Memory and Belief in the Transmission of Counterintuitive Content

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Abstract

Cognitive scientists have increasingly turned to cultural transmission to explain the widespread nature of religion. One key hypothesis focuses on memory, proposing that that minimally counterintuitive (MCI) content facilitates the transmission of supernatural beliefs. We propose two caveats to this hypothesis: 1) memory effects decrease as MCI concepts become commonly used; 2) people do not believe counterintuitive content readily, therefore additional mechanisms are required to get from memory to belief. In experiments 1-3 (n=283), we examined the relationship between MCI, belief, and memory. We found that increased tendencies to anthropomorphize predicted lower memory for anthropomorphic-MCI content. MCI content was found less believable than intuitive content, suggesting different mechanisms are required to explain belief. In experiment 4 (n=70), we examined the non-content-based cultural learning mechanism of credibility enhancing displays, and found that it increased participants' belief in MCI content, suggesting this type of learning can better explain the transmission of belief.

Keywords: MCI theory, memory, religion, anthropomorphism, CREDs, cultural learning.

1 Introduction:

One of the more prominent and influential hypotheses in the cognitive science of religion is minimally counterintuitive (MCI) content (see Atran & Norenzayan, 2004a; Barrett, 2004; see Boyer, 2001; 2003). This hypotheses suggests that religious representations are widespread because they are uniquely adapted to exploit the structures of our minds by violating reliably developing intuitive understandings of the world (Barrett & Nyhof, 2001; Boyer & Ramble, 2001). More specifically, supernatural content violates our core ontological assumptions of the world. It is therefore distinctive and more memorable than non-supernatural content. This memory bias makes religious ideas stick better and remain in human minds through generations. In this way, MCI theory is a parsimonious and wide reaching account of the cultural contagion of religious beliefs.

Nevertheless, recent developments in the cognitive science of religion have called this hypothesis into question (Gervais, Willard, Norenzayan, & Henrich, 2011; Henrich, 2009; Purzycki & Willard, 2015; Russell & Gobet, 2013). One of the early objections raised is the *Mickey Mouse problem* (Atran, 2002; Atran & Norenzayan, 2004a). Simply put, if minimal counterintuitiveness is all that is required for religious concepts to take root, then why is Mickey Mouse, an MCI concept, not treated as a god? This problem has been broadly reframed as the *Zeus Problem*: why don't people readily believe in, and worship, other peoples' gods as much as their own gods? Why don't Christians believe in Zeus (and start worshipping him), if he has similar MCI properties to the Christian God (Gervais & Henrich, 2010)? The exact same mental representation of a supernatural agent can ignite faith in some people but only incredulous mirth in others. The MCI hypothesis is silent about why some MCI content becomes the center of a powerful belief system, while others do not.

Other criticisms have come in the form of the cognitive structures required for MCI theory to create a unique and persistent memory effect (see Purzycki & Willard, 2015). MCI violations are violations of core ontological categories, or innate intuitions about how the mind works. This view has been countered with the suggestion that many MCI violations are schematic rather than ontological in nature (Purzycki, 2010; Upal, 2010). Simply put, this would place MCI violations in the "things we find surprising" category more generally, and not specific and persistent violations of ontological assumptions. This would mean that there is no difference between how we process information about something unusual, like a pink elephant, and something impossible, like an invisible elephant, other than the degree of surprise we feel. Further, this would suggest that once MCI ideas are accepted and commonplace, new schemas would be created that incorporate these ideas. New ideas that are consistent with these schemas will not be violating any of our expectations and should therefore not show a bias in memory. This implies that while counterintuitiveness might account for the spread of certain mental representations, it cannot explain the persistence of supernatural or other religious beliefs in particular. We will call this perspective the schema or schematic view of MCI content.

Here, we aim to both underline these concerns and to provide a partial solution (see Atran & Henrich, 2010; Henrich, 2009). We wish to address the issue of belief and distinctiveness in three hypotheses:

(1) We hypothesize that MCI content is not readily believed, and thus demands additional mechanisms to prompt belief. Minimal counterintuitiveness may, under some conditions, make a concept more memorable, but it consistently makes it less believable.

(2) We further hypothesize that people who more readily engage in MCI-like

thought processes of anthropomorphism should have an attenuated memory effect for this

type of content. Frequent use should change schemas. This would be evidence that MCI

violations are schematic in nature and that these types of beliefs can be updated with new

experiences and expectations of the world.

(3) We hypothesize that a non-content based cultural learning mechanisms can play

a role in overcoming the problem of belief for MCI content. We propose that exposure to

credibility enhancing displays (Henrich, 2009), can instill commitment to MCI content

despite the inherent non-believability of this content.

1.1   What is MCI?

The MCI hypothesis has played an important role in the cognitive science of religion

(Atran & Norenzayan, 2004a; Barrett, 2004; 2008b; Boyer, 1994; 2001; 2003). The

hypothesis rests on the idea that human minds possess innate or reliably developing

ontological categories governed by core knowledge domains, such as folk-physics, folk

biology and folk-psychology (see Spelke & Kinzler, 2007; Wellman & Gelman, 1992). A

concept becomes minimally counterintuitive when an implicit feature that pertains to one

of these categories is mildly but systematically violated (e.g. an object that can pass through

walls), or an implicit feature from a category gets transferred to an object or animal that it

should not apply to (e.g. a statue that knows your thoughts). These violations are attention

arresting and inferentially rich, and therefore encourage further cognitive processing that

facilitates their cognitive stabilization and cultural transmission. However, they are not

radical departures from common sense and do not rupture completely ordinary

expectations which would otherwise render them incomprehensible (Atran & Norenzayan, 2004a; Sperber, 1996).

What differentiates MCI concepts from just being bizarre (see Lang, 1995; McDaniel, Einstein, DeLosh, May, & Brady, 1995; Riefer & Lamay, 1998) is that the violations are about *core ontological categories* such as physical object, living form, or person—not just our learned expectations of the world (Barrett, 2008a). It has been argued that violations of these knowledge domains are surprising to us in a more fundamental way (Barrett & Nyhof, 2001), and we pay more attention to these violations and remember them better than ideas consistent with expectations. The MCI hypothesis asserts that this increased memorability allows MCI concepts to spread at a greater rate than intuitive concepts or maximally counterintuitive concepts, leading to a world full of myths and stories about the supernatural.

