MEMORY AND BELIEF FOR RELIGIOUS CONTENT

by

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Abstract

Past research on the evolutionary origins of religion has looked at content biases as a way to explain the spread of religions in human cultures. Specifically, the memory bias found with minimally counterintuitive (MCI) content has been theorized to be the source of the spread and diversity of religion around the world. This research has paid little attention to how people come to believe in these concepts, and if this is due to a memory bias alone. A debate exists within the literature questioning if content bias is enough to establish belief in religious concepts, or if some other mechanism is required. The following research looks at this question of if the transmission of belief can be driven by a minimally counterintuitive content, or if a separate mechanism is required to make the step from memorability to belief. If minimally counterintuitive content violates our expectations of the world, it should show less belief than intuitive content because of this violation. In the following set of studies participants were presented with different types of MCI and intuitive content and then were asked to recall, and state their belief in, this content. In all of the studies, participants believed in MCI content less. The previously found memory bias was only replicated in one of the three studies. Participants were also given an individual difference measure of anthropomorphism as a way of measuring their propensity to apply MCI concepts to the everyday world. This was done to look at the hypothesis that as these beliefs become common, the preserved unusualness of the minimally counterintuitive violation, and subsequently the memory bias, should decrease. Supporting this, a negative relationship was found between memory for MCI content and the tendency to anthropomorphize. People who regularly anthropomorphize show less of a memory effect than those that do not. Together, these findings suggest that belief is not tied to the content biases and that as people come to see these concepts as a normal part of the world, the memory effects are decreases.
Preface

Chapter 2 is based on work conducted in UBC’s Culture and Cognition Lab by Dr. Ara Norenzayan, Dr. Joseph Henrich, Will Gervais and Aiyana Willard. All collaborators contributed to the concept and structure of the experiments involved in this thesis. I was responsible for designing the experimental set up and running the data collection. The manuscript was written in entirety by me, with comments and suggestions from Dr. Norenzayan.

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Dedication

This thesis is dedicated to Enki, the Sumerian god of science; may it serve as a worthy sacrifice and ensure that our future experimental endeavors be fruitful and many.
1. Introduction

The spirits, or kami, worshiped in the Shinto religion, the traditional religion of Japan, are collectively known as *yaoyorozu no kami* which literally translates to ‘the 8 million kami’. The traditional belief in Hinduism is that there are 330 million gods, though many Hindus believe that there are actually only 3, or possibly 1. Christians believe in only one God, split three ways, and that belief in any other god is blasphemous, where Muslims believe that the Christian trinity is blasphemous and that the belief in only one God, without the Son or Holy Spirit, is the only true belief (Bowker, 2007). Though this is a very small slice of religious diversity worldwide, it illustrates the idea that, as humans, we are quite capable of coming up with an abundance of supernatural beings and a wide variety of religious beliefs. This is true to such a degree that there are no cultures that we know of, and have never been, that do not have some trappings of religious belief. Supernatural agent beliefs appear to be extremely widespread, if not culturally universal. What is it about these supernatural beings that makes them so compelling that they seem to exist everywhere?

This question is the foundational problem of the cognitive science of religion, which holds religion as a natural phenomenon and based in ordinary human cognition (see Atran, 2002; Atran & Norenzayan, 2004; Barrett, 2004; Boyer, 2001). It comes out of our normally functioning cognitive structures and causes us to create and believe some form of religious idea with little influence from our cultural surroundings (Barrett, 2010). A series of cognitive biases are offered up as an origin story for the human propensity towards religion and belief in the supernatural.

Before we can answer the question as to where religion comes from, we need to know what we mean by ‘religion’ in the first place. The wide variety of religious beliefs around the world is so
exceptionally varied that it becomes next to impossible to define exactly what religion is. Though many definitions have been offered, none seem to satisfy all the possible variations of religion without including many things we intuitively would not include in our concept of religious beliefs (like political convictions and sports clubs. See Slingerland, 2008). Religion, as a concept, is a category in which we place different types phenomenon that we see as related to one another and this concept of ‘religion’ (Atran & Norenzayan, 2004). How religious something appears to be is dependent on how well it fits into this category. This way of processing information allows for exceptions to every rule, for a variety of things to seem more or less religious, and for these things to differ from person to person. Though most people may classify Christianity clearly as a religion, something like Buddhism may be more religion-like to some than to others.

Even though this category definition makes sense as a way to think about religion, for something to be explained and tested within the confines of the scientific method it needs to be defined. We can get around this problem of religion as a category by studying the individual things commonly held to be part of this category. Religion as a whole may be difficult to define, but items like gods and ghosts are much more amenable to operational definitions. Concepts within the category of religion looked at individually can give us a better picture of how religion works as a whole. For the experiments presented here, I am specifically looking at the part of religiosity that relates to belief in things that are supernatural (see Bulbulia, 2007). In these studies, I will be looking at minimally counterintuitive content, a proposed template for what makes something supernatural, and how it relates to belief in supernatural items. The theory behind minimally counterintuitive (MCI) content suggests that people find this content surprising and as such, requires more attention. This in turn makes this content more memorable. This bias in memory has been proposed as a means by which these ideas become wide spread throughout culture (Boyer, 1994, 2001). The theory has little to say about how people come to believe in these items. I propose here that the very mechanism that makes them counterintuitive, the
violation of an innate expectation of how the world works, should also make them unbelievable. If unbelievability is tied in this way to the memory bias for these items, then, as people come to believe them, this memory bias should decrease. The people who believe in gods and ghosts should be less affected by this type of biased recall. If this is the case then a second mechanism is required to explain how people do come to believe in supernatural content, and how it is subsequently spread. The answers to the questions these ideas raise first requires a closer look at what it is that makes some content, and not others, seem supernatural.

### 1.1 What is Supernatural?

Pascal Boyer (1994) put forth the idea that identifying certain types of things as supernatural is caused by our innate cognitive systems. Supernatural concepts are a byproduct of how these systems organize and interpret the world around us. The broader hypothesis from which this is drawn, that religion is a byproduct of the natural workings of our brains, is commonly used in the cognitive science of religion to explain the widespread nature of religious belief (Atran, 2002; Atran & Norenzayan, 2004; Barrett, 2000, 2004; Boyer, 2001). Religion is a universal in human cultures because it is a natural, but unexpected, outcome of our normally functioning cognition; it is a byproduct of our cognitive makeup. These cognitive foundations of religious beliefs are what is known as a biological spandrel. A spandrel is a term used in architecture to describe the triangular shape that is created when the curve of an arch meets a square corner of a building. It is not made intentionally and serves no real purpose, but is reliably created by a structure that was intentional and does have a purpose. In particular, Boyer’s hypothesis claims that supernatural concepts are supernatural because they are minimal violations of our innate assumptions about how things should behave in our environment (Boyer, 2001). These assumptions are part of the cognitive structure we use to readily make sense of the natural world, and the bias is an unexpected outcome.
Humans have the capacity to understand particular aspects of the world around them right from birth. We understand objects as solid bound entities that follow specific paths of motion and cannot pass through other solid objects (Baillargeon, 2008; Spelke, Phillips, & Woodward, 1995). We understand that living things eat, grow and die and divide the world up into species level categories through the assumption that what makes something a member of any category is internal to an animal and essential, existing in all other members of that category (Atran, 1994; Gelman, 2003; Gelman & Hirschfeld, 1999). We have the capacity to understand minds as having desires, beliefs, and intents (Baron-Cohen, 1995; Leslie, Friedman, & German, 2004; Luo & Baillargeon, 2010). These three categories were outlined by Wellman and Gelman (1992) as innate core cognitive functions of the human brain (also see Keil, 1979). They are often referred to as folk physics, folk biology, and folk psychology (Boyer, 1994). Though other domains of core knowledge have been identified (e.g. number systems. See Xu, Spelke, & Goddard, 2005), it is these three that have been implicated as playing a role in the origin of religious belief.

Core cognitive capacities tell us what to expect from our environment by helping us predict how things will behave in the world without much learning. This is an effective strategy because the world, for the most part, behaves in very predictable ways (e.g. things fall when dropped) and has predictable properties (e.g. objects are bounded wholes). Having an innate understanding of how these things act greatly reduces the amount of effort required to interact effectively in the environment (Wellman & Gelman, 1992). Certain core capacities are widespread across species (e.g. Agrillo, Dappa, Serena, & Bisazza, 2008; Lea, Slater, & Ryan), suggesting that having some innate knowledge of the world is common, even necessary for survival. In the case of humans, these core capacities allow us to interact with the physical and social world in a way that makes us capable of gaining and generalizing knowledge quickly and easily. We are not consciously aware of any of these processes; they are functioning in the
background of our minds, constraining how and what we perceive in the world in a way that makes our experiences of the world intuitive and meaningful with as little effort as possible.

Since these categories determine how we expect the world to be, it seems particularly remarkable when a concept comes our way that violates one of these core assumptions (Boyer, 1994, 2001). The idea of a rock that does not fall when you drop it or a person that can know everything you are thinking sticks out in our minds as a notable acceptation to an ontological rule. Where our brains normally sort concepts in a way we are largely unaware (all rocks fall when dropped, another falling rock has nothing new to add to our understanding of the world), this new information does not fit with our automatic processing system and has to be stored in memory as something different.

Boyer’s (2001) theory claims that supernatural concepts are made up of these types of things; they minimally violate one of our ontological categories, and in doing so, become minimally counterintuitive. Boyer’s survey of supernatural concepts from around the world makes a decent case for this idea. Gods, ghosts and mountains that require sacrificial food all appear to violate some core concept. This theory has been supported by empirical work showing that people view minimally counterintuitive content as more supernatural than content that is entirely intuitive (Atran & Norenzayan, 2004; Pyysiäinen, Lindeman, & Honkela, 2003). Since the ability to represent and be compelled by unnatural or supernatural items is not in any way the purpose of these core systems, but an outcome created accidently by their actual function, these supernatural outcomes are a byproduct of a cognitive system build for other purposes.

