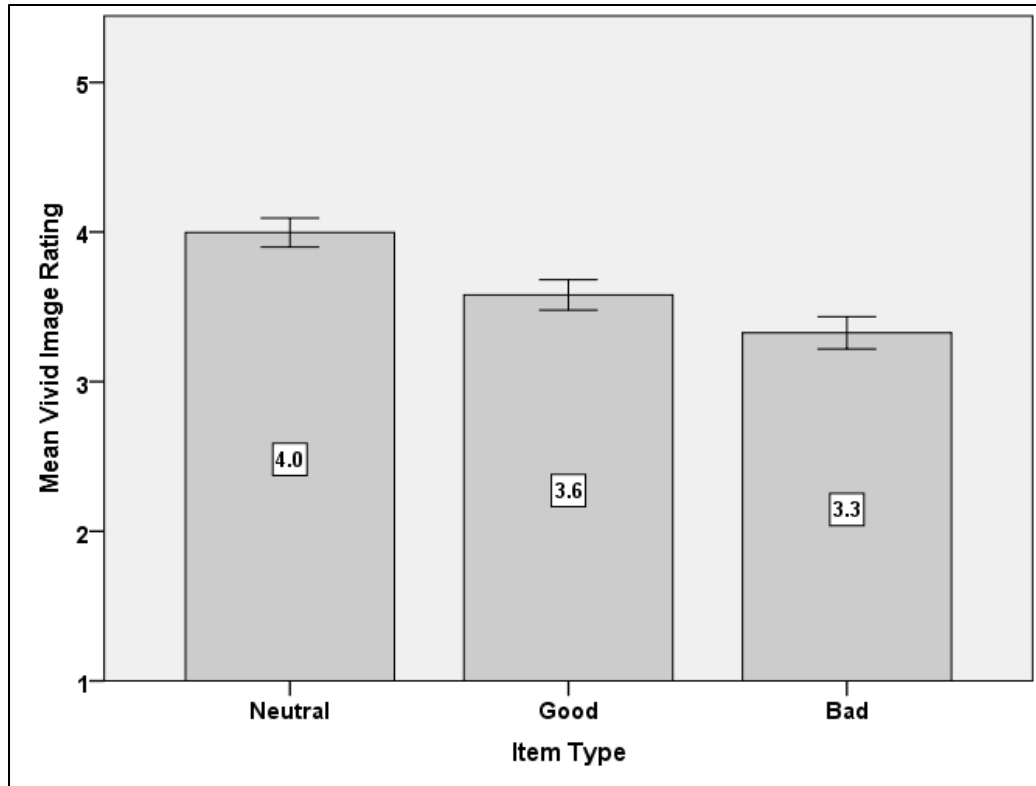


Figure 4. Mean vivid image ratings for test items from Study 1, organized by valence. Error bars represent 95% confidence intervals.

Mean vivid image ratings for Neutral, MCI, Norm Violation, and MCI + Norm Violation items from Study 2 are depicted in Figure 5. A two-way ANOVA revealed a significant main effect for minimal counterintuitiveness ($F(1, 1192) = 178.29, p < .001$, partial eta squared = .13) but not for norm violation ($F(1, 1192) = .83, p > .05$). There was no significant interaction between these two variables ($F(1, 1192) = 1.41, p > .05$). Participants thus indicated that it was more difficult to form vivid mental images of MCI items than non-MCI items but that it was no more difficult to form images of norm violation items than items without norm violations.