1.2   Previous research on the MCI effect

Two foundational studies established this MCI effect (Barrett & Nyhof, 2001; Boyer & Ramble, 2001). Both of these studies used stories that contained sets of intuitive and MCI items, and found that people remembered more of the MCI items than the intuitive ones. Norenzayan, Atran, Schaller, and Faulkner (2006 study 2), analyzed Grimm fairytales and found stories with 2 to 3 MCI violations (but not more) were the most culturally successful. Another showed that Roman Prodigies, collected between 218 and 44 BCE, with minimally counterintuitive content are also more likely to be recorded than ones with only bizarre or intuitive content (Lisdorf, 2004).

Other research has looked at the narrative context in which MCI content is presented (Gonce, Upal, Slone, & Tweney, 2006; Upal, 2010; Upal, Gonce, Tweney, & Slone, 2007). Their findings suggest that the memory bias for MCI content is only apparent when the content is not expected. When stories are prefaced with "In a dream…" or presented as science fiction, the memory bias disappears. This is a potential problem for myths and fairytales, where MCI content should be expected (Gonce et al., 2006), but also adds support to a schema view of the MCI memory effect (Upal, 2010). If expecting MCI content means that the content is no longer surprising and requiring of special attention, then the possibility that MCI content is driving the spread of these types of cultural information is called into question.

1.3   Distinctiveness and MCI theory

It is clear that the first time a person hears that trees can understand and remember their conversations, they will find this distinctive and potentially memorable. Still, what happens when that person has become well acquainted with this concept? How would they see it if they had been raised since birth with this as a belief? Humans are amazingly adaptable to novel concepts and artifacts. Magnets and helium balloons are 'counterintuitive' items we see as commonplace. This problem of declining distinctiveness rests on the tension between whether these concepts exist as unchangeable core concepts or whether they are part of updatable schemas of the world. This tension has been addressed in greater detail elsewhere (see Purzycki & Willard, 2015).

For the MCI hypothesis to explain the persistence of many supernatural representations, it has to go beyond a description of what happens when people come in

contact with an unusual idea and account for the persistence of these beliefs over time. A key question, therefore, is whether the memory bias remains when these ideas become more schema-consistent, and therefore unlikely to violate expectations of the world.

1.4   The problem of belief

The fact that people can become deeply and powerful committed to religious concepts is part of what makes them so intriguing. Though it is clear that not all supernatural ideas are believed in (consider fairytales), and not all religious traditions equally hold belief as the main defining component of religious devotion (Cohen, Siegel, & Rozin, 2003; Purzycki & Sosis, 2011; Shariff, Purzycki, & Sosis, 2014), belief still remains a powerful motivating factor for the way people relate to some core supernatural ideas. The very fact that these concepts are 'counterintuitive' should suggest that they are less believable than our intuitive perceptions of the world. Nevertheless, people are willing to offer time and resources to, and possibly even die for, beliefs that are inherently non-verifiable and contradictory to the way we intuitively see the material world. This is puzzling, and brings us to a fundamental question in the relationship between MCI concepts and the supernatural. How do people come to believe in and commit to these non-intuitive ideas?

MCI content should be, on average, less believable than intuitive content *because* MCI content violates our intuitions about the world. These intuitions exist based on our experience of the world, either in our lifetimes or as they have been encoded into our genes through generations, and exist because of the benefit they give in accurately predicting the world.[1] From an evolutionary point of view, it is expected that people are skeptical of

claims that defy experience or expectations (Bergstrom, Moehlmann, & Boyer, 2006; Harris & Koenig, 2006).

Based on these ideas we hypothesize here that MCI content is *less* believable than intuitive content and additional mechanisms are required to make MCI content the center of genuine belief. Still, this question of belief has yet to be empirically explored.

1.5   Cultural learning and Credibility enhancing displays (CREDs)

Thus far, we have articulated two ideas about MCI content and belief: 1) when MCI content involves ideas we call "religious", it is not merely represented and remembered, it contains commitment or belief; 2) MCI content, as a violation of our intuitions about the world, should be particularly unbelievable—otherwise we would lose much of the benefit of having these intuitions in the first place. The second observation might seem self-evident—after all, counterintuitiveness suggests the absence of believability. Yet, to the extent that this is empirically true, we are left with an apparent paradox: if MCI content is memorable, but less believable, how do we explain both its prevalence in religions and the deep faith they can inspire? One answer, we suggest, might be found in cultural learning mechanisms that can facilitate the spread of beliefs even if they were intuitively implausible.

There are several cultural learning mechanisms that are likely to be involved in the transmission of religious beliefs. Henrich (2009) has proposed a mechanism that is relevant to difficult-to-verify beliefs: Credibility Enhancing Displays (CRED). The CRED hypothesis suggests that we learn beliefs from others to the extent that these beliefs are backed up by credible displays. When someone behaves in a way that is credible and

consistent with their beliefs, such as by giving tithes to the church they claim to believe in,

or eating a mushroom they claim is not poisonous, their associated beliefs become more

plausible and more likely to be acquired by observers. Their actions underwrite their

words.

CREDs are actions that a person would be unlikely to engage in unless they truly

believed their expressed conviction. This cultural learning bias helps learners navigate a

world in which others should want to convince them of untrue things for selfish reasons

(e.g., the advertising industry, lawyers, and politicians). The classical example for religion

would be the pairing of verbal statements about beliefs in life-after-death and the actions of

martyrdom. Martyrdom is powerful as a transmitter of the faith because it shows that—if

nothing else—the martyr herself must have unreservedly held the belief she verbally

expressed.

1.6   Overview of Experiments

We conducted four experiments to explore these ideas. Experiments 1-3 establish

that counter-intuitive representations are less believable than intuitive representations,

even when they are more memorable. We also tested whether individual differences in

trait anthropomorphism, that is, a chronic tendency to apply human characteristics widely

to non-human things (Waytz, Cacioppo, & Epley, 2010a), moderates the memory effect for

similar content. We hypothesized that high anthropomorphizers should show less of a

memory bias for anthropomorphic content then low anthropomorphizers, simply because

they find anthropomorphic content less distinctive. Finally, experiment 4 tests the

hypothesis that MCI content can become believable through cultural learning. We assess if

witnessing a CRED would enhance people's willingness to endorse or believe in science news stories independent of MCI content.

2   Experiment 1 – 3

In the first three experiments, we address the question of believability of MCI content across three different types of stimuli. This was done by comparing ratings of believability for intuitive and counter intuitive content. Additionally, we assessed the impact of individual differences in the tendency to use one particular type of MCI content—anthropomorphic content—on the memory bias for MCI content. Anthropomorphism reliably varies across individuals and affects how people interact in the world in predictable ways (Epley, Akalis, Waytz, & Cacioppo, 2008a; Epley, Waytz, Akalis, & Cacioppo, 2008b; Waytz, Cacioppo, & Epley, 2010a; Waytz, Morewedge, Epley, Monteleone, et al., 2010b), and this variation allows us to test the hypothesis that MCI content that is more expected is less memorable. We assessed this a validated scale of anthropomorphism (the IDAQ;; Waytz, Cacioppo, & Epley, 2010a). This scale assesses the willingness to attribute human-like states to animals, nature and technology.