The necessity of only minimal violations is an important observation. A minimal violation allows for the information to be processed easily, while still causing it to stand out in our minds as something unusual (for similar ideas in schema research, see Alba & Hasher, 1983; Koriat, Goldsmith, & Pansky, 2000). A dog that can speak to us is still in essence a dog. It has fur and a tail, and has similar stuff on the
inside to other dogs, and can therefore be processed using our folk biological understanding of ‘dog’, but is demarcated from other dogs through an ontological violation: it can talk. If an item has too many violations it loses this ease of processing. A dog that can talk, is invisible, can’t die, and stops existing whenever we are thinking about it, is not something we can easily grasp or remember. This is what we would call maximally (rather than minimally) counterintuitive. It is frequently suggested that if we tried to recall this item at a later date, we would end up simplifying it to something that more closely fits our intuitive understanding of the world (for examples of this process using the maximally counterintuitive Christian God, see Barrett, 1999; Barrett & Keil, 1996).

1.2 Minimally Counterintuitive Content as an Origin Story for Religion

This description of minimally counterintuitive content is a reasonable explanation for what makes certain concepts seem supernatural, but has yet to speak to how this theory explains the widespread nature of religious beliefs. Boyer’s minimally counterintuitive theory addresses this by claiming that minimally counterintuitive concepts are more memorable than the normal intuitive concepts we come across every day. Concepts that are more easily remembered should out complete concepts that are less easily remembered, especially in cultures that pass on information orally. Since it is difficult to pass on information you cannot recall, things that are easily remembered will have an advantage over things that are not in oral transmission. As such, they will spread further and survive longer than less memorable concepts. Within the broader realms of cognitive science and anthropology, there are two theoretical stances on how this could be the case. One looks at how culture evolves and uses the tools of biological evolution to outline this process, treating cultural items as subject to selection pressures in an environment of the human mind and a broader cultural context (Boyd & Richerson, 1985; Richerson & Boyd, 2005). The other perspective uses the analogy of epidemiology to
outline how such concepts might spread through cultures, clumping around attractors that come out of the innate structures of cognition (Sperber, 1996).

Boyer’s conception of minimally counterintuitive content follows an epidemiological view of cultural transmission. The existence and spread of religious ideas can be explained through how we represent them in our minds and how we communicate them to others (Boyer, 1994, 2001). Natural selection has shaped our brains to have certain cognitive dispositions and susceptibilities. These things function as attractors for various types of content and cause ideas to cluster around them as they are communicated from one person to another, thus becoming important and widespread features of a culture. These concepts are not replicated, but rather reproduced through reconstruction based on the properties of their attractors (Atran, 2001; Sperber, 1996). In the case of religion, concepts are given an advantage with the memory bias associated with an ontological category (Boyer, 2001). This content is based on, and reconstructed by, minds using these ontological categories. The specific features given to content are constrained by these categories. Violations are minimal so they can still be easily reconstructed and communicated to others. The fidelity of these reproductions has to do with the cognitive attractors, these ontological categories and the associated bias, and not the ideas themselves.

This theory suggests two things: that minimally counterintuitive content exhibits a memory bias and that supernatural ideas that do not conform to this formula will come to conform when they are reconstructed by individual minds. There has been some empirical work looking at these ideas. A study conducted by Barrett and Keil (1996) looks at this second idea, that supernatural representations will be reconstructed to fit with the minimally counterintuitive bias (in this case, anthropomorphism). An issue that has been brought up in the context of religious cognitions being minimally counterintuitive is the fact that the Christian God appears to violate a large number of ontological categories. He is omnipotent, omniscient, invisible, and can be everywhere at any one time. Barrett and Keil constructed
a story about God which demonstrated these qualities and asked people to recall it. In the recall, people misremember God as more human-like and not possessing all of these traits. Instead of doing multiple activities at the same time, people recalled events as happening serially, changing the violation into something that fits our basic understanding of how agents act in the world. Still, it does seem to be the case that people can, and do, reproduce God concepts in their more theologically correct multi-violation form quite easily or these ideas would not persist in Christianity. People do not need to revisit their Bible every time they wish to talk about or act upon the idea of a God that is maximally counterintuitive.

A number of studies have looked at the memory bias for minimally counterintuitive information. Barrett and Nyoff (2001), following the work of Bartlett (1932), used Native American folk tales and demonstrated that participants were more likely to remember the minimally counterintuitive content than the intuitive content. They followed this up with a science-fiction like story about an ambassador to a foreign planet and all the unusual things he saw there. Here again they showed that the minimally counterintuitive content was recalled at a greater rate than intuitive content. This effect held after a duration of 3 months. Boyer and Ramble (2001) replicated these results cross culturally using a similar story about a traveler to a foreign planet (or a distant village). Both studies showed that this memory bias is stronger than a similar memory bias for items that are bizarre (as outlined by Waddill & McDaniel, 1998) but not minimally counterintuitive.

Norenzayan, Atran, Faulkner, and Schaller (2006) tested this memory bias with lists and found that lists with a few minimally counterintuitive items were better remembered than either lists with all intuitive items, or all minimally counterintuitive items. Interestingly, they found that the minimally counterintuitive items were actually remembered less than the intuitive items, but more items overall were remembered from lists that contained only a few of these minimally counterintuitive items. This
effect was not found in immediate recall, but only found after a span of one week. In their second study, they surveyed randomly selected Grimm Brother’s fairy tales. They found that tales with a few minimally counterintuitive violations were more popular (based on Google hits) than folk tales that had either none or many. This suggests that it is not only minimally counterintuitive content that is important, but stories that are minimally counterintuitive as a whole spread better and become more popular that either initiative or maximally counterintuitive stories. A similar study that looks at Roman prodigy lists (records of micro stories that circulated in the Roman Empire between 218-44 BCE) and shows that minimally counterintuitive prodigies are more common than either bizarre or common prodigies (Lisdorf, 2004).

Underlying many of these studies is the idea that these concepts themselves, outside of their context, exhibit enough of a bias to become culturally successful, but this is not the only perspective. In another view context in which a minimally counterintuitive ideas is presented is important. Other studies have looked at the can written context that the minimally counterintuitive content is placed (see Gonce, Upal, Slone, & Tweney, 2006; Upal, 2010; Upal, Gonce, Tweney, & Slone, 2007). Another view holds context to mean the situation in which the information is being transmitted, who is telling it, or how many other people hold that view (see Gervais, Willard, Norenzayan, & Henrich, forthcoming; Henrich, 2009; Henrich & Boyd, 1998; Henrich & Gil-White, 2001). Both probably play an important role. The first view will be dealt with here. The second will be address in the following section.

Upal (2010) addresses this first type of context with the premise that the memory bias for minimally counterintuitive content is contingent on the other information with which the content is presented. He comments that minimally counterintuitive content should only be more memorable when it is placed in a coherent context. In one study, Upal and colleges look at the difference in recall between placing intuitive or minimally counterintuitive content in either confirmatory or contradictory contexts.
or not contexts at all (Gonce et al., 2006). Similar to Norenzayan, et al. (2006), they found that intuitive content was more memorable than minimally counterintuitive content when it was placed in lists (the no context condition). Minimally counterintuitive items where more memorable than intuitive items when they were followed by a short explanation of the term\(^1\) (context condition), but this relationship was reversed when the explanation was contradictory to the term (e.g. saying the term was grammatically incorrect or a misnomer). From this Upal and his colleagues have concluded that this memory bias is contingent on it being placed in a coherent and non-contradictory context.

A second set of studies makes even more specific predictions about what the context for minimally counterintuitive concepts is doing (Upal et al., 2007). These studies claim that the coherence of the context (see Kintsch, 1980) is not the only thing implicated in memory, but also how predictable the content is. They hypothesize that when the minimally counterintuitive content is predictable it should be less remembered. They manipulate this by taking the stories used in Boyer and Ramble (2001) and Barrett and Nyoff (2001) and adding a contextual sentence at the beginning to make the minimally counterintuitive content less strange. This was done by either saying that the story was part of a dream, or that many objects on the distant planet were made with artificial intelligence chips that made them behave like humans. The dream context lowered the memory bias for the minimally counterintuitive items, and the artificial intelligence context eliminated it entirely. Contexts which lead you to expect minimally counterintuitive content to be present reduce or eliminate the memory bias for that content.\(^2\)

This collection of studies is not without its issues and leaves the evidence for a memory bias for minimally counterintuitive content on somewhat shaky ground. The studies that use stories made up of

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\(^1\) It is worth noting that the context given to the MCI concept in the sample changes the MCI concept from being a true statement about the world into a metaphorical, and possibly intuitive, one: “Solidifying ladies. The novel solidifying ladies tells a story of a black mother and daughter who strengthen in character as they attempt to survive through the trials and tribulations of the civil war period.” Gonce et al. (2006), pg. 530.

\(^2\) Though the authors do not talk about it in their paper, this may have implications for the memorability of stories. If people are expecting there to be minimally counterintuitive items in a story, such as a fairy tale, they may not show a memory bias in favor of the minimally counterintuitive content in those stories.
list of simple descriptions find a bias in favor of minimally counterintuitive items (Barrett & Nyhof, 2001; Boyer & Ramble, 2001), but only if these items are unexpected (Upal et al., 2007). Studies looking at lists with no context show that intuitive items are more memorable than minimally counterintuitive ones (Gonce et al., 2006; Norenzayan et al., 2006). Even though list containing minimally counterintuitive content are better remembered as a whole, if the minimally counterintuitive content in those lists is less remembered than the intuitive content, this minimally counterintuitive content should disappear completely in a few generations and this bias should disappear. From this, it is clear that context plays an important role in this bias, but narrows the framework in which such a bias can work. The ease at which the bias can be eliminated suggests that it is not very robust and may work only within certain constraints. Similarly elusive effects have been shown for a memory bias using bizarre items, where the effects can only be found in mixed lists made up of simple sentences, and fall apart if the context is too simple or too complex (Riefer & Lamay, 1998).

