The Role of Memory, Belief, and Familiarity 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 religious representations. One key hypothesis focuses on memory, proposing that that minimally counterintuitive (MCI) content facilitates the transmission of supernatural beliefs. We propose two caveats to the MCI hypothesis: 1) distinctiveness, and therefore memory, decreases as MCI concepts become familiar; 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. MCI content was less believable than intuitive content. Individual differences in anthropomorphism negatively affected memory for anthropomorphic-MCI content, suggesting thinking chronically about MCI content reduces its memorability. In experiment 4, we examined a non-content-based cultural learning mechanism driven by credibility enhancing displays, and found that it was effective in increasing participants' (n=70) belief in MCI content.

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 that of minimally counterintuitive (MCI) content (see Boyer, 2001, 2003; Barrett 2004; Atran & Norenzayan 2004). This hypotheses suggests that religious content is widespread because it has 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 innate ontological assumptions of the world, and is therefore distinctive. This distinctiveness makes supernatural content more memorable than non-supernatural content. The bias in memory makes religious ideas last longer, 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 (see Gervais, Willard, Norenzayan, & Henrich, 2011; Henrich, 2009). One of the early objections raised is the "Mickey Mouse problem" (Atran, 2002; Atran & Norenzayan, 2004). Simply put, it points out that 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? Or possibly more to the point, there is also the "Zeus Problem:" why don't people believe in, and worship, other peoples' gods—for example, why don't Christians believe in Kali (and start worshipping her), when she has MCI properties just like the Christian God (Gervais & Henrich, 2010)? It appears that the exact same mental representation of a supernatural agent can ignite faith in some people but only incredulous mirth in others. These objections converge on the role of faith,

commitment, or belief. People believe that certain supernatural agents actually exist and are important in their lives. 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, 2014). 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 innate assumptions. This would mean that there is no difference between how we process information about a pink elephant and an invisible elephant, other than the degree of surprise we feel. Further, this would suggest that once MCI ideas are presented and accepted, we will create new schemas that incorporate these ideas. New ideas that are consistent with these existing 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.

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 by

(1) Demonstrating that MCI content is not readily believed, and thus demands additional mechanisms to prompt belief. While making an intuitive concept slightly

counterintuitive may, under some conditions, make it more memorable, it consistently makes it less believable.

(2) Further hypothesizing that familiarity with this type of content should attenuate the memory effect for MCI content, because it no longer violates intuitions about the world. This would be further evidence to suggest that MCI violations are schematic in nature and can be updated with new experiences and expectations of the world.

(3) Providing evidence for how non-content based cultural learning mechanisms, for example exposure to credibility enhancing displays, can instill and maintain belief in supernatural representations and thus overcome a memorability deficit of MCI content.

1.1   What is MCI?

The MCI hypothesis has played an important role in the cognitive science of religion (Atran & Norenzayan, 2004; Barrett, 2004, 2008; Boyer, 1994, 2001, 2003). The hypothesis rests on the idea that human minds possess innate ontological categories governed by core knowledge domains, such as folk-physics, folk biology and folk-psychology (see Spelke & Kinzler, 2007; Wellman & Gelman, 1992). There is a wide array of research suggesting that this is the case (for a thorough overview, see Carey, 2009).

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, the idea is that they are not radical departures from common sense and do not rupture completely ordinary expectations which would otherwise render them incomprehensible (Atran & Norenzayan, 2004; Sperber, 1996). Moreover, 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, 2008). 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. However, these studies did not examine the transmission of stories or narratives as a whole. A few studies have looked at MCIs as part of whole narratives. In one such study, Norenzayan, Atran, Schaller, and Faulkner (2006, study 2), analyzed Grimm fairy tales to see which ones were the most culturally successful. They found that the most popular stories (as assessed by Google hits and subjective ratings of popularity by participants), the

ones we all know and love, such as Cinderella and Snow White, had a moderate number of

MCI concepts in them. Stories that had no MCI concepts, and stories that had too many

were found to be far less popular. This finding suggests that MCI content is the most

culturally successful when housed in mostly intuitive content. This is not surprising to

anyone who has read a myth or folktale. Another similar study shows that Roman Prodigies,

collected between 218 and 44 BCE, with minimally counterintuitive content are also more

likely to be recorded than bizarre or intuitive prodigies (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 more schema based 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   Commonness and MCI concepts

According to the MCI hypothesis, most supernatural concepts are MCI concepts

(Boyer, 2001). Though no systematic study has been conducted of supernatural concepts to

demonstrate this, it does appear to be the case that MCI concepts are perceived as being

supernatural (Norenzayan et al., 2006; Pyysiäinen, Lindeman, & Honkela, 2003). Still, this

hypothesis attempts to do much more than explain a characteristic of supernatural content. It attempts to explain the spread of religious beliefs throughout human culture by emphasizing the memory advantage for MCI content. Barrett (2008) illustrates the relationship between MCI concepts and *maturational naturalness* (see McCauley, 2011). He points out that at least some of what is natural will be based on the cultural context a person was raised in. This is contrasted with *practical naturalness*, which is the stuff we are born expecting about the world, and the stuff that lends distinctiveness to MCI concepts.

We are interested in the idea that *practical naturalness* might also be affected by maturation. It is clear that the first time a person hears that trees can understand and remember their conversations, they will find this distinctive and 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 things we see as commonplace, and the fact that all of the authors of this paper carry around handheld machines that can talk should not be distinctive or memorable to anyone who has lived in the western world for more than a few months. This problem of declining distinctiveness rests on the tension of whether our core understandings of the world are updatable with new information, or whether the expectations we were born with remains forever unchanged. This is a problem that is far beyond the scope of this paper, but has been addressed in part elsewhere (see Purzycki & Willard, 2014).