2.1   Methods:

2.1.1   Participants:

See table 1. All participants were recruited from a university human subject pool and given course credit for their participation.

[Insert Table 1]

2.1.2 Materials

Each of the three experiments used a different set of stimuli to assess the memorability and believability of MCI versus intuitive content. They are as follows:

Exp. 1: *Folktales.* Three different "folktales" were constructed by the experimenters (see supplemental material). Each story had three different versions pertaining to each of the categories (anthropomorphic-MCI, physical-MCI, social-intuitive), for a total of 9 stories, all approximately 200 words in length. The stories were constructed to be easily divisible into individual 'concepts' for coding purposes and so the content type could be changed without changing anything else in the story. This was done to control for anything idiosyncratic about any one of the stories.

Exp. 2: *Museum story.* This stimuli was taken from Boyer and Ramble (2001). It consists of a short introduction about Mr. Wurg and his trip to the natural history museum on the planet Zeon 3. The story lists 24 items: 12 objects and 12 people. Of each of these sets of 12 items, 6 were minimally counterintuitive and 6 were entirely intuitive. All the MCI objects use some type of animacy and/or a mental trait as their MCI violations rather than the physical violations used in the previous experiment and should be considered anthropomorphic in nature (e.g. "Objects that hide when they are scared"; "Objects that can notice people are staring at them").

Exp. 3: *Science news stories.* This stimuli consisted of 12 single-paragraph-long summaries of news stories. Six of the 12 news stories were intuitive and 6 had a minimally counterintuitive violation. Of the minimally counterintuitive stories, 3 were real news stories, and 3 were created by the experimenter (see supplemental material). Science news was selected as something that could be presented as new information that is plausible

true about the world. This allowed us to assess if believability findings from the first two experiments were due to the clear fictional nature of the stimuli.

After reading all the stimuli, participants were asked to (1) recall it, and (2) rate how believable they thought each story was. This was done with a 1 item measure in experiment 1 ("I believe this story could be true) and a 3 item measure for experiments 2 and 3 ("I believe this item is real"; "Its plausible this item could exist"; "I doubt this item is true"; α = 0.84). This change was made to make the believability score more reliable and less prone to error (see Traub & Rowley, 1991). Additionally, participants in experiment 1 rated and how much they liked each story on a 7-point Likert scale. The IDAQ was used to assess each participant's tendency to anthropomorphize (Waytz, Cacioppo, & Epley, 2010a).

2.1.3 Design and Procedures:

For all experiments, participants came into the lab and were instructed to complete the experiment alone in a cubical. They read stimuli off a computer screen and told that they would be asked about it again later, but not informed that they would be recalling it. The order of stories/items was counterbalanced across participants. Participants were given 5 minutes to complete a distractor math question and then asked to recall what they had read by typing it out on the computer. For experiment 1, story recall was prompted by the main character in each story (i.e. recall the story about Jane) and asked to recall them as though they were writing them out for another person to read. For experiment 2 recall, participants were asked to recall as many items as possible and experiment 3 participants were asked to recall the main topic in a single sentence for as many stories as they could. After recall each story/item was listed and participants rated how much they believed each story/item. They then completed the anthropomorphism questionnaire.

In experiments 2 and 3, participants were asked to come back for a second session, one week later. This was done to assess change in memory and belief with time. Participants were asked to recall the items from the story they read the previous week, and then to again rate belief. This was done to see if either memory or belief changed with a short time interval (see Norenzayan et al, 2006). Finally, in experiment 3 a behavioral measure was added. After evaluating belief and memory in the second session, participants were told that some of the news stories were fake and untrue, and that we would give them $1 for each story they could correctly identify as either real or not. This was done to raise the stakes of reporting belief and to get away from only self-report measures of belief.

2.2   Results for Experiment 1:

Stories were divided up into sets of single concepts with an associated concept type (i.e. intuitive, anthropomorphic-MCI, physical-MCI) and each concept was coded as present or absent. Two independent coders coded recall (*Kappa*=0.93). The total number of recalled concepts was divided by the total number of concepts and reported as a proportion.[2] We found no significant difference in the memorability of our three story types, (F(2, 281)=1.96, p=0.14), or in how much participants liked each story (F(2, 278)=2.49, p=0.09). There was a significant difference in the believability of each category (F(1.46, 205.13)=68.69, p<0.001; Greenhouse-Geisser correction for sphericity; Greenhouse & Geisser, 1959; see Table 2). Using planned comparisons, we found that anthropomorphic-MCI and physical-MCI were believed less than intuitive stories (F(1, 282)=136.52, p<0.001). No difference was found in believability between anthropomorphic and MCI stories (F(1, 282)= 0.09, p=0.76).

[Insert Table 2]

This analysis was confirmed using a multilevel regression with random intercepts and fixed slopes for each individual. We show that a categorical change from the combined category of anthropomorphic-MCI, physical-MCI is associated with an average change of -1.75 (95%CI: -2.10 to -1.40; $t(90.34)=10.14$, $p<0.001$; $d=$ -2.49) points on a 7 point belief scale when compared with intuitive items, controlling for age, gender, ethnicity and order. A second multilevel regression using the same control variables showed no significant effect of the combined anthropomorphic-MCI, physical-MCI content on memory (-0.04; 95%CI: -0.08 to 0.01; $t(92.77)=-1.44$, $p=0.15$).

We ran an additional set of OLS regressions to examine the relationship between anthropomorphic tendencies and memory (Table 3). Our results show a significant negative effect of IDAQ on memory for anthropomorphic-MCI content and a marginal effect for physical-MCI content. We additionally found a negative effect of belief on memory for both anthropomorphic-MCI and physical-MCI content. No effects were found for intuitive content.

[Insert Table 3]

2.3 Results for Experiment 2:

Recall was recorded as number of individual items recalled in each category, using the same methods as Boyer and Ramble (2001). Two independent coders coded recall (*Kappa* =0.91). MCI items were significantly more memorable after a 5 minute delay (*M*=3.34, *sd*=1.90) than the intuitive items (*M*=2.34, *sd*=1.83; $t(88)=5.35$, $p<0.001$, 95%CI: 0.63 to 1.37; $d=0.57$). MCI items were significantly less believable (*M*=3.47, *sd*=1.27) than

the intuitive items (*M*=6.59, *sd*=0.61; *t*(88)=-20.51, *p*=<0.001, 95%CI: -3.43 to -2.82;

d=2.17).