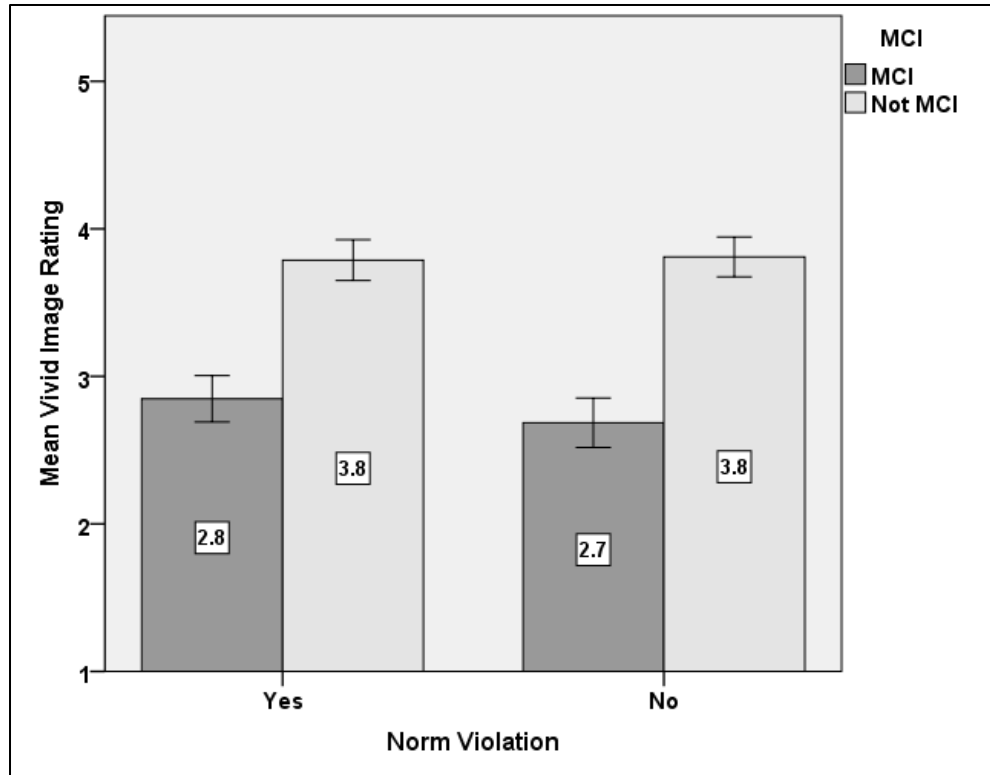


Figure 5. Mean vivid image ratings for test items from Study 2, organized according to whether or not they were MCI or involved a norm violation. Error bars represent 95% confidence intervals.

Mean vivid image ratings for Neutral, MCI, Existential anxiety, and MCI + Existential anxiety items from Study 3 are depicted in Figure 6. A two-way ANOVA revealed a significant main effect for minimal counterintuitiveness ($F(1, 1342) = 91.40, p < .001$, partial eta squared = .06) but not for existential anxiety ($F(1, 1342) = .04, p > .05$). There was also a rather small but significant interaction between these two variables ($F(1, 1342) = 10.24, p < .01$, partial eta squared = .01). Again, participants indicated that it was more difficult to form vivid mental images of MCI items than non-MCI items, but they indicated it was no more difficult to form vivid mental images of items that involved existential anxieties than items that did not.

