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Exploring Counterintuitiveness: Template- and Schema-Level Effects

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I hereby certify that this is entirely my own work unless otherwise stated ☑

Abstract

Pascal Boyer's theory of counterintuitive cultural representations asserts that concepts that violate developmentally natural intuitive knowledge structures demand more attention and are more transmittable than other concepts (Boyer and Ramble 2001: 535-64). Grounded in an empirically justified framework of ontological domain knowledge, counterintuitive representations have been identified across human cultures as consistently prevalent in religious beliefs and widely known folktales. Indeed, the ubiquity of counterintuitive representations of supernatural agents in world religions has led some to reason that its presence is a defining factor of "religion" (Atran 2002; Boyer 1994, 2001; Brown 1991; Pyysiäinen, Lindeman and Honkela 2003). The theory has attracted considerable attention from scholars. Boyer discussed and predicted the mnemonic advantages of culturally "familiar" counterintuitive representations (Boyer 2001: 58-105), yet this integral aspect has been poorly investigated, especially because subsequent free-recall studies have focused on novel representations that similarly violate assumptions about our intuitive ontologies. These studies have suffered from a variety of other shortcomings: small sample sizes that poorly represent population demographics and age ranges (most recruited university students); limited investigation of different modes of cultural transmission (most centred on written stimuli); emphasis on free recall at the expense of other measures of memory; and incomplete research into interactions of schema-level effects (e.g. positive and negative emotion, imagery, humour, and inferential potential) on the memorability of counterintuitive ideas. Although the theory claims universality across human cultures, purported differences between holistic and analytic types of cognition suggest that it is likely that East Asians process counterintuitive ideas differently from Westerners. But until this dissertation no data had yet been collected in East Asia. Hence, a large age-representative sample (*N* = 940), for three studies in both the UK and China, was used to investigate the interaction of template- and schema-level effects for wider forms of transmission biases endemic to cultural groups. The investigation comprised the interaction of the mnemonic effects of familiarity and counterintuitiveness and the impact of schema-level effects, employing a mixing of presentation media (Study #1), template-level preferences when generating schema-level ideas (Study #2), and transmission advantages for supernatural agents (Study #3). Study #1 consisted of two free-recall experiments: a minimal condition (subject-predicate statement) and elaborated condition (additional descriptive elements) of stimuli structure. The results were analysed by hierarchical linear model (HLM), with familiarity, counterintuitiveness, and delay as 2-level fixed factors, and age and schema-level effects as covariates. The findings revealed mixed support for predictions of the typical formulation of Boyer's hypothesis. However, subsequent analyses revealed a significant interaction of counterintuitiveness x age and of counterintuitiveness x familiarity, for all conditions and cultural sites. Schema-level effects were also found to predict recall rate. Study #2 investigated template-level biases in a statement generation task. An analysis of covariance (ANCOVA) considering counterintuitiveness and the covariate of age revealed that children are significantly more likely to author counterintuitive ideas than older adults, in both UK and China. Study #3 (comparable in design to Study #1) found a significant interaction of counterintuitiveness x ontological category, revealed to be due to participants' better recall rates, at both locations, for counterintuitive concepts belonging to the ontological category PERSONS. In summary, it appears that the counterintuitive effect is not as straightforward as it has been thought to be, and requires further theoretical development and empirical research to improve understanding about the interactive role of age, schema-level effects, and ontological category in the transmission and cultural epidemiology of such representations.