The more concise version of this issue is whether or not MCI content remains distinctive once it has been incorporated into schemas of the world. For an MCI memory

bias to persist, "Certain trees listen and remember" should always remain distinctive, regardless of how familiar that idea is to a person. 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 unfamiliar idea. 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

As a research topic, religious concepts are particularly intriguing because people are sometimes deeply and powerful committed to them. Though it is clear that not all supernatural ideas are believed in (consider fairy tales), 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 in the way people relate to 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 sometimes 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, or commit to, these non-intuitive ideas?

MCI content should be, on average, less believable than intuitive content, given no other external or additional information. MCI content violates our intuitions about the world. These intuitions exist based on our experience of the world, either in our lifetimes

or as intuitions that 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). This last hypothesis is a far harder problem to overcome because it requires a strong mechanism to make MCI content believable.

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 substance of genuine belief. This possibility has received little attention in the previous literature, and is the focus of the present set of experiments.

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 not be particularly believable—otherwise we would lose much of the benefit of having intuitions in the first place. The second observation might seem self-evident— after all, as we suggested, counter-intuitiveness implies 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? The 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 specific mechanism that is specifically 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 others. Their actions underwrite their words.

CREDs are actions that a person would be unlikely to engage in unless they actually believed their expressed belief. 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 fully held the belief she verbally expressed[2].

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. Experiment 1 used carefully constructed 'fairytales' to look at the memory bias for different types of MCI content (anthropomorphic and non-anthropomorphic) and intuitive content. In the MCI hypothesis, anthropomorphic content should be more salient than other MCI content (Boyer, 2001), though it's worth noting that previous work has not found this to translate into a memory effect (Barrett & Nyhof, 2001;

Boyer & Ramble, 2001; Lisdorf, 2004). We also tested whether individual differences in anthropomorphizing, that is, a chronic tendency to apply human characteristics widely to non-human things, moderates the memory effect (the IDAQ; Waytz, Cacioppo, & Epley, 2010). We hypothesized that high anthropomorphizers should show less of a memory bias for anthropomorphic content then low anthropomorphizers. We also measured participants' belief in each story, to see if MCI content is in fact less believable than intuitive content. Experiment 2 used the same format, but used different materials (Boyer and Ramble, 2001) and tested these memory effects over time (after five minutes and one week). In experiment 3, we used MCI and intuitive science stories to try to establish this effect for content that potentially contains real information about the world, and we incentivized the accurate reporting of beliefs with money. Finally, in experiment 4 we tested to see if witnessing a CRED would enhance people's willingness to endorse or believe in science news stories independent of MCI content.

2   Experiment 1

We constructed nine folk stories that had either MCI-anthropomorphic violations, MCI-violations of folk physics, or were fully intuitive but contained a social interaction to match the human characteristics in the anthropomorphic story. Based on prior research, physical violations were used instead of biological violations to decrease the likelihood that people would infer anthropomorphic content that was not explicitly there (see Epley, Akalis, Waytz, & Cacioppo, 2008). We expected that the two MCI types would be less believable, though more memorable, than the intuitive category. To test how familiar people are with anthropomorphic-MCI concepts we used a validated scale of anthropomorphism (the IDAQ;

Waytz, Cacioppo, et al., 2010). This scale assesses the willingness to attribute human-like states to animals, nature and technology. Anthropomorphism reliably varies across individuals and affects how people interact in the world in predictable ways (Epley, Akalis, et al., 2008; Epley, Waytz, Akalis, & Cacioppo, 2008; Epley et al., 2010; Waytz, Cacioppo, et al., 2010).

2.1   Methods:

2.1.1   Participants:

Ninety-five (78 female) psychology undergraduates from the University of British Columbia were tested. The ethnicity of the sample was 67.5% Asian, 28.8% Caucasian and 3.8% other. The average age was 19.25 (sd=1.74) years old. All participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite for signing up for the experiment.

2.1.2   Materials

Three different stories, constructed for this experiment, "Jane's Stroll in the Forest", "Kate Has a Picnic", and "Sam and the Library", were used (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 so that 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. The traits associated with each content type were referred to at least 3 times in each story to increase the salience of each content type.

After reading all three stories, participants were asked to (1) recall each story, and (2) rate both how believable each story was, 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.

2.1.3 Design and Procedures:

Participants were asked to carefully read 3 separate stories (one from each type and category) and that they would be asked about them again later, but not told they would be recalling them. The order of story types was counterbalanced across participants. Participants were then given 2 minutes to complete a distractor math question and then asked to recall each of the three stories with the instructions to retell the story as if they were telling it to another person. Story recall was prompted by the main character in each story (i.e. recall the story about Jane). After recalling each story participants were asked how much they liked the story, how much they believed that the story was true and then did the anthropomorphism questionnaire.

2.2 Results:

Story recall was coded by two independent coders (cohen's Kappa=0.93). We found no significant difference in the memorability of our three stories, ($F(2, 281)=1.96$, $p=0.14$), 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; see Table 1)(Greenhouse & Geisser, 1959). Using pairwise comparisons, we found that anthropomorphic and MCI stories were believed less than intuitive stories. No difference was found in believability between anthropomorphic and MCI stories (Table 2).

[Insert Table 1]

[Insert Table 2]

This coarse analysis is confirmed using a multilevel regression with random slopes and intercepts for each individual, we show that a categorical change from the combined category of MCI and Anthropomorphism 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 effects. A second multilevel regression using the same control variables showed no significant effect of the combined MCI and Anthropomorphic content on memory (-0.04; 95%CI: -0.08 to 0.01; $t(92.77)=-1.44$, $p=0.15$).