So far this review of the minimally counterintuitive memory bias leaves alone the question of why people believe in this type of supernatural construction. People don’t just recall this content, but believe in it vehemently. Religious believers are willing to pay high costs for their religious beliefs, through things like tithing, ritual practices, and even such things as religious wars and martyrdom. It is widely held in the cognitive science of religion that content alone is enough to explain belief (Barrett, 2008, 2010; Bering, 2010; Geertz & Markússon, 2010; McCauley & Cohen, 2010). Yet, others have argues that content alone does not explain why some minimally counterintuitive concepts are believed in and others are not, or why people believe in the supernatural content of their religion and not of other religions.
1.3 The Problem of Belief

This problem, what makes some supernatural things and not others believable, has been touched on in the literature in the form of two thought experiments. The first is known as the Mickey Mouse problem. Mickey Mouse is a minimally counterintuitive character that people do not believe to be a real entity in the world, much less one worth worshipping (Atran, 2002; Atran & Norenzayan, 2004). The distinction of ‘minimally counterintuitive’ includes a wide range of things that we would not put in the domain of religion. Without people who believe in and worship Mickey, we do not see him as a religious figure, but he still fits the basic criteria put forth by this theory. This is addressed by Barrett (2008) who makes that claim that Santa isn’t God based on the flexibility of some of the content of the myths around Santa. Santa make look like he fits the criteria set out by content biases, but this content is not consistent, people have different ideas about Santa, and therefore not believable (for an interesting rebuttal to this, see Gervais & Henrich, 2010). The second is a similar problem known as the Zeus problem (Gervais & Henrich, 2010). Though it can be argued that Mickey is missing some key content based characteristic that has yet to be identified which separates gods from cartoons (Barrett, 2008), this argument cannot be made for Zeus. Zeus is a god that was once widely believed in, and therefore clearly fits the constraints of the supernatural, yet no one believes in him anymore. More broadly, this problem asks why people don’t believe in other people’s Gods. This lack of belief needs to be explained if we are to assume that what makes something religious is caused by the content alone.

In the epidemiological approach to religion, belief is not something that needs an explanation on its own. It is part and parcel of the ideas themselves (Boyer, 2001; Sperber, 1996). Our basic beliefs about the world are determined by our perceptions and cognitive capacities. We believe the sky is blue, that trees have leaves, and even that children are like small adults who lack some cognitive functioning through our observation of these things. Other beliefs, which we cannot have direct experience with,
become beliefs because we tie them to already existing beliefs. This is where the greater culture comes into our understanding of belief. If we believe that the teller is right about things in general, then when the teller tells us that something, like and invisible being knows our thoughts is a condition of the world, we come to believe the latter because we’ve tied it to the former (Sperber, 1996). Another mode by which people are said to come to believe supernatural concepts is when the concepts become common and widely shared (Boyer, 2001). The more common an idea becomes the more it is believed by the people that hold it. Though these ideas both give a nod to the role of external culture in the acquisition of religious beliefs and are similar on the surface to other theoretical standpoints (see Henrich & Boyd, 1998; Henrich & Gil-White, 2001), the external role these things play is still seen to be minor and largely secondary to the content itself. Content causes certain ideas to preferentially spread, becoming widely shared, and believed, within a culture.

Other theories of cultural evolution put more emphasis on the mechanisms behind cultural learning in explaining how cultural items are acquired and spread. In this view content biases may be sufficient for explaining how cultural variants spread, they are not always necessary when other mechanisms are taken into account (Henrich & Boyd, 2002; Henrich & McElreath, 2003). These theories point out that the cultural contexts in which this content is displayed are enough to cause cultural ideas to spread, without needing content to play a major role. We should pay more attention to, and learn from, the majority or from single prestigious individuals because this will help ensure we learn strategies that have been demonstrated as successful, and are normative for our group. Cultural constructs, such as religion, spread and are believed in because they play an important role in the normative structure of the group. Cultural constructs such as religion are sets of ideas that have been adapted over generations to fit the physical and social environment of the people that hold them. They are adaptations to a set of conditions rather than simply a byproduct of the human mind. Content may help certain ideas spread,
but it is the structure of norms in the larger cultural context and how people learn these norms that
determine the role that content plays within the culture (i.e. whether it becomes a folk story or a myth).

These mechanisms alone may not be enough, or at least the only way, to cause people to believe in the unbelievable, especially in situations in which we might be taken advantage of. Another cultural learning mechanism has been proposed to deal specifically with beliefs learned from others (Henrich, 2009). This theory puts forth credibility enhancing displays (or CRED) as a mechanism for determining what others actually believe. If we are out in the woods with another person and that person tells us that the mushrooms in front of us are delicious and safe to eat, but will not eat them themselves, we should be wary. We have no way to verify if this person really believes these mushrooms are safe, or if this person is trying to gain an advantage on us. If this person eats a mushroom we should be much more confident that the person really believes that the mushrooms are safe. The act of eating mushroom is a CRED, it demonstrates that the other person believes what they are telling us is true. In the case of religion, CREDs can be anything from going to church every Sunday, to praying 5 times a day, sacrificing your finest goat to your god, or circumcising your children. You are less likely to do all of these things if you do not believe the reasons behind doing them, the existence of supernatural agents that require such commitment, are real.

1.4 Anthropomorphism

The category of minimally counterintuitive content includes anthropomorphism. This type of violation comes from violating the ontological category of human (specifically mental characteristics) by applying human qualities to on non-human entities. A talking dog is an anthropomorphic entity (apply human language abilities to something that does not have them), and so is an omnipotent god (extending mental abilities to being all knowing and giving them to a non-human supernatural agent). Anthropomorphism has been widely discussed in the cognitive science of religion literature as being one
of the foundations for religious belief (Atran, 2002; Atran & Norenzayan, 2004; Barrett, 2000, 2004; Barrett & Johnson, 2003; Guthrie, 1993, 1996). Boyer (2001) discusses how anthropomorphic violations will allow for greater elaboration in myths and stories and should be therefore more potent than other types of violations as a base for religious content.

There is some empirical evidence that looks at when people tend to use anthropomorphic explanations for the world around them (Epley, Akalis, Waytz, & Cacioppo, 2008; Epley, Waytz, Akalis, & Cacioppo, 2008; Waytz, Morewedge et al., 2010). This seems to be mostly done when people are either motivated to have some more human connection to the world (like when they are lonely; Epley, Akalis et al., 2008), or when things in the world are behaving in some sort of random or indeterminate way (Epley, Waytz et al., 2008). A scale has been designed to measure individual differences in the tendency to use anthropomorphic explanations to explain the world has come out of this body of work (the Individual Differences in Anthropomorphism Quotient, or IDAQ; Waytz, Morewedge et al., 2010). This scale looks at how much people are willing to attribute human mental states to non-human objects likes toasters, the ocean, insects and other animals. This is essentially an individual difference measure in the tendency to see one specific type of minimally counterintuitive violation in the world.

The IDAQ is used in the following studies as an individual differences measure looking at the extent people use this type of violation as common way to describe the world. If it is the case that people can get used to minimally counterintuitive violations and stop seeing them as unusual, then people who use anthropomorphism as an everyday mechanism for explaining the world should be less surprised to come across these sorts of violations in other sources (like a religious doctrine). Similarly, if the violation is common it should be less surprising and more readily encoded than if it is not. This should lead to a decrease in the memory bias associated with minimally counterintuitive content. Once people are familiar with a violation, it should no longer seem like something notable about the world. It
may even become part of its own ontological category. Statues don’t have minds unless they are
depictions of deities and have undergone some ritual to imbue them with the spirit of that deity. If this
is an idea you have experiences your entire life, it should not seem unusual or particularly memorable.
There are no known scales to in what ways people are willing to accept minimally counterintuitive
violations in general, so the IDAQ was used in proxy to measure how much people are willing to accept
these sorts of violations.

*****

Belief in supernatural content is central to religious convictions. But is this belief natural? We
are left with two possibilities: that supernatural content is believed in naturally and automatically as it
spreads through culture, or that supernatural content requires a secondary set of mechanisms to
explain this belief. Due to the minimally counterintuitive nature of supernatural content, I propose that
this content should not be naturally believed in and that additional mechanisms are required. Minimal
counterintuitiveness violates our core assumptions of how the world works; these violations should
leave us with a sense of disbelief that these supernatural concepts are real. The proposed memory bias
does not address the possibility of skepticism. It may be the case that we do not find things that violate
our core assumptions of the world as particularly unbelievable. We simply pay more attention to them
because they are unusual, and therefore preferentially encode them. If there is no difference in belief
between minimally counterintuitive content and intuitive content, a case can be made for supernatural
belief as spreading based on content biases with little cultural influence. The advantage that the
memory bias gives should cause these ideas to spread and be pervasive within cultures, and if belief in
these concepts is natural, then there may be no need to invoke cultural learning as a further
explanation. On the other hand, if thing violate that our intuitive assumptions of the world are less
believable, it becomes necessary to invoke a different mechanisms to account for belief. The following
studies looks at this problem of belief. Across all three studies presented below, I test both belief in, and memory bias for, minimally counterintuitive content. I suggest that the belief in minimally counterintuitive content should be lower than in intuitive content, and that people who are more prone to using a minimally counterintuitive type explanation for things in the world should be less prone to the memory bias.
2 Methods and Results

2.1 Experiment 1

In experiment 1, I tested the hypothesis that minimally counterintuitive ideas should be more memorable, yet less believable, than intuitive ideas. Though the memory bias for minimally counterintuitive biases has been examined in a number of different ways, no previous studies have addressed or measured the degree of belief in these ideas. Beyond this, I looked at the hypothesis that people who find these ideas more intuitive should lose some of the effect of the memory bias. Our surprise at these violations comes from our disbelief. What makes them stand out in our minds is this very fact that they seem incongruent with how we understand the world. This should make us skeptical of these concepts. When we come to see a counterintuitive concept as common, it should no longer violate how we expect the world to be.