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1 Introduction

Emerging evidence from the multidisciplinary field of cognitive science indicates that religious beliefs and concepts are the natural by-products of cognitive mechanisms that come online during early childhood in normal developmental contexts. These psychological capacities are present in all humans. Evidence suggests that these cognitive mechanisms that generate intuitive assumptions about objects specific to ontological domains originally evolved for purposes unrelated to religion (Boyer 1994, 2000, 2003; Barrett 2000, 2004; Atran 2002; Bloom 2007; Pyysiäinen and Hauser 2010). Our ability to reason in intuitive and systematic ways within the ontological domains of animacy, biological kinds, causation, agency, and sociality could well offer the cognitive underpinnings to explain the recurrent distributed concepts of spirits, ghosts, and deities with supernatural attributes (amongst other culturally universal religious ideas) that we see in cultural groups. Religious representations then could be the predictable outputs of these domain-specific, inference-generating cognitive mechanisms that would typically provide intuitive knowledge for reasoning about target objects other than religious concepts. (Keil 1979, 1989; Boyer and H.C. Barrett 2005; Spelke and Kinzler 2007; J.L. Barrett 2008). We might then expect religious concepts to adhere in form and content to the same cognitive constraints as nonreligious concepts that fall within the same ontological domains (Boyer 1994, 2000, 2003; Barrett 2000; Atran 2002; Sperber and Hirschfeld 2004). Cultural representations such as supernatural agents have been recognised as universally prevalent in human cultures and identified as similarly violating the intuitive assumptions our template-level cognition makes about target objects. (Brown 1991; Boyer 1994, 2000, 2001; Atran 2002; Pyysiäinen, Lindeman and Honkela 2003). Pascal Boyer has spearheaded this approach explaining religion as a by-product of normal cognitive development.

Boyer's theory postulating the transmission advantages of counterintuitive ideas is a central tenet of the cognitive science of religion and has garnered considerable attention, including theoretical and empirical support for its predictions (Barrett and Nyhof 2001; Boyer and Ramble 2001; Norenzayan et al. 2006; Upal et al. 2007; Johnson, Kelly and Bishop 2010; Banerjee, Haque and Spelke 2013). This theory promises not only new explanations for why certain types of religious representations proliferate across cultures, but also a way to understand universal commonalities in terms of shared human cognition. It claims to identify key conceptual features of religious representations found in all human societies. Concepts that violate developmentally natural intuitive knowledge structures, without threatening semantic coherence, demand our attention and take hold in our memories. To frame this advantage in terms of the epidemiology of cultural representations, this attention bias increases the likelihood that *counterintuitive* cultural concepts will be transmitted within cultural groups, to the detriment of concepts consistent with intuitive assumptions dictated by the specific ontological domain to which the object was assigned by task-specific categorizer devices (Boyer and Ramble 2001: 535-64). These often striking, even fantastical cultural representations recur in cultural events and materials and in everyday acts of communication that are not necessarily overtly religious. Invisible people, weeping statues, and talking animals with human mental capacities are good examples of counterintuitive representations. Scholars have documented their presence in historical texts (Lisdorf 2004), folktales and children's stories (Barrett and Nyhof 2001; Barrett, Reed-Burdett and Porter 2009; Norenzayan et al. 2006), and general acts of communication, such as metaphorical usages in commercial advertisements (Upal 2007, 2011b). These representations are often quite removed from direct visual and other sensory experience of the world, inhabiting the realm of imagination or reason or existing in cultural events and representations of ambiguous sensory information that permit a variety of interpretations (consistent or not with the beliefs of the cultural agents engaged in these events). In spite of these foundations, Boyer (2001: 58-105) demonstrates that counterintuitive representations are consistently familiar and commonplace to people within all human societies, for whom they are established and accepted as the furniture of the world, intrinsic to the way it works.

Although evidence for the pan-cultural role that intuitive ontologies play in developing everyday knowledge and folk theories grows steadily, there is still little comprehensive experimental investigation of intuitive ontologies in East Asia (De Cruz and De Smedt 2007). In addition, evidence for the existence of a dyad that pits the holistic thinking of East Asia against the analytic cognition of "Westerners" is still hotly debated (see Nisbett 2003; Nisbett et al. 2001). These amongst other considerations motivated me to compare the populations of Oxford in the United Kingdom and Beijing in China, for three experimental studies developed for this thesis and replicated in both locations.