To examine the relationship between anthropomorphic tendencies and memory, we ran a set of analyses that regressed our measures of memory on our IDAQ for each person, controlling for age, gender, order and ethnicity (Table 3). We used OLS regressions, rather than multilevel, here because it allowed us to look at the effects for individual stories as main effects rather than as interaction terms. Our results show a significant negative effect of IDAQ on memory for anthropomorphic content and a marginal effect for physical MCI content. We additionally found a negative effect of belief on memory for both anthropomorphic and physical MCI content. No effects were found for intuitive content.

[Insert Table 3]

2.3   Discussion

The significant difference in believability between the MCI and intuitive stories supports the hypothesis that MCI information is less believable than intuitive content. The

average belief rating for intuitive stories was 1.75 (d=-2.49) points higher on a 7-point

scale when all controls were included, despite the intuitive story also not being readily

believed.

The negative relationship between anthropomorphism (IDAQ) and memorability is

apparent for anthropomorphic MCI information (β = -0.25), and marginally present for

physical MCI information (β = -0.19). This finding supports the hypothesis that this

memory bias is moderated by how intuitive people find these types of violations. For

people who are prone to anthropomorphic inference, anthropomorphic information is

more familiar, less distinctive, and therefore less memorable. This 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 MCI on memory. Presumably, this effect would not lead religious zealots to have a

greater capacity to recall their supernatural beliefs. Rather, it suggests skeptics would be

more affected by the MCI memory bias. Religious believers have other reasons to

remember their beliefs, and MCI violations may not be necessary for people who have

already embraced a belief. Similarly, we found a negative effect of belief on memory for

both types of MCI content. Decreasing the skepticism with which people view this type of

information lessens the memory effect, supporting the idea that belief can lessen this effect.

There were no significant differences found in the memorability of the two types of

MCI and intuitive information. It is possible the memory bias was washed out by the other

information presented in these stories (Gonce et al., 2006; Upal et al., 2007) or by the

narrative structure itself (e.g. Brewer, 1985; Ericsson & Kintsch, 1995; Rubin, 1995). There

is also evidence to suggest that social information exhibits its own memory bias (Mesoudi,

Whiten, & Dunbar, 2006). Since our intuitive stories were social in nature, it is possible that

the memory bias effects were not seen because the bias for social information is similar in

strength to the bias for minimally counterintuitive content.

It could be that the effects we are seeing between believability and MCI content

would not emerge in cases in which MCI content has a clear memory advantage relative to

intuitive content. It is also possible that a memory bias that is not present after a short

delay would show up over time as in Norenzayan et al. (2006, study 1), where memory for

list information was no different in immediate recall, but MCI lists became significantly

more memorable after 1 week. Experiment 2 was designed to rule these possibilities out by

using previously tested MCI stimuli and adding a one-week delay for recall.

3   Experiment 2

The MCI materials used in experiment 2 were taken from Boyer and Ramble (2001).

This type of stimuli has been used across several other studies (e.g. Barrett & Nyhof, 2001;

Upal et al., 2007) and have successfully revealed a memory bias.

We also wanted to address the possibility that these effects could emerge over time.

For a memory bias in these items to influence cultural transmission, the bias must persist

much longer than the two-minute interval used in the first experiment. Similarly, even

where belief is not present at first, people may come to believe more as they become more

familiar with concepts over time. To address both of these possibilities, participants were

asked to recall the items twice: after a 5-minute delay and after a 1-week delay. Belief in the

items was measured with a set of three questions instead of the single question used in the

previous experiment.

3.1   Methods:

3.1.1   Participants

Eighty-nine (63 female) psychology undergraduates from the University of British Columbia were tested. The ethnicity of the participants was 61.9% Asian, 34.5% Caucasian and 3.65% other. The group was 46.5% Christian, 15.1% other religions and 38.4% non-religious. The average age was 19.9 (sd=2.6) years old. All participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite for signing up in the experiment. Nine participants failed to return one week later to complete part two of the experiment.

3.1.2   Materials

The story used in this experiment was taken from Boyer and Ramble (2001). It consists of a short introduction about Mr. Wurg, an intergalactic ambassador, and his trip to the natural history museum on the planet Zeon 3. The story listed the items he saw in this intergalactic museum. The story consists of 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 Experiment 1 of this paper.

Believability of each item was assessed using 3 questions about belief. Participants once again were given an anthropomorphizing scale (the IDAQ) to evaluate how much they anthropomorphize the world around them.

3.1.3   Design and Procedure

The procedure was largely the same as in experiment 1. Participants came into the lab and were instructed to complete the experiment alone in a cubical. After a short demographic survey, they read the story in 4 sections. The sections were counterbalanced between subjects to control for order effects. Participants were then given 5 minutes to complete a distracter math task before being asked to recall the items in the story. After recall, each item in the story was listed one at a time along with a series of three questions to assess the participant's belief in an item. The anthropomorphism scale was administered and participants were dismissed with the instructions to return in one week's time.

In the second session, one week later, participants sat at a computer and were asked to recall the items from the story they read the previous week. After this was done, belief in each item was reassessed in the same way as the first session. Participants were then debriefed and sent on their way.

3.2 Results:

Item recall was coded by two independent coders (cohen's Kappa =0.91). At time 1 (five minute delay), our analyses show that the MCI items were significantly more memorable (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), and that 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).

At time 2 (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), controlling for age, gender, ethnicity, as in

experiment 1. Religious affiliation was added as an additional control. Affiliation

information was not included in experiment 1 because it was not collected. All of the

results are robust to the inclusion or exclusion of any of these covariates. For 5-minute

recall, our analysis showed a significant negative effect of anthropomorphism on both MCI

objects and people. There was also a negative effect of anthropomorphism on memory for

intuitive people items. Recall at one week showed a marginal 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 belief effects found in experiment 1, in this

experiment belief was found as a significant predictor of memory, but only for MCI objects

on 5 min recall.