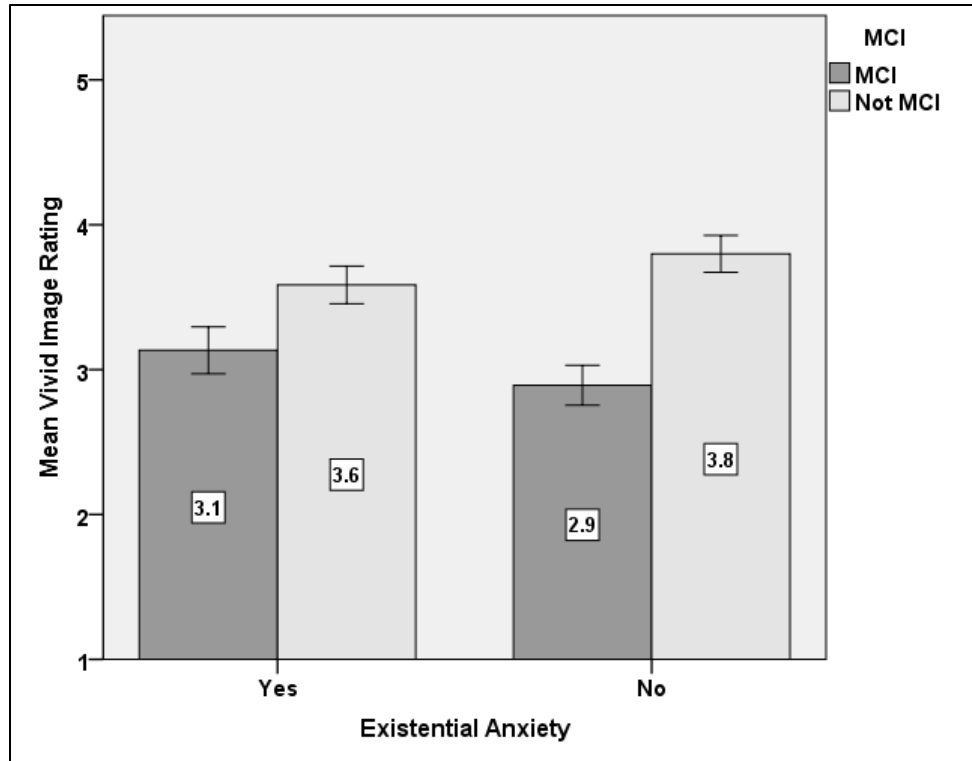


Figure 6. Mean vivid image ratings for test items from Study 3, organized according to whether or not they were MCI or associated with existential anxiety. Error bars represent 95% confidence intervals.

4.3. Discussion

The vivid image ratings obtained in Study 4 tell against the hypothesis that the greater memorability of (negatively) valenced, norm violation, and existential anxiety test items was due to their greater visualizability. Although negatively valenced items in Study 1 were recalled better than positively valenced items, and positively valenced items were recalled better than neutral items, we found that negative items had lower visualizability ratings than positive items, and positive items had lower scores than neutral ones. Thus, negatively valenced items were recalled better in spite of their visualizability disadvantage. No difference in vivid imagery reports was observed between items that did or did not involve norm violations or between items that did or

did not involve existential anxieties, and yet norm violation and existential anxiety items were recalled better than matched items involving no norm violations or existential anxiety.

General Discussion

Some researchers within the cognitive science of religion such as Barrett and Boyer hypothesize (1) that MCI concepts enjoy a transmission advantage over both intuitive and highly counterintuitive concepts, (2) that religions concern counterintuitive agents, objects, or events, and (3) that the transmission advantage of MCI concepts makes them more likely to be found in the world's religions than other kinds of concepts. These researchers admit that minimal counterintuitiveness is not sufficient to make a concept of any religious concern but contend that the characteristics that give MCI concepts 'inferential potential' are not the ones responsible for their transmission advantage. Our findings support the hypothesis that sources of inferential potential such as moral valence and existential anxiety are central to the memorability of memorable MCI concepts and that without inferential potential MCI concepts will often fail to be memorable. We observed that concepts involving norm violations or existential anxieties were recalled at higher rates than MCI items that did not involve these concerns.

In two of our studies (Studies 2 and 3), recall rates for MCI items trended slightly in the direction predicted by Barrett and Boyer but failed to have a large enough effect to achieve statistical significance. These trends suggest that with more statistical power a significant main effect of minimal counterintuitiveness or significant interaction effects between minimal counterintuitiveness and sources of inferential potential might be observed. Nevertheless, at the power level used in our studies, we were able to find meaningful effects of sources of inferential potential when none were found for minimal counterintuitiveness.

Barrett and Boyer (Barrett & Nyhof, 2001; Boyer & Ramble, 2001) have argued (a) that the transmission advantage observed for MCI concepts was not merely an instance of the ‘bizarreness (or distinctiveness) effect’ in memory (Hirshman, 1988; Hirshman et al., 1989; Waddill & McDaniel, 1998), whereby incongruous concepts are remembered better than less surprising ones but (b) that minimal counterintuitiveness imparts a special transmission advantage to concepts that goes beyond any advantage granted by the distinctive or surprising nature of those concepts. Our failure to find a statistically significant effect for minimal counterintuitiveness is unfriendly to this hypothesis. Thus, we take our findings to challenge important claims made by leading researchers within the cognitive science of religion regarding MCI concepts and to suggest some potentially fruitful avenues of future research that further examine and compare the importance of inferential potential in contributing to the memorability of counterintuitive concepts.

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