After a one week delay, we once again found that MCI items were significantly more

memorable (*M*=2.20, *sd*=1.81) than the intuitive items (*M*=1.61, *sd*=1.81; *t*(82)=3.10,

p=0.002, 95%CI: 0.21 to 0.97; *d*=0.34) and that MCI items were significantly less believable

(*M*=3.17, *sd*=1.27) than intuitive items (*M*=6.61, *sd*=0.60; *t*(81)=-20.80, *p*=<0.001, 95%CI: -

3.77 to -3.11; *d*=2.29).[3] There was no change in believability from time 1 to time 2 for

either MCI (*t*(78)=0.75, *p*=0.46) or intuitive items (*t*(78)=1.41, *p*=0.16).

To assess the effects of belief and anthropomorphism on memory, we again

conducted a series of OLS regressions (Table 4). Religious affiliation was added as an

additional control. Affiliation information was not collected in experiment 1. All of the

results are robust to the inclusion or exclusion of any of these covariates. Our analysis

showed a significant negative effect of anthropomorphism on both MCI objects and people

after the 5 minute delay. There was also a negative effect of anthropomorphism on memory

for intuitive people items. Recall at one week showed a marginal negative effect of

anthropomorphism on MCI objects, but no other effects. The time 2 effects use the

anthropomorphism measure taken at time 1. We did not replicate the effect of belief

reducing memory found in experiment 1.

[Insert Table 4]

2.4   Results for Experiment 3:

Recall was coded as a yes or no for each story. Participants got a yes if they

remembered the main point of the news story (e.g. "A story about teleporting objects", "A

story about widows that produce solar power"). Memory was coded by two independent

coders (*Kappa*=0.79). Mean level differences in memory between MCI stories (*M*=3.05,

sd=1.38) and intuitive stories (*M*=2.85 sd=1.19) where not significant at conventional

levels after a 5-minute delay (*t*(95)=1.35, *p*=0.18, 95%CI; -0.09 to 0.49; *d*=0.19).

Memorability was marginally different between MCI (*M*=2.44, *sd*=1.48) and intuitive

stories (*M*=2.12, *sd*=1.23) after 1 week (*t*(83)=1.87, *p*=0.07, 95%CI: -0.02 to 0.66; *d*=0.27).

Nevertheless, a multilevel model approach with random intercepts for each individual and

controlling for age, gender, ethnicity, religious affiliation and fake stories, estimate that MCI

content (relative to intuitive content) increase the odds of recall by 41% (*z*=2.33, *p*=0.02;

Odds: 1.41, 95%CI: 1.06 to 1.89) after 5 min. At one week the odds of recall increase by

79% (*z*=3.64, *p*<0.001; Odds: 1.79, 95% CI: 1.31 to 2.46).

Consistent with the previous experiments, MCI stories were significantly less

believable (*M*=3.23, *sd*=1.03) than intuitive stories (*M*=4.78, *sd*=1.18 after 5 min; *t*(95)=-

16.54, *p*<0.001, 95%CI: -1.74 to -1.37; *d*=-1.67). Believability remained significantly lower

for MCI (*M*=3.25, *sd*=1.04) than intuitive items (*M*=4.75, *sd*=1.23) at one week (*t*(83)=14.65,

p<0.001, 95%CI: 1.29 to 1.70; *d*=-1.58). There was no change in believability between time

1 and time 2 for either MCI (*t*(82)=0.75, *p*=0.46) or intuitive items (*t*(82)=1.41, *p*=0.16)[4].

The fake MCI stories were *more* believable than the real MCI stories, discrediting the

hypothesis that participants were simply identifying unreal stories in their believability

estimates (Fake: *M*=3.46, *sd*=1.17; Real: *M*=2.99, *sd*=1.15; *t*(98)=4.79, *p*<0.001; 95%CI: 0.30

to 0.71; *d*=0.48).

We used regression analyses to assess the effect of IDAQ and belief on memory. Although we found a similar pattern for anthropomorphism's relationship to memory at 5 minutes, the effect was only significant at the second session.

The behavioral money task resulted in comparable effects to our believability scores, with nearly twice as much cash bet on intuitive stories (money per story: M=$0.61, sd=0.25; t(82)=6.73, p<0.001) compared to MCI stories (money per story: M=$0.37, sd=0.24; 95%CI: -0.32 to -0.17; d=0.71). On average, participants wagered a total of $1.47 less (95%CI: -1.91 to -1.04) on MCI stories than on intuitive stories. Money bet on both MCI and intuitive items were positively correlated with previous belief measures, serving as a behavioral validation of the latter (MCI: r=0.46, t(79)=4.56, p<0.001, 95% CI: 0.26 to 0.61; INT: r=0.59, t(79)= 6.48, p<0.001, 95%CI: 0.43 to 0.72).

[Insert Table 5]

2.5   Discussion

We did not find a memory effect for MCI content in the first experiment, but did find an effect in experiments 2 and 3. The memory bias in experiment 1 may have been washed out by the other information presented in these stories (Gonce et al., 2006; Upal et al., 2007), such as social information (Mesoudi, Whiten, & Dunbar, 2006), or by the narrative structure itself (e.g. Brewer, 1985; Ericsson & Kintsch, 1995; Rubin, 1995). The significance of the memory effect in experiment 3 was dependent on the statistical method used. This makes sense, given that the memory effect here is small to medium (5 min: d=0.19; 1 week: d=0.27), and our sample size lacked the power to reliably detect it based on a mean difference t-test. The memory effect was the most robust in experiment 2 and was similar

in magnitude to the effect found in Boyer and Ramble (effect after 5 min: d=0.57; Boyer and Ramble, experiment 1; d=0.68, estimated from F-test, n=18). Together, these effects suggest that a memory bias is present but is sensitive to contextual changes.

As predicted, trait anthropomorphism had a negative effect on memory for anthropomorphic content across all three experiments, but varied in magnitude and was less consistent across the two session experiments. The effect was strongest in experiment 1 looking at anthropomorphic-MCI content (β = -0.25), but still marginally present for physical-MCI stories (β = -0.19). In experiment 2, an effect for both MCI objects and people, and a marginal effect on MCI object recall after 1 week was found. Since all of these 'objects' contains anthropomorphic violations, the larger effect for objects is consistent with the hypothesis. In experiment 3 the effect was only present in the second session. This may be due to the stimuli itself; the MCI content in these stories was not limited to specifically anthropomorphic information. Given the medium size of this effect in the prior two experiments, it should be expected to be non-significant some of the time in samples of this size.