These hypotheses were tested by constructing nine folk stories that had either MCI-anthropomorphic violations, MCI-violations of folk physics, or were fully intuitive with a social partner. 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 et al., 2008). Since people are particularly prone to pay attention to and remember social information (Mesoudi, Whiten, & Dunbar, 2006), I hypothesized a memory difference between each of the two MCI types and the intuitive-social category, and memory difference between the MCI-anthropomorphic and MCI-physical stories, with MCI-anthropomorphic being the highest, followed by MCI-physical and intuitive-social as the lowest. I expected that the two MCI types would be less believable than the intuitive category. Previous experiments have tested only memory for different types of content within stories (e.g. Barrett & Nyhof, 2001; Boyer & Ramble, 2001), not between stories with different content. For minimally counterintuitive content to explain the existence of myths and stories, it needs to explain how minimally counterintuitive stories as a whole would outcompete non-minimally counterintuitive stories.
The amount to which people see these MCI concepts as a plausible part of the world was tested using a scale of anthropomorphism (the IDAQ, Waytz, Cacioppo, & Epley, 2010). Anthropomorphism, as a type of minimally counterintuitive content, has been demonstrated to exhibit individual differences across populations and affect how people interact in the world (Epley, Akalis et al., 2008; Epley, Waytz et al., 2008; Epley et al., 2010; Waytz, Cacioppo et al., 2010). Since there are no measures looking at the use of minimally counterintuitive content in general, we used individual differences in anthropomorphism as a proxy. No previous study has looked at individual differences in the memory effects of MCI biases.

2.1.1 Methods

Participants

Ninety-five (78 female) psychology undergraduate 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 years old. All Participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite to signing up in the study.

Materials

Three different stories, “Jane’s Stroll in the Forest”, “Kate has a Picnic”, and “Sam and the Library”, were used (see Appendix A.1). All three were constructed for the experiment. Each story had three different versions pertaining to each of the categories (MCI-anthropomorphic, MCI-physical, Intuitive-social), for a total of 9 stories, all approximately 200 words in length. The stories were constructed in such a way so that the content type could be changed without changing anything else in the story. Only one item or character changed within each story to make the story MCI-anthropomorphic, MCI-physical or Intuitive-social. This was done to control for anything idiosyncratic about any one of the stories and to allow for a within subject design. 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.
Participants were asked to rate how believable the story was on a 7 point scale, as well as how much they liked each story. They were given an anthropomorphizing scale (the IDAQ) to evaluate how likely they are to see things in the world as anthropomorphic (e.g. To what extent does the wind have intentions? To what extent does the environment experience emotions? Waytz, Morewedge et al., 2010).

2.1.2 Design and Procedures
Participants came into the lab and were directed by a research assistant to a cubical with a computer. The basic procedures of the experiment were explained and participants were left to complete the experiment on their own. The instructions were also presented on the screen before each section of the experiment. Participants filled out some basic demographic information and then asked to read 3 separate stories, one from each type and category. The order of story type was counterbalanced across participants.

Participants were then given 2 minutes to complete a distracter math problem 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. This was done to encourage participants to tell the whole story, rather than just recall small disconnected parts. Story recall was prompted by the character in each story (i.e. recall the story about Jane). After recalling each story participants were asked how much they liked the story and how much they believed that the story was true. Participants filled out the anthropomorphism questionnaire after the recall and were then debriefed and sent on their way.

2.1.3 Results
Two independent coders coded all the stories for how much total content was remembered from each story (inter-rater reliability: Krippendorff’s $\alpha = .93$, 95%CI[.89, .96]). An average of the two coders was taken. A propositional coding scheme was used (see Kintsch, 1974). A proposition was defined as one single concept (e.g. ‘Jane went for a walk’) and the coding scheme laid out what each
proposition was before the coding began. Each proposition was coded as either being present or not. The total number of propositions remembered was taken for each story and then converted to a proportion of the total possible propositions in that story. Each story type (Jane, Sam, or Kate) had a slightly different number of propositions, but the proposition number did not vary across conditions (MCI-anthropomorphism, MCI-physical, and Intuitive-social) within each type. Each participant was exposed to the same number of total propositions. No difference was found in the number of propositions recalled across any condition ($F(2, 188)=.848, p=.43, n.s.$). This study failed to find a minimally counterintuitive memory bias as discussed in the literature. Though this is not an exact replication of previous work, the theoretical stance of this bias claims that whole stories should be affected by this bias for myths and folk stories to be passed on in an epidemiological way.

Significant differences were found in the believability of the story types ($F(1.47, 138.23)=88.70, p<.001$), Mauchly’s test indicated that the assumption of sphericity was violated, $\chi^2(2)=41.51, p<.001$, therefore the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity, $\epsilon=.74$. Social stories ($M=3.32, SD=1.62$) were significantly more believable than either MCI stories ($M=1.52, SD=.95$; $t(94)= 10.14, p<.001$) or anthropomorphic stories ($M=1.57, SD=.92$; $t(94)= 10.09, p<.001$)(See Figure 2-1). There was no significant difference in believability between MCI and anthropomorphic stories ($t(94)= .25, p =.59$). No difference was found in likability between the three content types ($F(2, 91)=1.95, p=.148$). Significance tests were conducted using Bonferroni adjusted alpha levels.
A negative relationship was found between believability and memorability, as well as anthropomorphism (IDAQ) and memorability for MCI-anthropomorphic (see Table 2-1) and MCI-physical stories (see Table 2-2). This was not the case for social stories (see Table 2-3). This supports the hypothesis that people who regularly use this type of content as an explanation of their environment show a decrease in memory for such content. There was a positive correlation between believability and the anthropomorphism scale for both MCI-anthropomorphic and MCI-physical, but not the Intuitive-social stories (see Table 2-4).

Table 2-1: Effects of Belief and Anthropomorphism on memorability of MCI-Anthropomorphic content

<table>
<thead>
<tr>
<th>Content type</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCI-Anthropomorphic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belief</td>
<td>-.048</td>
<td>.018</td>
<td>-.265</td>
<td>-2.72</td>
<td>.008</td>
</tr>
<tr>
<td>IDAQ</td>
<td>-.030</td>
<td>.011</td>
<td>-.264</td>
<td>-2.71</td>
<td>.008</td>
</tr>
</tbody>
</table>

*Notes: R² = .171, p = <.001*
Table 2-2: Effects of Belief and Anthropomorphism on memorability of MCI-Physical content

<table>
<thead>
<tr>
<th>Content type</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCI-Physical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belief</td>
<td>-.057</td>
<td>.014</td>
<td>-.388</td>
<td>-4.09</td>
<td>.038</td>
</tr>
<tr>
<td>IDAQ</td>
<td>-.019</td>
<td>.009</td>
<td>-.200</td>
<td>-2.10</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Notes: $R^2 = .233$, $p = <.001$

Table 2-3: Effects of Belief and Anthropomorphism on memorability of Intuitive Social content

<table>
<thead>
<tr>
<th>Content type</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intuitive Social</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belief</td>
<td>-.004</td>
<td>.011</td>
<td>-.094</td>
<td>-.895</td>
<td>.373</td>
</tr>
<tr>
<td>IDAQ</td>
<td>-.011</td>
<td>.012</td>
<td>-.035</td>
<td>-.338</td>
<td>.736</td>
</tr>
</tbody>
</table>

Notes: $R^2 = .011$, $p = .605$

Table 2-4: Correlations between self reported belief and anthropomorphism for each content type.

<table>
<thead>
<tr>
<th></th>
<th>IDAQ</th>
<th>Belief MCI-Anth</th>
<th>Belief MCI-Phys</th>
<th>Belief Int</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDAQ</td>
<td>-</td>
<td>.223*</td>
<td>.272**</td>
<td>.129, n.s.</td>
</tr>
<tr>
<td>Belief MCI-Anth</td>
<td>-</td>
<td>-</td>
<td>.487**</td>
<td>.207*</td>
</tr>
<tr>
<td>Belief MCI-Phys</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.176, n.s.</td>
</tr>
<tr>
<td>Belief Int</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: *$p<.05$, **$p<.01$.

2.1.4 Discussion

The expected difference between levels of belief for minimally counterintuitive and intuitive stories was demonstrated with the minimally counterintuitive stories showing a significantly less belief. This supports the hypothesis that people should be more skeptical of minimally counterintuitive content than intuitive content. These stories were clearly fictional and the belief ratings for the two minimally counterintuitive conditions were very low overall. Still, the intuitive stories were equally fictional, and presented in the same manner as the other two stories. A belief rating for these stories was almost two points higher on a 7 point scale. The negative relationship between anthropomorphism and
memorability for both types of minimally counterintuitive information suggests that this memory bias is affected by how intuitive people find these types of violations. People who score higher on the anthropomorphism scale should expect the world to show more of this type of ontological violation, and therefore it should seem less surprising to them. The increase in scores on this scale was related to decrease the effect of the memory bias for this type of content. This relationship can be extended to suggest that the amount by which we expect the world to behave according to these ontological categories can be different across individuals, and this difference translates into an individual difference on the effect of minimally counterintuitive effects on memory. Notably, this difference would not lead to religious zealots having a greater capacity to recall their supernatural beliefs, but rather the other way around. Skeptics should be more affected by this bias.