     Memory at 5 min and 1 week were strongly correlated (INT: r=0.72, t(76)=9.15,

p<0.001, 95%CI: 0.60 to 0.82; MCI: r=0.75, t(76)=9.75, p<0.001, 95%CI: 0.63 to 0.83). Five

minute recall was not included as a control variable in time two regressions due to

problems with multicollinearity and independence of data points.

[Insert Table 4]

3.3   Discussion:

The memory effect after 5 minutes (d=0.57) is a replication of the effect found by Boyer and Ramble (2001, experiment 1; d=0.68, estimated from F-test, n=18) in their original experiment. We have added to this replication a replication of our own belief finding from Experiment 1. As expected, MCI content is far less believable than intuitive content, even in established MCI stimuli.

Belief effects were consistent across both sessions (d=2.17 after 5 min; d=2.29 after 1 week), showing almost no change between the first and second session. Time (at least a short time) does not lead to more belief in our sample. It could be argued that repeated exposure over 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 participants had read the items 3 times and recalled them twice. This repeat exposure did not affect their willingness to believe in these items.

Similar to the anthropomorphism finding from Experiment 1, we find that people who score higher on the anthropomorphism scale show a decrease in the memory bias for MCI items. Unlike Experiment 1, where no effect was shown for our non-anthropomorphic MCI story, we show an effect for both MCI objects and people, and a marginal effect on MCI object recall after 1 week. Looking at the MCI object items used in this experiment, it is apparent that most or all of the MCI objects in this experiment could be considered anthropomorphic (e.g. "Objects that hide when they are scared"; "Objects that can notice people are staring at them"), making this finding consistent with the hypothesis. This was not the case in Experiment 1, where the non-anthropomorphic MCI violations were all specifically selected to be only violations of folk physics.

We also found a negative effect of anthropomorphism on memory for the intuitive people stimuli. This could suggest a more general mechanism, or a mechanism specific to mixed anthropomorphic and non-anthropomorphic stimuli. More research is needed to draw any conclusions from this effect. The effects of anthropomorphism on memory after 1 week were not significant and only showed a marginal effect for MCI objects.

We did not replicate the effect of belief on memory found in Experiment 1. Belief was positively related to memory for MCI objects. This effect was not found in any of the other conditions.

4   Experiment 3

One concern with experiments 1 and 2 is that the material used in both of the previous experiments was framed as fictional 'stories'. However, believers experience religious content as facts about the world. For this third experiment we used science news items as MCI content we could present as true information about the world. We chose these over religious items so as to prevent participants' existing religious beliefs from biasing the belief responses for items. Participants were again called in for two sessions one week apart, in the same manner as in experiment 2.

Another concern with Experiments 1 and 2 is that belief was assessed with a self-report measure, and although unlikely, it is conceivable that participants were not motivated to answer the belief questions based on their actual beliefs. To address this concern, we added a monetary behavioral measure to the second session, which served as an additional measure of commitment, as well as a means to validate the self-report belief measure. After evaluating belief and memory in the second session, participants were told

that some of the news stories had been made up and where untrue, and that we would give them $1 for each story they could correctly identify as either real or made up. Essentially, people could put their money where their mouth is.

4.1 Methods:

4.1.1 Participants:

Ninety-nine (68 female) psychology undergraduates from the University of British Columbia participated. The ethnicity of the sample was 67.1% Asian, 23.3% Caucasian and 9.6% other. The religious affiliation was 41.1% Christian, 16.4% other religious affiliation and 42.5% not religious. The average age was 20.16 (sd=3.10) years old. All participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite for signing up in the experiment. Nine participants who participated in session 1 failed to show up to session 2.

4.1.2 Materials:

The stimuli consisted of 12 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). All participants read all 12 stories. A pilot test (n=20) of the stories showed that the minimally counterintuitive stories (M=4.07, sd=0.83) were seen as more supernatural than the intuitive stories (M=2.13, sd=0.96; t(19)=8.14, p<.001, 95%CI: 1.44 to 2.44; d=1.82). Participants were again asked to rate their belief in each story with the 3 questions used in experiment 2, and given the IDAQ to measure their tendency to anthropomorphize.

4.1.3   Design and Procedures:

Experiment 3 followed the same procedure as experiment 2, but with the addition of a behavioral task in the second session. Participants read each of the 12 new summaries in a randomly generated order. They were then given a five-minute math task. In the recall task, participants were asked to recall the main point of each news story in one sentence per story. Participants were then presented with only the headlines from each story, and asked a series of three questions to assess their belief in the accuracy of each news story. The anthropomorphism questionnaire was administered and participants were dismissed with the instructions to come back in one week's time.

In the second session, participants were again requested to recall the main points of the news stories with one sentence per story. Their belief in the news stories was assessed in the same way as in the first session, using only the headlines as a cue for each story. After this was complete a behavioral task was administered. Participants were given a paper-based questionnaire with all 12 complete stories on it. They were told that some of the stories had been made up by the experimenter and were instructed to re-read the stories and mark down which they thought were the real stories and which were made up. They were also told that they would be given $1 for each right answer they gave. Once the sheet was filled out, a research assistant scored it, and the participants were paid for their correct answers, debriefed and dismissed.

4.2   Results:

Memory was coded by two independent coders (Cohen's 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 and slops 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 1.4 times (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 1.8 times

(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 again used regression analyses to assess the effect of IDAQ and belief on memory

while controlling for, age, gender, ethnicity and religious affiliation. Although we found a

similar pattern for anthropomorphism's relationship to memory at 5 minutes, it was not

significant (Table 5). This effect was significant at the second session, after one-week. The

effect of anthropomorphism on memory for intuitive content was in the negative direction as before, but not statistically significant at either time point.