Interestingly, we also found a negative effect of anthropomorphism on memory for the intuitive people stimuli in experiment 2. This could have been a statistical fluke or represent a more general trend of the impact of anthropomorphism on memory. Though this seems unlikely and the mechanism remains unclear, there is a negative, though non-significant, impact of anthropomorphism on memory for intuitive content in studies 1 and 3 as well. Regardless, the effect of trait anthropomorphism on memory for anthropomorphic content is a larger and more robust effect. This effect suggests that how much we expect the world to behave according to these ontological categories can be

different across individuals, and this difference can translate into individual differences in

the effect of anthropomorphic content on memory.

The effects of MCI content on belief were unambiguous. Across all three

experiments, MCI content was found much less believable that intuitive content (*d*s

between -1.58 and -2.49). These effects did not decline after a 1-week interval, suggesting

that, at least in the short term, this effect does not change with time. It could be argued that

repeated exposure, rather than just time, could lead to increased belief (e.g. Zaragoza &

Mitchell, 1996). Though we did not test this directly, by the time the belief measure was

taken for the second time in experiments 2 and 3 participants had read the items 3 times

and recalled them twice. This repeat exposure did not affect their willingness to believe in

these items.

The monetary measure in study 3 replicated the belief findings (*d*=-0.71), indicating

that people were willing to systematically bet against the reality of MCI stories. Even when

rewarded for correct answers, people persistently believed that the intuitive stories were

more likely to be true than MCI ones.

3   Experiment 4

Experiments 1-3 showed that people found MCI content less believable than

intuitive content. When we consider the religious content the MCI hypothesis proposes to

explain, this lack of belief becomes a problem. Religious ideas are ideas people believe in. If

religious ideas include MCI content, then people must come to believe in this type of

content somehow. A partial solution to this puzzle is that belief—particularly

counterintuitive belief—is sustained by a variety of cultural learning mechanisms (Atran &

Henrich, 2010; Gervais et al., 2011; Henrich, 2009; Norenzayan, 2013). The theoretical

problem of belief (why do people come to believe in some MCI concepts and not others)

has been widely claimed, but never empirically shown. In the first three experiments, we

show that MCI content is found to be highly unbelievable. At the same time, we know that

people do come to believe in this and other types of unbelievable content. This problem of

belief is not insurmountable and we propose it is frequently and easily overcome with non-

content-based cultural learning (i.e. learning based on social transmission and not based on

the content of the idea itself).

In our fourth experiment, we investigated one possible cultural learning bias, CREDs

(Henrich, 2009), that could potentially explain how MCI content becomes believable

through the observation of another persons behavior. Participants were given news stories

from the previous experiment, as well as $5 in dollar coins to bet on the truth of stories.

Their money was doubled on correct bets and lost on incorrect bets. Any money they did

not bet was theirs to keep. A confederate disguised as another participant also completed

the experiment at the same time as the participant and was observable by the participant.

The confederate either verbally endorsed the MCI stories or the intuitive stories and either

put money down on the stories he endorsed (the CRED) or put no money down at all (no

CRED). We hypothesized that participants who witness an endorsement combined with a

CRED, would be more likely to themselves endorse a given story by betting money on it.

3.1   Methods:

3.1.1   Participants:

See table 1.

3.1.2   Materials:

The stimuli consisted of 10 of the 12 stories from the experiment 3. One MCI story and one intuitive story were removed from the set to make five stories of each type. This was done to make the experiment shorter so the confederate could move from one room to another without risking bumping into the next participant.

3.1.3   Design and Procedures:

Participants came into the lab and were given the news stories to read in a random order. They rated their belief in each story with the same three questions used in experiments 2 and 3. The anthropomorphism scale was excluded because memory was not theoretically relevant to this task since memory was not being assessed.

Participants were brought into a room with a confederate posing as a second participant. Both people were given five $1 coins and told to bet the money on any story they believed was a true story. If their belief was correct, the money would be doubled, if they were incorrect, they would lose the money. They were instructed to discuss their decisions with one another. The confederate either bet all of his money, $1 per story, on either the MCI or on the intuitive stories (CRED), or bet no money (no-CRED). In both the CRED and verbal (no-CRED) conditions he verbally endorsed one set of stories (MCI or intuitive) over the other. The same statements of endorsement were used in both the CRED and no-CRED conditions (see supplemental). In the CRED condition, the confederate additionally stated that he would put a dollar down for each of relevant stories. No comment was made about money and the confederate did not write on the paper at all in the verbal (no-CRED) condition. The confederate's comments about each story were scripted, but he was allowed to make small talk outside of the script if it wasn't about the

story. The confederate was further instructed to disagree with the participant if the

participant expressed a differing option. For any disagreement that was not covered by the

script, the confederate was instructed to disagree, but not add any additional information

about the content. For example, if the participant would say that they thought an intuitive

story was correct in the MCI condition, the confederate would no reason and simple say

something like "it just doesn't sound right to me" or "it seems untrue". Though the

confederate and the participant were in the same room, the confederate could not see what

stories the participant marked. This interaction was cut off after 2 minutes. The participant

and the confederate were once again split up into separate rooms and the participant was

asked to rate the confederate on likability, trust, reliability and how much they agree with

his opinions. Suspicion was probed with a funneled debriefing. Eight participants were

removed due to suspicion.

3.2   Results

The initial pre-betting ratings of belief replicated the belief findings from the

previous experiments. Participants rated the MCI stories as less believable (M=3.18,

sd=1.10) than the intuitive stories (M=4.66, sd=0.99; t(60)=-9.95, p<.001, 95%CI: -1.76 to -

1.17; d=-1.22). Across the whole sample we found a significant difference between the

money bet on MCI stories (M=$0.98, sd=1.25) and intuitive stories (money per story:

M=$1.84, sd=1.71; t(60)=-3.08, p=0.003, 95%CI: -1.41 to -0.30; d=0.32). Critically, we

found that when the betting was credibly displayed, the participants bet more money

across all stories (M=$3.65, sd= 1.67) than when it was not displayed (M=$1.96, sd=2.04;

Welch's t(58.05)=3.58, p<0.001, 95%CI: $0.74 to $2.63; d=0.98).