It remains questionable if the relationship between memorability and belief clearly supports the hypothesis that commonness of minimally counterintuitive concepts should decrease memory. Since the believability rating were taken at the point of recall, it is possible that the negative relationship between believability and recall was a product of the study design (people believe the content more because they cannot actually recall the story), rather than a state of the world. This does not affect the relationship between the independent measure of anthropomorphism and recall for the two MCI stories as this measure is not dependant on the study design.

No significant differences were found to support either the hypothesis that anthropomorphism is more memorable than MCI physical, or that MCI in general as more memorable than the intuitive stories. It is possible that my minimally counterintuitive stories were not minimally counter intuitive enough, or that the memory bias was washed out by the other information presented in these stories or the narrative structure itself. It has been demonstrated that content is better remembered when put in some type of narrative structure (e.g. Brewer, 1985; Ericsson & Kintsch, 1995; Rubin, 1995). There is also evidence to suggest that social information should also exhibit a memory bias (Mesoudi et al., 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. If this is the case there is no demonstration of the additive effects of these memory biases in the anthropomorphism condition which is both minimally counterintuitive and social in nature. The negative correlation with anthropomorphism suggests that some sort of memory difference is present, but that on average it is not discernable from the initiative stories. This supports the idea that other information may have washed out the bias. 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).

2.2 Experiment 2

A potential criticism of this previous experiment is that the content was not minimally counterintuitive enough and this was why it failed to show a memory bias as well as belief in this type of content. Each story had only one violation, and though one study has suggested that one violation is the optimal number of violations across surveyed folktales (Barrett, Burdett, & Porter, 2009), other work has suggested two or three are the most common (Norenzayan et al., 2006). If this is the case, the belief effects may not be generalizable to content that is minimally counterintuitive enough to demonstrate a memory effect. Experiment 2 addresses this issue by using materials taken from Boyer and Ramble (2001) to test the memory bias and belief in minimally counterintuitive content. This type of stimuli has been used across several of the studies which have demonstrated the minimally counterintuitive memory bias (e.g. Barrett & Nyhof, 2001; Upal et al., 2007). This was done to replicate the belief findings in study 1 with the established material used to test this bias. I also wanted to look at whether or not these effects change over time. For a memory bias in these items to influence culture, the bias must persist much longer than the two minute interval used in the first study. It is possible that even where belief is not present at first, people come to believe in these things more as they get used to them over time. To address both of these possibilities, participants were asked to recall the items twice: after a 5
minute delay and after a one week delay. Belief in the items was measures with a set of three questions instead of the single question used in the previous study.

### 2.2.1 Methods

#### Participants

Eighty-nine (63 female) psychology undergraduate 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 19.10 years old. All Participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite to signing up in the study. Nine participants completed the first part of the experiment but failed to return in one week to complete part two.

#### 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 (see Appendix A.2).

Participant's belief in the stories was assessed using 3 questions instead of the single question in study 1. Participants were given an anthropomorphizing scale (the IDAQ) to evaluate how much they anthropomorphize the world around them.

### 2.2.2 Design and Procedures

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 questionnaire, 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 that 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 were sat at a computer and 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 debriefed and sent on their way.

2.2.3 Results

Two independent coders coded the recall for the number of items in the story that were remembered (Inter-rater reliability: Krippendorff’s $\alpha = .91$, 95%CI [.81, .97]). A list of all possible items was complied and coders coded for each item as recalled or not. Recall rates were compiled by counting the total number of minimally counterintuitive and intuitive items. Recall was averaged across the two coders.

A memory bias in favor of MCI items ($M=3.36$, $SD=1.84$) over intuitive items ($M=2.37$, $SD=1.76$) was found after both 5 min ($t(88)= 5.23, p<.001$) and one week ($MCI: M=2.25$, $SD=1.78$; Int: $M=1.66$, $SD=1.76$; $t(78)= 2.92, p=.005$)(See Figure 2-2). This replicates previous studies that use similar stories that use similar materials. The belief findings found in experiment 1 were also replicated. Believability was much higher for intuitive items ($M=6.62$, $SD=.60$) than MCI items ($M=3.41$, $SD=1.36$) after both 5 min ($t(88)= -19.12, p<.001$) and one week (Int: $M=6.58$, $SD=.55$; MCI: $M=3.29$, $SD=1.31$; $t(79)= -20.10, p <.001$). The belief in these items did not change between the two recall times (see Figure 2-3).
The relationship between anthropomorphism and recall was also replicated from experiment 1. There was a negative relationship between that anthropomorphism scale and memory for MCI items (This relationship was no longer significant after 1 week, see Table 2-5). This was not the case for
intuitive items (see Table 2-6). Anthropomorphism was positively correlated with belief in MCI items, but not intuitive items (see Table 2-7). No correlations between belief and recall were found for any of the conditions.

Table 2-5: Relationships between anthropomorphism, belief and recall for MCI content

<table>
<thead>
<tr>
<th>Content type</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCI Recall: 5 min¹</td>
<td>IDAQ</td>
<td>-.312</td>
<td>.128</td>
<td>-.276</td>
<td>-2.43</td>
</tr>
<tr>
<td></td>
<td>Belief</td>
<td>.061</td>
<td>.153</td>
<td>.046</td>
<td>.402</td>
</tr>
<tr>
<td>MCI Recall: 1 week²</td>
<td>IDAQ</td>
<td>-.086</td>
<td>.131</td>
<td>-.082</td>
<td>-.659</td>
</tr>
<tr>
<td></td>
<td>Belief</td>
<td>.170</td>
<td>.164</td>
<td>.129</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Notes: ¹$R^2=.069, p=.049$; ²$R^2=.015, p=.56$

Table 2-6: Relationships between anthropomorphism, belief and recall for Intuitive content

<table>
<thead>
<tr>
<th>Content type</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int recall: 5 min¹</td>
<td>IDAQ</td>
<td>-.153</td>
<td>.116</td>
<td>-.142</td>
<td>-1.317</td>
</tr>
<tr>
<td></td>
<td>Belief</td>
<td>-.104</td>
<td>.317</td>
<td>-.035</td>
<td>-.328</td>
</tr>
<tr>
<td>Int recall: 1 week²</td>
<td>IDAQ</td>
<td>-.028</td>
<td>.120</td>
<td>-.027</td>
<td>-.235</td>
</tr>
<tr>
<td></td>
<td>Belief</td>
<td>.295</td>
<td>.330</td>
<td>.103</td>
<td>.894</td>
</tr>
</tbody>
</table>

Notes: ¹$R^2=.020, p=.416$; ²$R^2=.012, p=.64$

Table 2-7: Correlations between self reported belief and anthropomorphism for both content types.

<table>
<thead>
<tr>
<th></th>
<th>IDAQ</th>
<th>Belief-MCI 5 min</th>
<th>Belief-Int 5 min</th>
<th>Belief-MCI 1 week</th>
<th>Belief-Int 1 week</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDAQ</td>
<td>-</td>
<td>.376**</td>
<td>-.098, n.s.</td>
<td>.322**</td>
<td>-.071, n.s.</td>
</tr>
<tr>
<td>Belief-MCI: 5min</td>
<td>-</td>
<td>-</td>
<td>-.176, n.s.</td>
<td>.740**</td>
<td>-.140, n.s.</td>
</tr>
<tr>
<td>Belief-Int: 5min</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-.042, n.s.</td>
<td>.627**</td>
</tr>
<tr>
<td>Belief-MCI: 1 week</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-.161, n.s.</td>
</tr>
<tr>
<td>Belief-Int: 1 week</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: **p<.001

2.2.4 Discussion

Using more standard stimuli material, I replicated my previous finding that minimally counterintuitive content is less believed in than intuitive content. This replicates and extends previous
findings on the minimally counterintuitive memory bias. I also replicated the finding that people who score higher on the anthropomorphism scale show a decrease in the memory bias for minimally counterintuitive content. Like other studies using this material, a memory bias for minimally counterintuitive content was found. This eliminates the possibility that these effects were specific to the materials that I had constructed for the previous study, or had something to do with the level of minimally counterintuitiveness of those materials. These effects support the hypotheses that people should be more skeptical of minimally counterintuitive information and that when these ideas are a common strategy the memory bias is decreased.

Belief effects were shown to be consistent across both sessions, showing basically no change between the first and second session, suggesting that time does not lead to people believing in these concepts more. It might be argued that repeated exposure over time could lead to increased belief. 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 familiarity did not affect their willingness to believe in them. Though we can’t rule out the possibility that coming into contact with things a larger magnitude of times or over a longer period of time would change this, this does suggest that there is little effect of repeated contact on the willingness to believe in these things.

2.3 Experiment 3

In both of the previous studies the material used was clearly fictional. This may cause people to be less likely to believe in it. This type of information would likely be presented as fact to potential believers if it was intended to inform religious conviction. To address this, science based news stories were used in experiment 3 to test if these results would be different for less obviously fictional stimuli. Science news is presented as factual information about the world in our society. In the past, and in many societies still today (including occasionally our own), supernatural explanations have been used to explain natural processes like wind and rain and where things come from. Science was used as a proxy
for this type of supernatural explanation so participants would not suspect that I was testing religious content, and that is more plausibly real even amongst nonbelievers. Participants were called in for two sessions one week apart, in the same manner as in study 2.

In this study, I wanted to rule out the possibility of demand characteristics. It is possible that people were answering in a way they thought I wanted them to and not what they really believed. This would a less plausible claim if making accurate choices was more rewarding than behaving in socially desirable way. To accomplish this, I added a monetary behavioral to the second session. Participants were told that some of the news stories had been made up, and to guess which were correct and which were not. They were given one dollar for each correct answer as a way to increase the motivation to be accurate rather than answer in a socially desirable way.