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]

4.3 Discussion:

The memorability advantage of MCI was present but its detection depended on the particular statistical technique we used. Though memory was greater for MCI items than intuitive items after both 5 minutes and 1 week, neither time point was significant at conventional levels using a t-test. However, both became significant when modeled hierarchically, which is a more powerful statistical technique. 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.

However, the effect of MCI content on belief was unambiguous. Participants were more likely to endorse the reality of intuitive stories over MCI stories in this experiment. Again, belief did not appear to change between 5 min (d=-1.67) and 1 week (d=-1.58).

Fictional stories were on average believed *more* than factually true ones, ruling out the hypothesis that believability ratings merely reflect participants' ability to correctly guess this difference. The monetary measure replicated these 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. There was a positive correlation between the monetary measure and the prior belief ratings for both MCI (r=0.46) and intuitive stories (r=0.59). These correlations suggest that the belief ratings are, to some degree at least, reflective of sincere commitment and are linked to actual behavior.

The anthropomorphism effect was less clear here than in the previous two experiments. A significant effect was found only at time 2. This may be due to the stimuli itself; the difference between anthropomorphic and non-anthropomorphic information was much less clear than in either of the previous two experiments. This was also different from experiment 2, where the effect of anthropomorphism was found only at time 1. Still, the general trend was maintained. Despite the potential for these stories to be real and the increase in belief even in the MCI type news summaries. Given the medium size of this effect in the prior two experiments, it should be expected to be non-significant some of the time, especially in small samples. Additionally, the MCI content in these stories was not limited to specifically anthropomorphic information.

5   Experiment 4

Experiments 1-3 showed that people found MCI content less believable than intuitive content. This lack of belief did not seem to change in the one-week interval. While

this finding should not be surprising, when we consider religious content that the MCI

hypothesis proposes to explain, lack of belief becomes a problem. Religious ideas are ideas

people believe in. If religious ideas consist of 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 (see Atran & Henrich, 2010; Gervais et al., 2011; Henrich, 2009; Norenzayan,

2013).

In our fourth experiment, we wanted to investigate one possible cultural learning

bias that supports CREDs (Henrich, 2009) that could explain how MCI content becomes

believable. Participants were given news stories from the previous experiment, as well as

$5 to bet on stories. They were told to make bets of $1 on any story they believed was real.

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 sat and talked

with them while the bets were being placed. The confederate either 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.

5.1   Methods:

5.1.1   Participants:

Seventy (41 female) psychology undergraduates from the University of British

Columbia were tested. The ethnicity of the participants was 52.3% Asian, 44.6% Caucasian

and 3.1% other. The religious affiliation was 44.6% Christian, 12% other religions, and 43.4% not religious. All participants were recruited from a human subject pool and given course credit for their participation. The average age was 20.38 (sd=1.88). English fluency was a prerequisite for signing up in the experiment.

5.1.2 Materials:

The stimuli consisted of 10 of the 12 stories from the previous experiment. 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.

5.1.3 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. They were then brought into a room with a confederate posing as a second participant. Both the participant and the confederate were given five $1 coins and told that some of the stories were true and some of them were made up. They could put money down on any story they thought was a true story. If they were correct, the money would be doubled, if they were incorrect, they would lose the money. The experiment was constructed as a 2 x 2 design, with either CRED or verbal (no-CRED) and MCI or intuitive. Before the participant decided to bet, the confederate either bet all of his money, $1 per story, on either the MCI or on the intuitive stories (CRED), or bet none of his 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 verbal endorsement script was used in

both the CRED and no-CRED conditions. In the CRED condition, the confederate additional

stated 'I'm going to put a dollar on _____ story' for each of the set relevant stories, and

then marked the paper. No comment was made about money and the confederate did not

write on the paper at all in the verbal (no-CRED) condition. The participant marked which

stories that they wished to bet money on. Though the confederate and the participant were

in the same room, the confederate could not see what stories the participant marked. 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.

5.2   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,

controlling for prior rating of belief, age, gender, ethnicity and religious affiliation. This

effect is reversed when CREDs were placed on intuitive items.

[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]

5.3 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. This does not seem to simply be an effect of mimicking betting (vs. not betting) in general, as participants tended to endorse the stories that the confederate bet on rather then just picking stories at random, or picking the stories they had previously rated as believable. 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 are 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, more reliable, and marginally more likable, suggesting that acting according to one's beliefs may lead to reputational benefits as well as spread behaviors and potentially beliefs.

Giving participant real money to work with created real costs and benefits for their beliefs. Participants could gain or lose money according to what they endorsed as true. If participants were going along with the confederate simply because the correct answer was ambiguous, we would not see such a large jump between the verbal endorsement and the

CRED manipulation. What we do see is that the CREDs endorsement increased the participants' endorsement of even the initially less plausible stories (MCI). In the CREDs condition, MCI stories are endorsed at a higher rate than the intuitive stories were in the verbal condition. It also does not seem, based on the previous experiment and pre-manipulation ratings of belief, that there was much ambiguity in which stories participants thought were false.

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 gives no special place to MCI information. 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 if initially less believable. If backed up by credible displays, it can evoke passionate commitment and belief.

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, but this research suggests CREDs as a plausible candidate to transmit religious practices and beliefs. This is an area of research that is yet to be thoroughly explored in the cognitive science of religion.