To assess if the credible display affected bets over all, or only items that were bet upon, we regressed the four conditions as dummy codes on the amount of money places on each story type individually. If the CRED affected betting over all then both CREDs conditions should be significant for both story types. If the CRED affected only the stories the CRED was directed towards, then we should see type specific effects (i.e. CRED for MCI should positively affect the money placed on MCI stories, but not the money places on intuitive stories; Table 6). When CREDs were displayed for MCI items, participants increased the amount of money they placed on MCI stories but not intuitive stories. When CREDs were displayed for intuitive items, participants increased the amount of money places on intuitive stories, but not MCI stories.

[Insert Table 6]

We analyzed the data a second time using a multilevel logistic regression with random intercepts and slopes for each individual. This allows us to compare the items that were endorsed to those that were not endorsed as well as whether the endorsement was only verbal or involved a CRED in one analysis. The random intercepts correct the standard errors for the non-independence of our data points. We found a main effect of CRED, increasing the odds of betting by an average of 6.68, but not of verbal endorsement (Table 7). This effect is controlling for the significant effect of prior belief on betting. There was no significant interaction between CRED and story type (MCI) and a marginal interaction effect of verbal endorsement of MCI stories in our sample (see Fig. 1).

[Insert Table 7]

We also found a significant positive effect of the CRED manipulation on how much the participant thought the confederate was trustworthy and reliable, as well as a marginal

effect on liking (Table 8). There was a negative effect of endorsing MCI stories on the

agreement rating.

[Insert Table 8]

[Insert Figure 1]

3.3   Discussion

The CRED preformed by the confederate, that is, betting money in accordance with

their opinions, increased the odds by nearly 7 times that the participant would bet on the

same stories. Participants tended to place their money on the stories that the confederate

bet on rather then just picking stories at random, or picking the stories they had previously

rated as believable. When participants saw the confederate bet on, MCI stories, those

stories were endorsed at a higher rate than intuitive stories with only verbal endorsement.

It also does not seem, based on the pre-manipulation ratings of belief, that there was much

ambiguity in which stories participants thought were false. This experiment supports the

idea that witnessing a behavior that is consistent with a model's expressed beliefs

increases the likelihood of endorsing those beliefs. In other words, beliefs that are backed

up by CREDs can be culturally contagious.

Also consistent with the hypothesis, the CRED manipulation also affected the

participants' opinions of the confederate. When the confederate acted in accordance with

his opinions, the participants saw him as more trustworthy (β = 0.68), more reliable (β =

0.51), and marginally more likable (β = 0.50), suggesting that acting according to one's

beliefs may lead to reputational benefits as well as spread behaviors and potentially beliefs.

Within the betting scenario, there was no significant interaction between CRED and story type. The CRED manipulation was effective for both types of information. This is consistent with the theory, which suggest that all types of information should be susceptible to social and cultural learning cues (see Henrich, 2009; Henrich & McElreath, 2003). Nevertheless, the CRED effect on MCI content is of particular interest, because it could help resolve the apparent paradox that MCI content is commonly found in religious traditions even though it may initially be less believable.

This is just a first step in testing a complex set of processes, with many open questions. This experiment offers some insight into the plausibility of cultural learning and social influence as a source of belief in supernatural concepts. There are several other social learning mechanisms that could work as additions to, or in the place of, CREDs. Still, this research suggests CREDs as one plausible candidate to aid the transmission of religious practices and beliefs. This is an area of research that is yet to be thoroughly explored in the cognitive science of religion.

4   General Discussion

Evidence from the above experiments, and previous research, suggests that the memory effect of MCI content is present but fragile and boundary conditions need to be identified (see Purzycki & Willard 2015). For example, changes in context seem to be enough to make the effect disappear (see Gonce et al., 2006; Upal et al., 2007). This and other research suggests that if an MCI memory bias exists, then further work needs to be done in exploring the boundaries of this bias. Under what conditions is this bias robust and under what conditions is it not?

One possible boundary, explored in this paper, is the effect the trait tendency to anthropomorphize content on memory for anthropomorphic MCI content. We surmise that this decrease is due to the lack of distinctiveness of this type of MCI content to people who see this type of explanation everywhere. If one believes the ocean is conscious and that one's computer occasionally gets mad at them, they may not be surprised when this type of anthropomorphic thinking is applied to other phenomena in the world.

There are two potential explanations for this. One, is a schema view of MCI content expressed by Upal (2010), Purzycki (2010), rather than the original ontological category view expressed by others (Atran & Norenzayan, 2004a; Boyer, 2001; Boyer & Ramble, 2001). If this is the case, then we should expect that the memory effect of MCI content will disappears and these concepts become familiar. When we first come across these concepts, they seem surprising and therefore are memorable, but as we become familiar with them they are integrated into certain schemas we have of the world. They become commonplace and the memory advantage disappears. A declining memory advantage like this cannot explain religions' spread through time, but only why it might initially spread. A separate mechanism would have to explain why it persists. Two, is the view that anthropomorphism is a special case, and other types of ontological violations, governed by core knowledge domains, are not so easily updated. Further work is needed to assess this.

Given the general negative trend for anthropomorphism on memory for all content types, it is possibly that some of the effects we are seeing are due to some other cognitive capacity related to both increased anthropomorphism and decreased memory. Still, even if this is the case it would not explain the type specific decreases we see in these experiments.

If a general effect was entirely responsible for these affects, there should be no differences across conditions.

It is clear in all of the above experiments that people do not readily believe MCI concepts. Though the idea that counterintuitive content is hard to believe may be an uncontroversial claim, the religious phenomena which the MCI hypothesis proposes to explain entails some degree of belief or commitment, otherwise the hypothesis cannot be about religious *belief*. It could be argued that the lack of belief we found comes from our sample, which is made up entirely of educated Westerners (see Henrich, Heine, & Norenzayan, 2010). It is possible that people in other places and times, without western influence and education, or those not exposed to Abrahamic religions, would not show so much skepticisms towards MCI items. This conjecture runs counter to one of the foundational premises of the MCI hypothesis, namely, that these violated categories are rooted in reliably developing, core intuitions. Further, it seems unlikely that people in other places and times were less, rather than more, familiar with counterintuitive claims about the world then we are in the West today.

We also found the MCI content was consistently deemed less believable than intuitive content. This relationship between MCI content and belief illustrates three points: 1) MCI items are seen as more supernatural than intuitive items (see Atran & Norenzayan, 2004b; Pyysiäinen, Lindeman, & Honkela, 2003); 2) MCI items are less believable than intuitive items; and 3) supernatural concepts are believed in all around the world. For all of these to be true, we need to explain how people come to believe in the unbelievable that is separate from memorability. Given the existence of complex cultures and ritual practices to support religious beliefs, multiple processes are likely to contribute to belief. One process

we found evidence for is that of credible displays. These displays convey the authenticity of beliefs to others and can increase the likelihood that witnesses adopt similar practices and beliefs (Henrich, 2009).