2.3.1 Methods
Participants
Seventy-four (53 female) psychology undergraduate from the University of British Columbia were tested. 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% non religious. The average age was 20.34 years old. All Participants were recruited from a human subject pool and given course credit for their participation. English fluency was a prerequisite to signing up in the study. Nine participants who participated in session 1 failed to show up to session 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 made up by the experimenter. All participants read all 12 stories. A pilot test (n=20) of the stories showed that the minimally counterintuitive stories (M=4.07, SD=.83) were seen as more supernatural than the intuitive stories (M=2.13, SD=.96; t(19)=8.13, p<.001). Participants
were again asked to rate their belief in each story with the 3 questions used in study 2, and given the IDAQ to measure how much they naturally anthropomorphize the world. The behavioral task was conducted in the same manner as in Study 2.

2.3.2 Design and Procedures
Experiment 3 followed the same procedure as experiment 2, but added a behavioral task in the second session. Participants came into the lab in session one, were explained the process and sat in front of a computer to complete the experiment. After a brief demographics questionnaire, participants read each of the 12 new summaries in a randomly generated order. They were then given a 5 minute math task. In the recall task participants were asked to recall the main point of each news story in one sentence. 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 in one sentence per story. Their belief in the accuracy of 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 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 it was scored by the research assistant. The participants were paid for their correct answers, debriefed and dismissed.


2.3.3 Results
The recall responses were coded by two independent coders (inter-rater reliability: Krippendorff’s $\alpha = .76$, 95%CI [.59, .90]). Coding was done by counting the number of stories of each type mentioned and summing them. The average was taken between the two coders. No significant difference in recall was found between the MCI ($M=3.07$, $SD=1.39$) and intuitive ($M=2.89$, $SD=1.24$) news summaries after either 5 minutes ($t(72)= 1.05$, $p=.30$, ns) or one week (MCI: $M=2.51$, $SD=1.33$; Int: $M=2.20$, $SD=1.25$; $t(63)= 1.64$, $p=.107$, ns). Believability was significantly higher for intuitive items ($M=4.74$, $SD=.99$) than MCI ($M=3.29$, $SD=1.25$) after both 5 min ($t(72)=10.11$, $p<.001$) and one week (MCI: $M=3.83$, $SD=.45$; Int: $M=4.32$, $SD=.52$; $t(63)= 8.348$, $p<.001$) (see Figure 2-4). This finding could not have been driven by a lower belief in the made up minimally counterintuitive stories ($M=3.56$, $SD=1.68$) as these were significantly more likely to be believed then the real ones ($M=2.97$, $SD=1.17$) after both 5 minutes ($t(72)=3545$, $p=.001$), and one week (MCI-fake: $M=3.92$, $SD=.50$; MCI-real: $M=3.74$, $SD=.53$; $t(63)=3.00$, $p=.004$). The relationship between recall of minimally counterintuitive stories and anthropomorphism was not significant (5 min: $\beta=-.167$, $p=.188$, n.s.; 1 week: $\beta=-.176$, $p=.209$, n.s., controlling for belief). No relationship was found between belief and recall in any of the conditions.
Figure 2-4: Belief in stories rated on a 7 point scale. Error bars are a 95% confidence interval.

There was a significant interaction between session and belief ($F(1,62)=51.90, p<.001$) as well as a main effect of belief ($F(1,62)=158.9, p<.001$). The main effect of session was not significant ($F(1,62)=.632, p=.430, n.s.$). Though belief was higher over all for intuitive content ($M=4.57, SD=.081$) than MCI content ($M=3.55, SD=.086$), belief in intuitive stories was higher after 5 minutes then after 1 week ($t(62)=3.50, p=.001$) but lower for the minimally counterintuitive stories after 5 minutes than 1 week ($t(62)=-5.02, p<.001$).

In the behavioral measure participants were significantly more likely to pick the intuitive ($M=3.67, SD=1.38$) stories as the real news stories over the minimally counterintuitive ones ($M=2.33, SD=1.47; t(62)=5.071, p<.001$)(see Figure 2-5). The amount of money put on both intuitive items and minimally counterintuitive items was significantly correlated with the corresponding self report belief measures taken in both sessions of the experiment (see Table 2-8).
Figure 2-5: Average endorsements of each of the content types. Error bars are a 95% confidence interval.

Table 2-8: Correlations between belief rating and behavioural measure.

<table>
<thead>
<tr>
<th>Behavioural measure</th>
<th>Belief in MCI items</th>
<th>Belief in intuitive items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 minutes</td>
<td>1 Week</td>
</tr>
<tr>
<td>MCI</td>
<td>.254*</td>
<td>.370**</td>
</tr>
<tr>
<td>Intuitive</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Notes: *p<.05, **p<.01, ***p<.001.

2.3.4 Discussion

Once again, I failed to find a memory bias for minimally counterintuitive stories over intuitive stories. This experiment, like experiment 1, presented the conditions as separate stimuli. Though these stories were presented separately, the 12 of them together can be seen as a list similar to the stimuli in experiment 2. If this is the case, then the difference between in experiment 2 and experiment 3 was the complexity of the context each item was placed. The news stories had more detail and explanation of each MCI and Intuitive item than the museum items used in experiment 2. This is similar to findings in the bizarreness literature that shows the memory bias for bizarre stimuli disappears when the bizarre
items are paired with complex, rather than simple sentences contexts (McDaniel & Einstein, 1989; Richman, Dunn, Kahl, Sadler, & Simmons, 1990).

My belief findings were replicated from the previous two experiments with a more realistic set of stimuli. Even though the stimuli were presented as true, participants were less likely to endorse this for the minimally counterintuitive stories than the intuitive ones. There was a change in belief between time one and time two, with a decrease in belief in intuitive items and an increase in belief in minimally counterintuitive items. It is possible that this indicates that people do come to believe in minimally counterintuitive information more over time, but it seems more likely to have been caused by the methodology used in this experiment. Since the belief questions were cued using just the headlines and not the entire stories, it is possible that participants were more likely to rate a mean level of belief in both conditions after one week simply because they could not remember the story in question. This would be an effect similar to the statistical phenomenon of regression to the mean. Ratings in both conditions converge towards the mean because participants’ more extreme views have been lessened with their decrease in memory. Despite this, belief levels were still significantly different in both conditions. In the behavioral participants were given the whole stories to read through again and again rated belief in the intuitive stories significantly higher than the minimally counterintuitive stories.
3 Conclusion

3.1 General Discussion

Though minimally counterintuitive content biases have been put forth as an explanation for the origin and widespread nature of religion, they do not explain how people come to believe in supernatural content. People the world over are intensely devoted to their religious beliefs and are willing to go through extreme sacrifice, such as ritual scarification, fasts, pilgrimages, and martyrdom, to demonstrate this belief. Belief and religion seem closely tied, yet this is something that in the current literature in the cognitive science of religion has not clearly examined. If we are to accept content biases as playing a central role in the origins of religious belief, than this content should be believed in whole heartedly of its own accord. From the studies presented here, this does not seem to be the case. The focus on content biased by the field does not paint a complete picture of religious devotion. A content bias such as minimally counterintuitive content cannot cause religious belief without the introduction of another mechanism if the content not thought to be real.

According to this research, minimally counterintuitive content is not easily believed in. People find it less believable than intuitive content across a variety of stimuli. This makes sense if we consider that minimally counterintuitive content violates our expectations of how our environment should behave. Time does not seem to be enough to make people believe in these ideas, based on a test of a one week interval. If we consider this effect alone, it is possible that the memory bias accounts for the spread of these beliefs, but that belief requires some additional mechanism. People should be skeptical of information that goes against their expectations of the world. We should be wary of false information, especially in situations where we cannot verify information with any external display or behavior (Henrich, 2009). Supernatural beliefs require all sorts of costly displays that could easily put us at a disadvantage to those around us if we are doing them erroneously. Though some benefit of religious conviction is present when a groups all holds the same beliefs (see Norenzayan & Shariff, 2008;
Shariff & Norenzayan, 2007; Wilson, 2002), a disadvantage is associated if we are alone in paying the cost of religious conviction. This fact alone should influence us to be wary of adopting beliefs in unverifiable supernatural agents without some cultural display from those around us. This is an adaptive view of religiosity and brings us to a different set of conclusion that the epidemiological view presented earlier.

In two of our three studies we found a negative correlation between the rates of recall for minimally counterintuitive content and how much people anthropomorphize the world. Since the memory bias is associated with our surprise at an ontological violation, when anthropomorphism is a strategy someone commonly uses to interpret the world, that person should find things that display these or similar characteristics less surprising, thus reducing the memory bias. Expanding on this suggests that people who believe there is an intentional God behind the happenings of the world should show a lower minimally counterintuitive memory bias for this concept than those that find this idea unlikely or implausible. Those who are compelled to transmit such a belief because they feel it reflects a real state of the world will be less likely to remember it based on this mechanism than those who think the idea is incorrect and are therefore less compelled to spread it.

Clearly, people who believed in such a God will have to remember that God if they are to maintain their belief, but this belief doesn’t require that the content be minimally counterintuitive. This is true of any type of information. People remember specific beliefs because they believe them, but it is not necessarily true that people will believe in things because they are memorable. Being minimally counterintuitive and being remembered is not enough to spread religious concepts; the willingness to transmit beliefs because one is devoted to them is required to maintain these concepts in culture. Devotion should make the associated bias lessen or even disappear. Our data cannot make the case that
the memory bias will be eliminated completely. It could be argued that a reduced bias is still enough to cause the spread of religious belief if this bias can be consistently demonstrated.