6   General Discussion

Evidence from the above experiments, and previous research, suggests that the memory effect of MCI content is present but fragile. There likely are several boundary conditions that are yet to be identified. For example, changes in context seem to be enough to make the effect disappear (see Gonce et al., 2006; Upal et al., 2007). In this paper, we found the memory effect in two of our three memory experiments. The stimuli used in experiment 2 have been used to demonstrate and replicate this memory effect in the past. However, they are artificial in nature and push the limits of external validity in representing the religious and mythic stories we see in the world. 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 possibly boundary explored in this paper is the effect of familiarity on memory for MCI content. We used a measure of anthropomorphism to estimate how much participants used this type of reasoning to explain the world more generally, and showed that this tendency to anthropomorphize decreased the memory effect of anthropomorphic 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. It is worth noting that this supports one of two possibilities: One, is a schema view of MCI content expressed by Upal (2010), Purzycki (2010), and to a lesser extent Barrett (2008), rather than the original ontological category view expressed by others

(Atran & Norenzayan, 2004; Boyer, 2001; Boyer & Ramble, 2001). 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. These possibilities can be explored in future work.

Other researchers have suggested that anthropomorphism is an intuitive (Waytz, Cacioppo, et al., 2010; Waytz, Morewedge, et al., 2010), rather than counterintuitive tendency, and its prevalence in religion is governed by this fact rather than its distinctiveness or memorability (Guthrie, 1993; Willard & Norenzayan, 2013). Future research can address these two possibilities. 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.

Other similar memory effects have been explored in psychology, such as the distinctiveness effect in text recall (e.g. Waddill & McDaniel, 1998) and the bizarreness effect (Lang, 1995; McDaniel & Einstein, 1989; McDaniel et al., 1995) that also may fit with a schema view of the MCI hypothesis. This research has come to similar questions and conclusions about the context and reliability of this type of memory effect and may be worth exploring in any future attempts to define the borders of the MCI memory effect. Moreover, the issue of familiarity also is a factor worthy of consideration. When MCI content becomes commonplace, additional mechanisms of transmission will still be necessary to maintain MCI concepts in a population.

If it is the case that a memory effect is one of the primary drivers of religions' spread, we should see religious concepts that are unique and unfamiliar spreading further and faster than ones that are just variations on a familiar theme. All else being equal, the levitation of transcendental meditation should be more novel and spread further than the reworked Christianity of Mormonism. All else is of course not equal, and Mormonism's claim to the religious landscape is proportionally increasing faster than any other religion in the world right now (Stark, 2005), probably due to a variety of cultural technologies Mormonism employs.

It is clear in all of the above experiments that people do not readily believe MCI concepts, or accept them as true states of the world. 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*. This will not only be true for traditions, like Christianity, where belief is a defining factor, but also for traditions where belief is not emphasized beyond the existence of supernatural agents. Even in the latter case, the very existence of supernatural agents and objects are still seen to impact the lives of religions followers and ritual participants. The problem of belief is therefore an interesting problem for this hypothesis (Atran, 2002; Atran & Henrich, 2010; Gervais & Henrich, 2010; Gervais et al., 2011; Henrich, 2009).

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 this hypothesis, namely, that these violated categories are rooted in reliably developing, core intuitions. Previous research has found that anthropomorphism is a stronger predictor of alternative supernatural beliefs than Christianity, and even suggested the possibility that living in a Christian society may decrease anthropomorphic tendencies (Willard & Norenzayan, 2013). 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.

Even if one was to reject the necessity of belief in religious concepts as a primary concern of religions, the issue of familiarity with MCI concepts removing their memory effect remains. This supports a schematic view of the MCI hypothesis. This view argues against the uniqueness of MCI concepts that long-term multi generational transmission would require, namely the idea that they remain distinctive and we never get used to them.

The relationship between MCI content and belief illustrates 3 points: 1) MCI items are seen as more supernatural than intuitive items (see Pyysiäinen et al., 2003); 2) supernatural concepts are believed in all around the world; 3) MCI items are less believable than intuitive items. If people come to believe in the unbelievable, a process is needed to explain this, one that does not rely on the distinctiveness of MCI content. Given the existence of complex cultures and ritual practices to support religious beliefs, multiple processes are likely to contribute to belief in the face of implausibility. 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 these witnesses adopt similar practices and beliefs (Henrich, 2009).

There are many other cultural learning mechanisms through which people transmit information (see Henrich, 2009; 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 the idea that CREDs can increase the endorsement of belief, for both intuitive and MCI information. There is much more to be done to understand the role of CREDs and other cultural learning mechanisms. This is in no way meant to be a conclusive test in regards to the robustness of CREDs, but rather as a simple demonstration that social cues can influence peoples' belief in the implausible.

7   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. If familiarity reduces the memory effect of MCI content, then we need a better explanation of where this memory effect is important in establishing and maintaining religious traditions. This is only one boundary in a theory that may still have many more caveats worth exploring.

To explain the role MCI information plays in religions, we need to explain how people overcome the initial tendency to not believe. In this paper, we report a preliminary test of one possible mechanism. Our findings suggest that culture 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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[1] Another hypothesis could be 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] This theory shares some similarities with the theory of costly signaling (see Sosis, 2004; Sosis & Alcorta, 2003), but differs in that the credible actions influence the cultural transmission process for behaviors and beliefs rather than acting to signal group membership or cooperative dispositions. CREDs also differ from signaling models in that they need not be costly.

[3] Using a multilevel logistic regression with random intercepts and slopes 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 remembered over intuitive items with an average log odds of 0.57 ($z=4.98$, $p<0.001$; Odds: 1.77, 95%CI: 1.41 to 2.21) after five minutes. This difference was an average log odds of 0.51 ($z=3.51$ $p<0.001$; Odds:1.66, 95%CI: 1.25 to 2.21). Belief was similarly modeled with a multilevel linear regression. 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; $t(165.40)=-49.53$, $p<0.001$).