The first study engages with Boyer's original description of the mnemonic advantages of culturally successful and "familiar" counterintuitive representations (Boyer 2001: 58-105). Until now experimental studies on the transmission of counterintuitive concepts have unilaterally focused on participants' free recall of unfamiliar and novel counterintuitive stimuli. But these studies do not truly test Boyer's theory, because they fail to test the mnemonic interaction between the template-level violation (the counterintuitive effect) and schema-level effect (the familiarity effect). In contrast, this research investigates two central aspects of Boyer's theory. First, to replicate previous research, it asks whether concepts (both culturally familiar and novel) that violate our template-level natural intuitions about the world, yet which do not threaten semantic coherence, are more memorable than intuitive concepts that do not violate these ontological assumptions that are universal to human psychology. Second, this research builds on existing empirical research, examining the interaction between familiarity and counterintuitiveness and exploring how well familiar counterintuitive concepts help to spread representations among cultures. To this end, the study asks, Are familiar counterintuitive concepts more memorable than their unfamiliar counterparts? The experimental design also allowed me to investigate the impact of several other empirically determined schema-level effects on how well subjects were able to recall concepts, including: positive and negative emotion, ease of generating mental imagery, humour and inferential potential. Furthermore, these studies aimed to shape a more complete understanding of how the counterintuitive effect worked among people of all ages within individual cultural groups. Given the impact of age on the recall of counterintuitive concepts in previous findings (Gregory and Barrett 2009; Hornbeck and Barrett, forthcoming), it is germane to ask if younger persons remember more counterintuitive representations and thus are more likely to transmit them than are older members of the population. To help answer this question, this research matches the age-ranges of subjects in the samples to the population demographics at the experiment sites. The findings generated by this age-related question might transform our understanding of the role children play in the distribution of cultural representations and point towards future research that would clarify the different roles adults and children play in introducing, disseminating, and maintaining cultural ideas.

Indeed, the second study in this research addresses an outstanding concern of scholarship on the memorability of counterintuitive concepts, as cultural transmission is constrained not only by individuals' ability to recall concepts but also their facility for contributing to the emergence of new representations within cultural distributions. While counterintuitive representations appear to be well remembered, no research reveals how difficult it is to produce them in the first place, nor shows who within populations is responsible for producing them. "Children's worlds" have been reported to contain more works of the imagination than those of adults (Harris 2000). Given preliminary findings on the impact of age on how memorable counterintuitive concepts are, might younger persons with more imaginative minds, rather than older persons, be responsible for generating counterintuitive representations and be most capable of producing them?

A third study investigates for the first time a central theoretical aspect of the framework used to explain the relationship between cognition and religion. Supernatural agents are reported to recur universally in world religions (Brown 1991) and are the primary defining trait of religion (Atran 2002; Barrett 2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and

Honkela 2003). Guthrie (1993), Boyer (2001) and Barrett (2000, 2004a) have hypothesised that a psychological mechanism hypersensitive to detecting agency would be adaptive in humans, since having a strong perceptual bias toward interpreting ambiguous events as having been caused by agents makes it far less likely that our ancestors would have succumbed to predators. Supernatural agents are concepts that are both counterintuitive and have attributes of mentalistic agency. Boyer (2001) and Barrett (2000, 2004a) have hypothesised that the interaction of counterintuitive effect and the *hypersensitive agency detection device* (HADD), due to its oversensitivity to the unseen presence of agents, helps to explain the universal proliferation of god and deity concepts. It is here predicted that counterintuitive concepts that fall under the PERSONS ontological category will be better recalled than counterintuitive concepts without mentalistic agency attributes and concepts otherwise consistent with domain-specific ontological assumptions.