Though it is true that a memory bias will improve the fidelity of a cultural transmission, provided that it is transmitted, it is not clear from these studies or the other literature that this is what is happening with religious content. Our experiments failed to show a consistent bias across experiments. There are many possibilities for the lack of a difference in recall between conditions found in experiments 1 and 3. The study by Norenzayan et al (2006) suggests that this bias may be associated with multiple violations in each story. Their study found curvilinear popularity bias for stories that had a few violations, but not too many or too few. It is possible that adding a second or third violation would increase this bias enough to differentiate our stories from the intuitive stimuli. Still, both of these experiments exposed participants to a multiple number of violations between different stimuli. It can be argued that a list of news stories within the frame of an experiment is similar to a series of violations in the frame of a single story, or a set of violations included in a list. An alternative explanation is the complex versus simple contexts mentioned in the introductory chapter.

The elusiveness of the memory effect for minimally counterintuitive content is comparable to the elusiveness of the memory bias for bizarre items (usually consisting of word pair that would not normally go together, such as ‘The BOY juggled the CAT’ but are not necessarily MCI. See Riefer & Lamay, 1998). Work on the memorability of bizarre stimuli has produced two different effects: the bizarreness effect and the commonness effect (Riefer & Lamay, 1998). The bizarreness effect refers to the memory bias for bizarre items, where the commonness effect refers to the memory bias for familiar items. The difference seems to be in how the stimuli are presented (McDaniel, Einstein, DeLosh, May, & Brady, 1995). A within-list design, where bizarre and common items are mixed, demonstrates a memory bias in favor of the bizarre items. In a between list design, where the items are listed separately,
memory bias for common items is demonstrated. This is only true when these lists are made up of simple sentences using associated nouns (Lang, 1995). When stimuli consists of only word triplets, rather than sentences, common triplets are more memorable than bizarre triplets (Collyer, Jonides, & Bevan, 1972). Even with this overarching theme, the effects are tenuous at best and replicate only under very specific conditions. The bizarreness effect disappears when the sentences are complex or recall is cued (McDaniel & Einstein, 1989; Richman et al., 1990; Riefer & Rouder, 1992). These effects have been noted as difficult to replicate, even when using similar stimuli and experimental designs to other successful bizarreness effect studies (Riefer & Lamay, 1998). Schema literature also suggests a similar function. Schema-inconsistent information is better remembered than schema-consistent, which in turn is better than scheme-irrelevant (Alba & Hasher, 1983). The unusual items are only more memorable if they violate our expectations of what is going to happen in a situation, like eating in a restaurant, but only if they can still fit in that schema.

The minimally counterintuitive memory bias has been shown in previous work, but is also similarly only reliably shown with specific types of stimuli. These conditions are notably similar to the conditions in which the bizarreness effect has been demonstrated. Experiments using lists of word pairs or triplets show a commonness effect (Gonce et al., 2006; Norenzayan et al., 2006), where other studies that use stimuli constructed of the stimuli embedded in collections of simple sentences shows a bizarreness effect (Barrett & Nyhof, 2001; Boyer & Ramble, 2001; Upal et al., 2007). Some of these studies did test the difference between bizarre and minimally counterintuitive items and confirmed that the memory bias was stronger for minimally counterintuitive content than bizarre content, but this does not preclude that the minimally counterintuitive effect is just an extension of the bizarreness effect. It is entirely possible that minimally counterintuitive information is just more bizarre and therefore demonstrated a stronger effect.
Since bizarre items are possible, though uncommon, it seems logical to assume that once they become familiar they would show a decrease in memory bias even under the specific conditions in which they are found. A pink dog is bizarre and would be more memorable until most of the dogs you saw were also pink. Familiarity would mean they are no longer bizarre. If minimally counterintuitive content is just more bizarre than bizarre, this logic should hold with it as well. This follows with the relationship we have found between anthropomorphism and recall of minimally counterintuitive content. This negative relationship suggests that when minimally counterintuitive information becomes common it also loses its associated surprise and becomes notable and memorable. The fact that people demonstrate individual differences in anthropomorphism at all suggests flexibility in the representation of these core cognitive categories. An anecdotal example of this in a different core cognitive domain is magnets. Magnets inexplicably stay on vertical surfaces rather than falling like other solid objects do. Though we may be surprised the first time we see a magnet, this surprise seems to disappear as magnets become an item we experience every day. It may be that there is no qualitative difference between bizarre stimuli and minimally counterintuitive stimuli in terms of memory, and possibly even how we represent them in our minds.

Under the right conditions the epidemiological view would show that these ideas, bizarre or minimally counterintuitive, would still spread as long as they still promote some type of biased memory. Still, it is not clear that these conditions will be regularly met across religions. It is difficult to maintain an effect that might be so easily washed out by the other content within a story, and even if this can be done, these specific conditions may or may not be true to the natural states of religious narratives. This line of reasoning sets up claims about how that content is constructed within the narrative not just the content itself (Norenzayan et al. 2006 takes this approach). An argument can be made for folk tales or even religious myths to use only simple sentences with a mix of minimally counterintuitive and intuitive information and therefore conform to these conditions. Even with this, it is not clear in the long run if
this would maintain memory for the entire story, or just the minimally counterintuitive (or intuitive) parts. If one type of information is remembered over another, the structure of the story should change to show more of that type of information over the other. If this was the case the story would quickly lose the appropriate conditions.

If we throw caution to the wind and suggest that there is some sweet spot that these stories and myths fall into that we are as of yet unaware, we still fall short of a complete argument. This line of reasoning would still suggest that the spread of religious content, and the belief in that content, would rely on the specific way religious myths and stories are constructed. It is not clear that belief in religious ideas relies on myths at all. Myths are a wide spread feature of religion, especially in the past, but it is possible to spread belief in minimally counterintuitive concepts without relying on stories as a template. In the United States evangelical Christianity appears to be gaining popularity at a rapid rate. Evangelical Christians are known for their strong religious beliefs and their commitment to the truth of the bible, yet many of them do not know most of the stories contained in the Bible and may not have read much of the book at all (Malley, 2004). We have already established that belief itself is not clearly tied to memory for minimally counterintuitive content, but it is clear that these ideas come to be believed in. The question then becomes whether or not the spread of the ideas that people come to believe in requires a content bias. It may be that in this case content biases fall into the sufficient but not necessary category of cultural evolution (Henrich & McElreath, 2003), but only if we consider the spread of ideas separate from the belief in those ideas.

How people come to believe in these items is something that has yet to be addressed experimentally in the cognitive science of religion. People do not just become devoted to supernatural beliefs or not, they become devoted to specific supernatural beliefs while rejecting many or all others. Most commonly, they become devoted to those supernatural beliefs that are held by their culture, and
not those of other cultures. Exposure to another culture’s supernatural beliefs is not enough on its own to make people believe in that content, even if the people already hold supernatural beliefs. These facts cannot be explained by a content bias alone. Culture does appear to play an important role in the adoption, or not, of religious beliefs. Future work in this field needs to address this issue and look at how cultural learning affects the adoption of and devotion to supernatural beliefs.

3.2 Future directions

If we cannot explain belief in supernatural concepts based on the unverifiable content of these concepts, how do we come to believe in such things at all? There have been several ways outlined in the literature by which we come to learn cultural information from others. Cultural learning mechanisms allow us to learn things socially from others and accumulate technology across generations of people. Research in to over-imitation in children has shown that humans do learn and repeat steps of a task on faith (see McGuigan, Whiten, Flynn, & Horner, 2007; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). When shown a task, like opening a puzzle box, children follow all the steps they are shown, even when some of the steps they are show are clearly unnecessary. They appear to hold the assumption that the other person knows these unnecessary steps are important in reaching their goal, even if the learner does not know why. Though it is apparent that children will willingly copy strategies from another without verifying the necessity of that strategy, there is a cost to being to gullible when it comes to questions of belief. Henrich (2009) has theorized that difference between believing and not believing information from a model should be determined by the willingness of the model to perform some type of credibility enhancing display (CRED), such as eating a mushroom they claim to be delicious and safe. People who demonstrate their belief in the supernatural with a willingness to engage in costly rituals, such as making sacrifices or going to church every single Sunday, demonstrate that they do believe in what they claim. This in turn should be taken by others as a reliable demonstration of belief and influence others to also adopt these beliefs at a greater rate than beliefs for which there is no display.
There is some empirical evidence supporting this idea. Though every culture in the world does seem to have some type of religious beliefs, there are parts of the world where atheism has become widespread. This is the most apparent in Scandinavian countries. What makes these places an interesting test case is the willingness of the people in these countries to still identify as being Christian, but still report no belief in God, Jesus or any other supernatural agent tied to their religious affiliation (Zuckerman, 2008). They do not seem to be effortfully maintaining their disbelief as has been suggested by theories that see religion as being natural and cognitively based non-cultural phenomenon (see Barrett, 2010; Bering, 2010; Bloom, 2007; Boyer, 2008). Instead, they simply do not believe. A set of studies looking at why it is that many people in Scandinavian countries simply do not believe, points to a difference in the amount of credibility enhancing displays non-believers and believers remember being exposed to as children (Lanman, submitted). Adults who remember their parents going to Church and participating in other religious rituals on a regular basis were more likely to be religious as adults than those that did not.