[4] Using a multilevel model with random intercepts and slops 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, controlling for age, gender, ethnicity, religious affiliation, and fake stories. After one week, this change in belief

was 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.

Story Stimuli – Study 1

JANE, MCI-Anthropomorphic

Jane went for a walk in the woods. On her walk she came across a talking squirrel. 'Hello' it said to her. Jane was startled. It looked like any other squirrel; it was small and grey and had a large bushy tail. I've never seen anything like this before she thought, so she picked it up and took it with her. She wandered further and further into the woods talking with the squirrel. She was distracted and not paying attention to where she was going. The squirrel ran ahead, and Jane chased after it. She became nervous about getting lost in the woods. Soon, she came to a fork in the road. She held the squirrel in her hand and said to it "what will I do! I'm lost and it's getting dark. I can't find my way home". The squirrel hopped onto her shoulder and said "I will lead you home, take the right hand path, and it will get you home". She followed the squirrel's directions and found her way safely home. She said goodbye to the squirrel on the path near her house, thanked it for its company and for being her guide, and went home to bed.

MCI Physical: Floating rock (touched it instead of talking to it)

Intuitive: another girl

SAM, MCI-physical

Sam was wandering in the library. He came across a section he had never seen before. The books were old and dusty and looked as though no one had read them in a long time. He pulled one down from the shelf and opened it. Suddenly, the book started to flicker as if it wasn't really there. "What is this?" Sam thought. "The story of John" read the title. "How long has this been here?" thought Sam. It looked like a very long time. "How did I find this part of the library!" thought Sam. Sam looked around, he wasn't sure how he'd gotten to this part of the library at all. There weren't flickering books in any other part of the library he had seen. "Maybe I can find an exit sign" Sam thought hopefully. "I'd be very grateful if I could

get me out of here" contemplated Sam. Sam started to wander down the aisles of the strange new part

of the library with the flickering book in his hand. Sam found an exit, but when he walked out the book

had disappeared.

MCI-Anthropomorphic: Ghost of John

Intuitive: John

KATE, Intuitive:

Kate went walking in the field behind her house. She sat down under her favorite tree for a picnic. Her

neighbor came from behind the tree and gave her a hug. Kate jumped up; she didn't know what to do.

She had never been hugged by her neighbor before. Her neighbor reached out and hugged her again.

Unsure what to do, she offered some cheese from her basket to her neighbor, but he shook his head to

decline. She sat under the tree and ate her picnic so fascinated by her new friend that she didn't notice

the sky turn black. By the time she did notice it was too late and a storm was upon her. Lightening

clapped and the rain started to fall. There was no way Kate could make it home in this weather. Her

neighbor reached over her to protect her from the wind and rain. She stayed sheltered under her

neighbor's coat until the storm passed and she could go safely home. She thanked her neighbor

profusely for all his kindness and promised to come again soon. With the sun shining overhead, she

crossed the field and made her way safely home.

MCI-Anthropomorphic: Hugging Tree

MCI-Physical: Vanishing Tree

News Stories – Studies 3 &4

Real MCI articles

*Jim the Wonder Dog Predicts the World Series

Jim was just a plain black and white setter, but in all the annals of dogdom there has never been anything his equal. Jim had the ability to predict the future. Psychology professors from Washington University in St. Louis and the University of Missouri in Columbia observed the uncanny things he could do. They shook their heads in wonder and had absolutely no explanation for his behavior. Even his master could offer no clue to his remarkable gift. For seven years in a row, he was shown a list of entries in the Kentucky Derby, and he picked the winner each time in advance of the race. With equal ease he could correctly predict the gender of unborn babies. In 1936 he predicted the winner of the World Series as well as the winner of the U.S. presidential race.

Teleporting larger objects becomes a real possibility

The dream of teleporting atoms and molecules - and maybe even larger objects - has become a real possibility for the first time. The advance is thanks to physicists who have suggested a method that in theory could be used to "entangle" absolutely any kind of particle. Anton Zeilinger, a quantum physicist at the University of Vienna in Austria, has already shown that this quantum state is possible with large molecules. Any scheme that expands the range of particles that can be entangled is important, says Zeilinger. Entangling massive particles would mean they could then be used for teleportation from one point in space to another. "It is fascinating," says Zeilinger. "The possibility that you can teleport not just quantum states of photons, but also of larger pieces of mater, that in itself is an interesting goal."

Radio evolves from the electronic soup

A self-organizing electronic circuit has stunned engineers by turning itself into a radio receiver. Using software to control the connections between 10 transistors plugged into a circuit board that was fitted

with programmable switches. The switches made it possible to connect the transistors differently.

Treating each switch as analogous to a gene allowed new circuits to evolve. Those that oscillated best

were allowed to survive to a next generation. These "fittest" candidates were then mated by mixing

their genes together, or mutated by making random changes to them. After several thousand

generations you end up with a clear winner, says Layzell. But precisely why the winner was a radio still

mystifies them. To pick up a radio signal you need other elements such as an antenna. After exhaustive

testing they found that a long track in the circuit board had functioned as the antenna. But how the

circuit figured out that this would work is not known.

Fake MCI

Artificial Intelligence advances make conscious machines a real possibility

It once was only in the realms of science fiction, but recent advances in the University of Waterloo's

Cognitive Systems and Computer Science research lab have made the possibility of fully conscious

machines a possibility within our lifetimes. Using solid state silicone chips with only minimal

programming the machines have managed to learn beyond their initial programming and react in novel

ways to their environment much like a living system would. "Self motivated machines have been the

holy grail of AI research since the beginning" says Dr. Christopher Austman who led this project.