There are many other cultural learning mechanisms through which people transmit information (see Henrich & Boyd, 1998; Henrich & Gil-White, 2001; Henrich & McElreath, 2003). We used CREDs here because it is a learning mechanism proposed to deal specifically with the type of unverifiable information we find in religious beliefs. Our findings support CREDs as a possible candidate for belief transmission. There is much more to be done to understand the role of CREDs and other cultural learning mechanisms in religious and other cultural beliefs. The study presented here are in no way meant to be a conclusive test in regards to the robustness of CREDs, but rather as a preliminary demonstration that social cues can influence peoples' belief in the implausible.

5   Conclusion

MCI content is a prominent feature of religious beliefs, but more work needs to be done to explain the boundaries and conditions of this phenomenon. Showing a memory bias solves only a small part of this issue, especially if this memory effect is fragile and affected by expectations. If belief is illusive for MCI content we further require a strong mechanism to explain how this content becomes the center of belief systems. We demonstrate CREDs to be one such mechanism. Our findings suggest that cultural learning and social influence are an important part of how we come to accept counterintuitive ideas as true. These types of influences on the belief in supernatural agents and concepts require

more attention and research if we wish to understand religions and their role in human

psychology and behavior.

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Dr. Willard is a Postdoctoral Research Fellow in Psychology at the University of Texas at Austin. Her research focuses on the cognitive and cultural origins of supernatural and religious belief. She is currently conducting research on "spiritual but not religious" people in North America and Europe and witchcraft beliefs around the world. She maintains an active field site in Fiji, where she conducts research with Hindu and Muslim populations.

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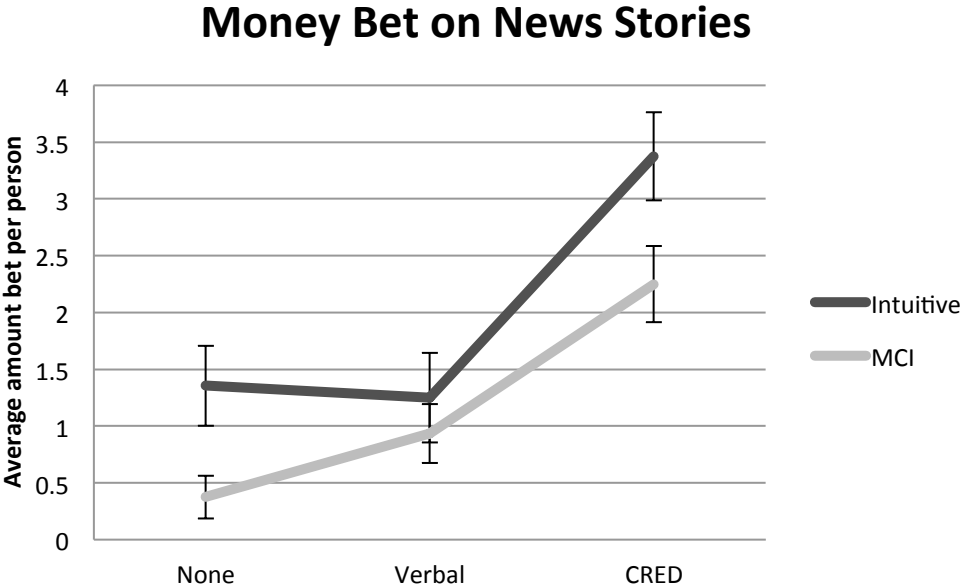Figure 1: The 'None' category represents a CRED or Verbal endorsement of the oposite category (e.g. if MCI stories had no endorsment it was because the intuative stories were being endorsed). The drop from Verbal to None in MCI stories reflects the fact that endorsing Intuative stories decreased the offers on MCI stories. The oposite was not the case (see Table 6). Error bars are 95% confidence intervals of the means.

Table 1: Demographics Exp. 1-4

	Exp. 1	Exp. 2	Exp. 3	Exp. 4
N	95	89	99	77
Female	78 (82%)	63 (71.6%)	68 (68.7%)	41
Age (sd)	19.25 (1.74)	19.9 (2.6)	20.16 (3.10)	20.38 (1.88)
Ethnicity				
Asian	64 (67.4%)	55 (61.9%)	67 (67.7%)	40 (51.9%)
Caucasian	27 (28.4 %)	31 (34.5%)	23(23.2%)	34 (44.2%)
Other	4 (4.2 %)	3 (3.6%)	9 (9.1%)	3 (3.9%)
Religious Affil.				
Christian	--	41 (46.5%)	41 (41.4%)	34 (44.2%)
Other Relig.	--	13 (15.1%)	16 (16.1%)	9 (11.6%)
Non-Religious	--	34 (38.4%)	42 (42.5%)	34 (44.2%)

Table 2: Means and Standard Deviations (in parenthesis) of DVs for each Story type

	Memory	Liking	Belief
Social	0.41 (0.21)	3.59 (1.51)	3.32 (1.62)
Anth	0.38 (0.19)	3.96 (1.52)	1.57 (0.92)
MCI (phys.)	0.36 (0.16)	3.82 (1.55)	1.52 (0.95)

Table 3: OLS Regressions examining the effects of Anthropomorphism and Belief on Story Memorability, Experiment 1

	B(SE)	β	95% CI of β Lower	Upper
Anth-MCI				
Belief	-0.05 (0.02)*	-0.22	-0.46	-0.06
IDAQ	-0.03 (0.01)*	-0.25	-0.45	-0.05
Phys-MCI				
Belief	-0.04 (0.02)*	-0.25	-0.47	-0.04
IDAQ	-0.02 (0.01)†	-0.19	-0.41	0.02
Social-Int				
Belief	0.00 (0.01)	0.00	-0.22	0.22
IDAQ	-0.01 (0.02)	-0.09	-0.31	0.14

Note: †$p<0.10$, *$p<0.05$. Controls: age, gender, ethnicity and order effects.