The remainder of this chapter is divided into six sections. Section 1.1 defines and explains what counterintuitiveness is and is not and sketches out how this template-level mechanism is believed to promote a mnemonic advantage. It also defines the contrasting operations of schema-level mechanisms, with which the counterintuitive effect (a template-level violation) is here hypothesised to interact. Section 1.2 reviews previous research on how counterintuitive representations are transmitted, and Section 1.3 provides the relevant background on children's imagination and creativity. Section 1.4 is a cognitive, demographic, and ethnographic description of the populations studied here. Section 1.5 considers the confounds of previous studies and the limitations of the current studies, and Section 1.6 provides an outline of the three studies investigating these research questions.

1.1 What is counterintuitiveness?

> Consider a human group. That group hosts a much larger population of representations. Some of these representations are entertained by only one individual for but a few seconds. Other representations inhabit the whole group over several generations. Between these two extremes,

> one finds representations with narrower or wider distributions. Widely distributed, long-lasting representations are what we are primarily referring to when we talk of culture. There exists, however, no threshold, no boundary with cultural representations on one side and individual ones on the other. Representations are more or less widely and lastingly distributed, and hence more or less cultural. So to explain culture is to answer the following question: why are some representations more successful in a human population, more "catching" than others? (Sperber 1996: 57-58)

Exploring how our cognitive and conceptual systems inform and constrain cultural expression provides insight into and means to stabilize and diversify cultural representations (Sperber et al. 2004). For representations to be "cultural" or "religious", as opposed to idiosyncratic, they must be widely distributed in the minds of persons within a cultural group. Hence, understanding how our cognitive systems privilege certain types of concepts is key to understanding what is and what is not cultural or religious.

Those who would explain religion have often devised exhaustive lists of religious examples from around the globe, in some ways emulating James Frazer's *The Golden Bough* (1911), which itself revealed that catalogues alone are not explanations. Boyer's approach was more or less inspired by Noam Chomsky's proposition of *universal grammar* in theoretical linguistics, which postulates the human universality of innately specified intuitive knowledge structures that govern the recurring patterns in language and in its functionality, and make universal communication possible (Chomsky 1980, 2002). Applying Boyer's analogue for Chomsky's universal grammar to culture and religion provides the tools to detect the universal grammar that is meta-culture and a syntax for religious concepts. This approach contrasts starkly with the fervent ethnographic cataloguing of many social anthropological documents that prove little more than that cultural representations are incredibly diverse. Grounded in template-level intuitive knowledge structures—the products a large body of research within developmental psychology—the theory of the transmission of counterintuitive ideas claims not only to explain how such diversity of religious representations in cultures is possible, but also aims to identify mechanisms responsible for universal *anchors* or human cognitive constraints on cultural expression—the means for the cultural stability of such representations.

1.1.1 Templates, domains, and intuitive knowledge

The adjective "intuitive" is applied in cognitive developmental psychology to cognition that does not require conscious inspection of the principles involved, and refers mostly to the natural assumptions and expectations of children. The child receives this information automatically by a *brute causal* process, triggered when he engages with the corresponding pre-specified stimuli. Brute causal learning is contrasted with *rational concept learning* (Fodor 2008). Rational concept learning describes how a subject acquires concepts as he forms and tests hypotheses, whereas brute-causal concept acquisition is a non-hypothesis-based process that bestows concepts on a subject. Intuitive knowledge is acquired through the brute-causal process. Upon a first encounter, the infant subject acquires access to the knowledge structure purely on the basis of proximity with the appropriate stimulus. The proximity with this stimulus is the brute-causal trigger for the acquisition of knowledge.[1] An example of this process could include a child's first proximity to the stimulus of the birth of an animal, say, a kitten. This stimulus triggers access to the intuitive knowledge structure of *like-begets-like*. Given this encounter, the child will, with no opportunity to form and test hypotheses, expect later cats also to give birth to kittens (and not to puppies, cubs, or wooden spoons), and other animal kinds also to beget like-kind (Keil 1989; Springer and Keil 1989). These units of intuitive knowledge are reported to be largely invariable across human groups, triggered naturally through typical interaction of the child and the natural and social environment.