"Though we are a long way off from the type of self motivated robots we see in films, this is still a very

exciting breakthrough in the field."

Haitian Zombies mimic horror movies

Voodoo has a long history in Haiti, with zombification existing for almost as long. Though the zombies of

Haiti are not the undead we are familiar with from horror movies of old, according to one Harvard

psychologist they may mimic the mindless zombies more frequent in the modern day version of the

genre. "The Hatian zombies are in most ways normal human beings" says Dr. Andrew Whitefield "but

when we put them in an fMRI , the parts of their brains that correspond with free will are not

responsive". According to local wisdom, these zombies are created by voodoo priests cursing the

victims. Though this has not been confirmed by the researchers, it is apparent that something has shut

down certain areas of the neo-cortex rendering the victims completely without free will and essentially

without a mind of their own.

Quantum Physics opens up the question: can 'consciousness' affect matter.

Researchers in quantum physics have long been thought of as the very fringe of science. This has never

been more true than it is about research being done at the University College of London that look at the

effects of consciousness on matter. "This is a real theoretical possibility" said Dr. Hamid Azar who is the

main force behind these projects. "It's not something that even most physicists have considered, but

this research may shed some light on the strange set of behaviors particles have on a quantum level."

The idea of the human mind being able to affecting matter is one that seems to have fascinated

humanity throughout history, but this is the first time science has shown it to be a real possibility.

Non-MCI articles

Solar Windows Capable of Generating Electricity

New Energy Technologies, is pleased to announce that researchers developing its SolarWindow

technology have achieved major scientific and technical breakthroughs, allowing the Company to unveil

a working prototype of the world's first-ever glass window capable of generating electricity in the

upcoming weeks. Until now, solar panels have remained opaque, with the prospect of creating a see-

thru glass window capable of generating electricity limited by the use of metals and various expensive

processes which block visibility and prevent light from passing through glass surfaces. Unlike

conventional solar systems, New Energy's solar cells generate electricity from both natural and artificial

light sources, outperforming today's commercial solar and thin-film technologies by as much as 10-fold.

*Quantum physics whiz takes professorship at 22

To have a physics teacher who is close to your age will be a new experience for students at the Indian Institute of Technology (IIT) Bombay where 22-year-old Tathagat Avatar Tulsi will be joining as assistant professor of physics next week. He will be the youngest to teach at this prestigious institution. A child prodigy who completed school, college and postgraduate studies as a teenager has chosen IIT where "I can teach as well as do research in quantum physics", he told Gulf News. Inspired by a book by Steven Hawking, at 14, Tulsi was admitted to the Indian Institute of Science, Bangalore, for a Phd programme in quantum physics.

Outlook plug-in keeps tone of your emails in check

For all those times that an e-mail sounds better in your head than it does to the recipient, ToneCheck thinks it can help. The plug-in, which is in a free-for-now beta for Microsoft Outlook and coming to web-based mail services in the future, reads over your e-mails for emotions such as elation, humiliation, excitement and fear. Users can set thresholds for how much emotion to allow in their e-mails, and ToneCheck essentially acts like a spell checker, flagging words and phrases that might be interpreted the wrong way. ToneCheck's website has a demo that shows how it works, but the real test will come in how many companies will be early adopters of this technology in hopes of improving their companies internal and external professional relations.

People Out Perform Computers at Protein Folding Tasks

In 2005, David Baker and his colleagues at the University of Washington in Seattle unveiled Rosetta@home — a distributed-computing projects in which volunteers download a small piece of software and let their home computers do some extracurricular work when the machines would otherwise be idle. The downloaded program was devoted to the notoriously difficult problem of protein folding: determining how a linear chain of amino acids curls up into a three-dimensional shape. But what

was surprising, says Baker, was that the Rosetta@home volunteers quickly began to chafe at the painfully slow progress of their screen saver. "People started writing in saying, 'I can see where it would fit better this way'," he says. Computers have to plod through thousands of degrees of freedom to arrive at an optimum energy state. But humans, blessed with a highly evolved talent for spatial manipulation, can often see the solution intuitively. By mid-2008, they had created an interface for Rosetta@home that not only allows users to assist in the computation, but gives them an incentive to do so by turning it into an online game, Foldit. Baker and his colleagues have now publish evidence that top-ranked Foldit players can fold proteins better than a computer

Ancient 'cat-like' crocodile had bite like a mammal

Palaeontologists working in Tanzania have unearthed fossils of a tiny crocodile-like creature with teeth resembling those of mammals. The animal, Pakasuchus kapilimai, lived between 144 and 65 million years ago - during the Cretaceous - in what is now sub-Saharan Africa. Scientists say the find shows that crocs were once more diverse than they are today. Paka means "cat" in Kiswahili, Tanzania's official language, and refers to the reptile's short, low skull with slicing, molar-like teeth. Patrick O'Connor, associate professor of anatomy at the Ohio University College of osteopathic medicine, led an international team of researchers. He said the new animal was a lot smaller than its modern relatives, adding that "its head would fit in the palm of your hand".

Four hours for forensic DNA test

Forensic scientists have developed a test that can match a suspect's DNA to crime scene samples in just four hours. The new technique could greatly speed up forensic DNA testing, making the process almost as easy as matching fingerprints. Police could check whether a suspect's DNA matches profiles in a database before a decision is taken on whether to release them from custody. Researchers describe their approach in the journal Analytical Chemistry. Their report points out that a large number of

individuals re-offend while on police bail. In the UK, 75% of people arrested are released from police custody within six hours and 95% are released within 24 hours. At the UK's Forensic Science Service (FSS), urgent samples can be prioritized on request and, once delivered to a lab, can be processed in about eight hours.

* Not used in study 4