Table 4: Effects of Anthropomorphism and Belief on Story Memorability, Experiment 2

	B(SE)	β	95% CI of β Lower	Upper
5-minutes				
MCI objects				
Belief	0.19 (0.09)*	0.24	0.01	0.47
IDAQ	-0.23 (0.09)**	-0.31	-0.54	-0.08
MCI people				
Belief	0.03 (0.09)	0.04	-0.19	0.27
IDAQ	-0.18 (0.08)*	-0.26	-0.49	-0.03
Int objects				
Belief	0.01 (0.26)	0.01	-0.27	0.28
IDAQ	-0.10 (0.08)	-0.15	-0.39	0.09
Int people				
Belief	0.15 (0.21)	0.09	-0.15	0.32
IDAQ	-0.19 (0.08)*	-0.26	-0.48	-0.05
1-week				
MCI objects				
Belief	0.06 (0.09)	0.08	-0.17	0.33
IDAQ	-0.14 (0.08)†	-0.23	-0.48	0.03
MCI people				
Belief	-0.03 (0.10)	-0.04	-0.31	0.23
IDAQ	0.03 (0.08)	0.04	-0.22	0.31
Int objects				
Belief	0.23 (0.23)	0.13	-0.14	0.40
IDAQ	-0.03 (0.08)	-0.13	-0.29	0.21
Int people				
Belief	0.12 (0.23)	0.07	-0.22	0.36
IDAQ	-0.06 (0.07)	-0.11	-0.36	0.14

Note: †$p<0.10$, *$p<0.05$, **$p<0.01$. Controls: age, gender, ethnicity, and religions affiliation.

Table 5: Effects of Anthropomorphism on Memorability for Experiment 3.

	B(SE)	β	95% CI of β Lower	Upper
5 minutes				
MCI				
Belief	0.01 (0.03)	0.03	-0.19	0.26
IDAQ	-0.02 (0.02)	-0.16	-0.42	0.26
Intuitive				
Belief	-0.03 (0.02)	-0.14	-0.34	0.07
IDAQ	-0.02 (0.02)	-0.16	-0.39	0.09
1 week				
MCI				
Belief	0.04 (0.03)	0.17	-0.05	0.39
IDAQ	-0.05 (0.02)*	-0.26	-0.48	-0.04
Intuitive				
Belief	0.02 (0.03)	0.08	-0.15	0.32
IDAQ	-0.02 (0.02)	-0.13	-0.37	0.11

Note: *$p<0.05$. Controls: age, gender, ethnicity, and religious affiliation.

Table 6: Regression using condition to predict bets above verbal endorsement.

	B(SE)	β	95% CI of β	
			Lower	Upper
Money on MCI				
Intercept	-0.37(1.52)	0.05	-0.56	0.65
Verb. Int	-0.60(0.36)	-0.48	-1.06	0.10
CRED Int	-0.59(0.36)	-0.47	-1.05	0.11
CRED MCI	1.30(0.37)***	1.04	0.45	1.63
Belief MCI	0.25(0.12)*	0.22	0.01	0.42
Money on Int				
Intercept	-0.75(2.58)	-0.40	-1.07	0.27
Verb. MCI	0.04(0.55)	0.02	-0.63	0.67
CRED Int	1.94(0.55)***	1.13	0.48	1.78
CRED MCI	0.26(0.56)	0.15	-0.51	0.82
Belief Int	0.42(0.21)	0.26	-0.05	0.44

Note: †$p<0.10$, *$p<0.05$, ***$p<0.001$, n=62. All DV ratings between $0-$5. Categorical variables were not standardized, leading to non-zero intercepts for β. These betas can be interpreted as the average standard deviation change in the dependent variable for each category compared to the intercept. The unstandardized betas are the average change in dollars. Controls: age, gender, ethnicity, and religions affiliation.

Table 7: Multilevel Logistic Regression using condition to predict bets

	B(SE)	Odds	95% CI for Odds	
			Lower	Upper
Place Bet (yes=1)				
Intercept	-4.68(0.67)***	0.01	0.00	0.03
CRED	1.90(0.67)**	6.68	1.80	24.68
Verbal	-1.31(0.83)	0.27	0.05	1.36
MCI	-0.45(0.51)	0.63	0.23	1.73
Belief	0.74(0.11)***	2.10	1.67	2.62
CRED*MCI	-0.13(0.87)	0.88	0.51	2.33
Verbal*MCI	2.05 (1.06)†	7.77	0.97	62.35
Number Obs: 630, groups (Subject): 63				

Note: †$p<0.10$, **$p<0.01$, ***$p<0.001$. Controls: age (centered at mean) and gender. Ethnicity and religious affiliation were not included in the model because the model failed to converge with the addition of these variables.

Table 8: OLS Regression using condition to predict ratings of confederate.

	B(SE)	β	95% CI for β Lower	Upper
Like				
CRED	0.58(0.31)†	0.50	-0.03	1.03
MCI	-0.31(0.32)	-0.27	-0.81	0.28
Trust				
CRED	0.87(0.30)**	0.68	0.21	1.15
MCI	-0.26(0.31)	-0.21	-0.69	0.27
Reliable				
CRED	0.73(0.34)*	0.51	0.03	0.98
MCI	-0.29(0.34)	-0.20	-0.68	0.27
Agree with				
CRED	0.50(0.35)	0.32	-0.13	0.77
MCI	-1.40(0.36)***	-0.89	-1.35	-0.43

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[1] Other have hypothesized that most religious concepts, and concepts that are labeled as MCI are actually supported by core intuitions about the world rather than the violations of those intuitions (Willard & Norenzayan, 2013).

[2] Since each story could be intuitive, anthropomorphic-MCI, physical-MCI, and story type was counterbalanced, the total number of clauses did not differ across content type even though it did differ by story.

[3] Using a multilevel logistic regression with random intercepts for each individual we can show that these effects do not change when we control for age, gender, ethnicity, and religions affiliation. MCI items are significantly more memorable than intuitive items after five minutes ($z=4.98$, $p<0.001$; Odds: 1.77, 95%CI: 1.41 to 2.21) and one week ($z=3.51$ $p<0.001$; Odds:1.66, 95%CI: 1.25 to 2.21). Belief was similarly modeled. Belief changed an average of -3.08 (95% CI -3.39 to -2.77; $t(81.00)=-19.46$, $p<0.001$, $d=$ -9.26) points on a 7 point scale between intuitive items and MCI items after 5 min, and -3.46 (95%CI: -3.60 to -3.32; $t(165.40)=-49.53$, $p<0.001$) after one week.

[4] Using a multilevel model with random intercepts for each individual, belief is associated with a change of -1.59 (95%CI: -1.67 to -1.39; $t(105.29)=-15.65$) $p<0.001$) points on a 7 point scale when comparing MCI to intuitive stories after 5 min, and an average of -1.58 (95%CI: -1.85 to -1.32; $t(118.70)=11.77$, $p<0.001$) points on 7 point scale after 1 week.