All humans acquire access to these intuitive knowledge structures during childhood, and the term "intuitive" is most often used to refer to the natural assumptions and expectations of children, but this does not mean that adults lack comparable intuitive mechanisms. Neither

[1] Based on Jerry Fodor's discussion of concept learning in *LOT2* (Fodor 2008).

children nor adults have direct conscious access to these intuitive knowledge structures. Rather, they have reflective theories of their own experiences and an understanding of those experiences to which they do have conscious access. A good way to understand this is to consider Immanuel Kant's (1781/2003) proposition, in the *Critique of Pure Reason*, that objects persist in spatiotemporal dimensions.[2] Until Kant concluded that this must be the case for the relationship between mind and object, and before this idea became popularised, it was entirely possible that no one in the history of human thought had entertained this theory. However, it is now the case, it appears, that we have *known this all along,* on a level inaccessible to conscious inquiry (Kahnemann et al. 1992). That is, we had intuitive knowledge of objects persisting in spatiotemporal continuity, and unknowingly developed and behaved in obedience with this knowledge, but had no conscious access to it, and no reflective theory of it. This could be seen as quite surprising as in all likelihood we share this knowledge with mammals and other creatures, for without such *intuitive knowledge,* life itself as we know it would not be possible. Imagine if we had to learn as infants by forming theories and then testing hypotheses that objects do not just disappear and reappear in and out of existence. This would be no viable starting point for a cognizing organism. The relationship between adults and their intuitive knowledge structures may be more distant than that between children and their own. Although we may have reflective theories of the intuitive mechanisms we possess and which were triggered in childhood, as life goes on, layer upon layer of competing theories in our extended learned lives and counter-factual examples from our experience of the world (especially for strange people like scientists!) could perhaps mar our initial theory of the intuitive knowledge structure. One of the most striking and valuable features of science is that it is able to demonstrate that the world around us does not always match our intuitive assumptions, and is often counterintuitive (McCauley 2000). The strange spatiotemporal behaviour of electrons in

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[2] Kant disagreed with the formulations of Newton and Leibniz that maintained that space and time existed independently of the subject's awareness. Instead Kant denies this answer in the *Transcendental Aesthetic* and argues that space and time belong to the subjective constitution of the mind. Kantian scholars still hotly debate the extent of Kant's metaphysical relativism.

quantum mechanics, and the predatory behaviour of Venus-flytraps that violate our intuitive assumptions about plants as inanimate are good such examples.

McCauley (2000) usefully distinguishes between two forms of natural cognition: *maturationally natural* cognition, the natural product of human maturation, develops early in life, is high in fast and mandatory operation and ease of acquisition and expression, and is low in cross-cultural variability; and *practiced natural* cognition, which is also automatic and effortless, but often requires special artefacts and explicit instruction to be acquired, and is high in intra- and intercultural variability. Intuitive knowledge is always of the first kind. Whereas maturationally natural cognition considers assumptions that pop into mind in domains where there is little or no experience, practiced natural cognition comes from extensive experience operating with some domain. The ability to play tennis well after many years of practice, or our acquired ability to do simple arithmetic with speed and little thought, is an example of practiced natural cognition. Maturationally natural cognition has a strong innate or pre-specified component, whereas abilities resulting from practiced natural cognition are acquired through repeated engagement in activity and interaction with similar pre-specified mechanisms. Nativists and empiricists alike agree and recognise that at least some mechanisms must be predisposed—to some degree—and present in early childhood. This starting point is necessary to facilitate a child's natural development in the social environment and his subsequent acquisition of practiced natural cognition as an emerging cultural agent. That the mind is simply a *tabula rasa* appears no longer tenable in light of decades of recent research. However, the "innateness" of these knowledge structures, as opposed to the "learning" of them, is still an area of much definitional debate.