CREDs are not the only way people selectively learn from models. Other theories have suggested prestige and conformity biases should work in some cases as well. Though all of these ideas are theoretically possible, there is little empirical evidence directly testing their effect on religious beliefs. Cultural learning mechanism offer solutions to some of the previously mentioned issues with using content biases alone to explain religious belief (specifically the Mickey Mouse and Zeus problems. Gervais & Henrich, 2010). Cultural variation should be expected within this frame work, as would strong boundaries against believing in another culture’s gods. Tests looking specifically at how these ideas effect supernatural belief could greatly enhance our understanding of religion. With these mechanisms, it may not be necessary to evoke content biases to explain the spread of religious belief. This is not to say that they play no role at all, but that the strength and consistency of a memory bias is less important in the shadow of cultural learning mechanisms. The consistency with which supernatural content
conforms to a minimally counterintuitive template is still notably in need of an explanation. It may be the case that there is something about this type of violation that compels people to use them to explain the unexplainable or unpredictable. This has been demonstrated with anthropomorphism (Waytz, Morewedge et al., 2010), and might also explain the proliferation of other minimally counterintuitive ideas in a similar way.
References


Appendix A

A.1 - Stimuli from experiment 1

Story set 1

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 "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

Jane went for a walk in the woods. On her walk she came across a floating rock. She reached out and touched it. Jane was startled. It looked like any other rock; it was small and grey and sort of round. 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 playing with the floating rock. She was distracted and not paying attention to where she was going. The rock floated on ahead of her, 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 rock in her hand and said "what will I do! I'm lost and it's getting dark. I can't find my way home". She looked at the floating rock and decided to take the right hand path, the right hand path would lead her home. She took the rock, followed the path and found her way safely home. She put the floating rock down by the path near her house, thinking what a fun toy it was, and went home to bed.

Intuitive-Social

Jane went for a walk in the woods. On her walk she came across another girl. 'Hello' she said to her. Jane was startled. It was just a normal girl; she was short, blond and wearing pigtails. She'd never seen another girl on the path before, so she asked her to come walk with her. They wandered further and further into the woods talking. She was having fun and not paying attention to where she was going. The other girl ran ahead of her, and Jane chased after her. She became nervous about getting lost in the woods. Soon, she came to a fork in the road. She held the girl's hand and said to her "what will I do! I'm lost and it's getting dark. I can't find my way home". The girl smiled and said "I will lead you home, take the right hand path, and it will get you home". She followed the girl's directions and found her way safely home. She said goodbye to the girl on the path near her house, thanked her for her company and for being her guide, and went home to bed.
Story Set 2

MCI-Anthropomorphic

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, a man appeared before him, floating two feet off the ground. “Who are you?” Sam asked. “My name is John” said the man. “How long have you been here?” asked Sam. “A very long time, I can’t find my way out of this library!” said the man. Sam looked around, he wasn’t sure how he’d gotten to this part of the library either. There weren’t floating people in any other part of the library he had seen. “Maybe we can find an exit sign” Sam offered helpfully. “I’d be very grateful if you could get me out of here” replied the man. Sam started to wander down the aisles of the strange new part of the library with the man floating behind him. Sam found an exit, but when he walked out the man had floated away.

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.

Intuitive-Social

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, a man walked towards him, looking slightly distraught. “Who are you?” Sam asked. “My name is John” said the man. “How long have you been here?” asked Sam. “A very long time, I can’t find my way out of this library!” said the man. Sam looked around, he wasn’t sure how he’d gotten to this part of the library either. People didn’t get lost in any other part of the library he had seen. “Maybe we can find an exit sign” Sam offered helpfully. “I’d be very grateful if you could get me out of here” replied the man. Sam started to wander down the aisles of the strange new part of the library with the man following behind him. Sam found an exit, but when he walked out the man had walked away.
Story set 3

MCI-Anthropomorphic

Kate went walking in the field behind her house. She sat down under her favorite tree for a picnic. The tree reached down and gave her a hug. Kate jumped up; she didn’t know what to do. She had never been hugged by a tree before. The tree reached out and hugged her again. Unsure what to do, she offered some cheese from her basket to the tree, but it shook its branches 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. The tree reached over her to protect her from the wind and rain. She stayed sheltered under the tree’s branches until the storm passed and she could go safely home. She thanked the tree profusely for all its kindness and promised to come again soon. With the sun shining overhead, she crossed the field and made her way safely home.

MCI-Physical

Kate went walking in the field behind her house. She sat down under her favorite tree for a picnic. The tree vanished right before her eyes. Kate jumped up; she didn’t know what to do. She had never seen a tree vanish before. The tree appeared and disappeared again. Unsure what to do, she threw some cheese from her basket at the tree, but it bounced off and fell to the ground. She sat under the tree and ate her picnic so fascinated by her new discovery 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. The invisible tree still protected her from the wind and rain. She stayed sheltered under the tree’s branches until the storm passed and she could go safely home. She stared right through the tree astonished and thought she’d come again soon. With the sun shining overhead, she crossed the field and made her way safely home.

Intuitive-Social

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.
A.2 - Stimuli from experiment 2

Mr. Wurg was about to be sent as an ambassador to the Zenon 3 galaxy. He wanted to know what things are like over there before leaving. So he went to the Arts and Sciences Museum, where two halls contain exhibits about Zenon 3.

In the first hall, there were exhibits about the various kinds of furniture you can find in houses in the Zenon 3 galaxy. Some of these objects are like what you find here on Earth, and others are really different. There are objects that can be taken apart to be fixed. You can take a part out to change it. There are objects that are aware of what’s around them. They know what’s going on. There are objects that see what’s in front of them. They can perceive what is opposite. There are objects made with parts from other objects. Someone took bits of other objects to make them. There are objects that hide away when they’re scared. If something frightens them they run for cover. There are objects designed by engineers. These people made a blueprint of the objects before making them. There are objects that hear sounds around them. They can perceive sounds not too far from them. There are objects made by people as a hobby. They like spending a Sunday making them. There are objects that want to go. If they plan to get somewhere they just go there. There are objects made of a special metal that’s hard to melt. It is difficult to make objects in that metal. There are objects manufactured in small workshops. There are small places where people make them. There are objects that can notice people are staring at them. If someone looks at them they notice it.

In the second hall, there were exhibits about the various kinds of people who live in Zenon 3. Some of these people are very much like us and others are very different. There are people who remember the past. They can recall what happened to them. There are people who are sad when they are alone. They don’t like being on their own. There are people you put together with a screwdriver. You screw the parts together to make them. There are people who try to do what they want. If they want to do something they try it. There are people who are made by machines. Special machines turn them out. There are people who can read books. If they open a book they can read it. There are people made of plaster. One uses plaster to make them. There are people who are manufactured when necessary. When you need more you make some. There are people who don’t like being bossed around. If you bully them they don’t like it. There are people who must be fine-tuned after installation. They must be adjusted after they are put into use. There are people you can fix yourself. If there is a breakdown you can fix them. There are people who understand jokes. They can get what is funny in a joke. After he had seen all these exhibits, Mr. Wurg went back to the main lobby of the Museum of Arts and Sciences. He had a coffee at the museum cafeteria. He then went back home and cooked his dinner.
Jim the Wonder Dog

Jim was just a plain black and white setter, but in all the annals of dogdom there has never been anything his equal. 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, Sam Van Arsdale, could offer no clue to his remarkable gift.

In 1936, just before the World Series games were played, Van Arsdale, in the presence of friends, placed before Jim two pieces of paper upon which the names of the teams had been written. He explained, “Jim, I have here the names of the two teams that will be playing in the World Series. Will you show us the one that will win?” Jim placed a paw on the slip bearing the word “Yankees.” Later events proved him correct.

Again in 1936, Jim was asked to predict the winner of the U.S. presidential race. The names of Roosevelt and Landon were written on pieces of paper and placed in a hat. The slips were drawn out by two ladies. Then Van Arsdale said, “Now, Jim, one of these ladies holds the name of the next president of the United States. Will you show us who it is?” Jim went immediately to one of the women. She unfolded her paper and read the name “Roosevelt.”

Such were Jim’s powers that he could look into the future and foretell coming events. 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.

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.

To see how it works, consider the angular momentum or "spin" of an electron. To entangle the spins of two electrons, you first need to make sure they're identical in all respects but their spin. Then you shoot the electrons simultaneously into a beam splitter.

Anton Zeilinger, a quantum physicist at the University of Vienna in Austria, has already shown that this quantum state is possible with buckyballs - football-shaped molecules of C_{60}. 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," he says. "The possibility that you can teleport not just quantum states of photons, but also of more massive particles, that in itself is an interesting goal."
Radio emerges from the electronic soup

A self-organizing electronic circuit has stunned engineers by turning itself into a radio receiver.

Layzell and Bird were using the 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 quantum fluctuations, the group has small, but self learning circuits in a solid state silicone based chip. With only minimal programming the chips have managed to learn beyond their initial programming and react to their environment much like an insect would.

“Self-learning 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 learning 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 Haitian 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 neocortex rendering the victims completely susceptible to the suggestions of others, and essentially, without a mind of their own.
“For most people the idea of not being mind-less is terrifying” adds Dr. Whitefield. But not to worry, whatever causes these rare cases of zombification has never been known to inflict people who live outside of the small Caribbean country.

**Quantum Physics opens up the question: can ‘consciousness’ could affect matter.**

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

**Real Non-MCI articles**

**Solar Windows Capable of Generating Electricity**

New Energy Technologies, is pleased to announce that researchers developing its proprietary SolarWindow(TM) 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.

New Energy's ability to generate electricity on see-thru glass is made possible by making use of the world's smallest working organic solar cells, developed by Dr. Xiaomei Jiang at the University of South Florida. 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.

His passion for quantum physics began on his sixth birthday when his father, Tulsi Narayan Prasad, presented him with A Brief History of Time, written by Stephen Hawking.
He finished the book, which inspired him, in three days. At 14, he 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.

Citizen science: People power

The whole thing began by accident, says David Baker, a biochemist at the University of Washington in Seattle. It was 2005, and he and his colleagues had just unveiled Rosetta@home — one of those 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 that minimizes the internal stresses and strains.

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. In the game Foldit, players compete, collaborate, develop strategies, accumulate game points and move to different playing levels — all while folding proteins. 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. The team reports its discovery in the journal *Nature*. 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".

It also looked quite different from modern "crocodilians" - the group which includes alligators and crocodiles, he added.

**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.