To think of the mind as possessing tools designed to solve specific problems has proved a useful analogical aid for cognitive science. Anthropologist John Tooby and psychologist Leda Cosmides were perhaps the first to popularise the notion of the mind as akin to a Swiss Army knife (Cosmides, Tooby and Barkow 1992; Cosmides and Tooby 1992), having multitudes of specialised tools.[3] Most of these devices operate automatically, without any conscious awareness. Fast and frugal in nature they solve specific tasks in much the same way as computer programs rapidly solve problems. As the distal sensory mechanisms of the mind are confronted with new inputs, the mandatory operations of devices such as the recognition of the boundedness of objects[4] (Spelke 1991), face recognition[5] (Meltzoff and Moore 1983, 1989, 1992, 1994) and animal and artefact identifiers[6] (Bloom 1998; Gelman, Durgin, and Kaufmann 1995; Spelke et al. 1995) act as *categorizer* devices that identify objects (broadly construed) as falling into one of five ontological categories: SPATIAL ENTITIES, SOLID OBJECTS, LIVING THINGS (that are not self-propelled), ANIMATES and PERSONS.[7] An object categorized as belonging to one of these ontological categories then triggers a *describer* device. Identifying an object as belonging to a particular ontological category triggers a barrage of specific inferential units of intuitive knowledge to describe the nature of that object (Barrett 2004a). Here known as "expectation sets" (Barrett 2004a; Keil 1979, 1989), these numerous inferential units can be understood as bundling in sets according to different domains of intuitive knowledge, consisting of: *spatiality, physicality, biology, animacy, universals* and *mentality*.[8] As shown in Table 1, objects identified as falling under the different ontological domains trigger the delivery of

[3] This notion of the mind is also described as being "massively modular" and comprises many domain-specific mechanisms, as determined and selected by evolutionary selection pressures for solving problems in the ancestral environment of the Pleistocene (see Cosmides and Tooby 1992; Pinker 1997).
[4] Some of these abilities have been observed in the absence of any visual experience, in newborn human infants, and in newly hatched chicks (Lea, Slater and Ryan 1996; Regolin and Vallortigara 1995; Valenza, Leo, Gava and Simion 2006).
[5] Human babies can discern faces from the surrounding environment and imitate the expression of the gazer within a day after birth, as illustrated by the studies of Meltzoff and Moore (1989, 1992), presumably without the babies' awareness that they themselves have faces.
[6] Some evidence shows that animal- and artefact-identifying devices are present before the age of two years (Bloom 1998; Gelman, Durgin, and Kaufmann 1995; Spelke et al. 1995).
[7] Capitalization of the written word here is used in reference to concepts or conceptual objects, rather than the public production of the word itself. Greater elaboration on this distinction is found below.
[8] Although the specifications of Frank Keil (1979; 1989) are adopted here, there are several competing versions for how these categories should be organised. Another popular account from Spelke and Kinzler (2007) claims the presence of four systems of intuitive expectation sets, or "core knowledge": physics, animacy, number, spatial, with the possibility of a fifth: social. Choosing between these approaches is not a concern to this thesis as there is an apparent convergence of these models at least by the age of 5 or 6 (Spelke's model is most concerned with the ontological categories that are evident in infancy).

different combinations of expectation sets. For example, identifying something as falling under the ontological category of ANIMATES triggers the intuitive expectation sets of spatiality, physicality, biology, animacy and universals, but not mentality. Categorisation of an object within the SOLID OBJECTS ontological category triggers the delivery of inferential units of knowledge only from the domains of spatiality, physicality and universals. However, PERSONS triggers all six expectation sets.

Table 1. *Expectation sets triggered by a given object's falling under an ontological category.*

Expectation Sets[b] (with coding abbreviation)	SPATIAL ENTITIES	SOLID OBJECTS	LIVING THINGS	ANIMATES	PERSONS
Universals (u)	√	√	√	√	√
Spatiality (s)	√	√	√	√	√
Physicality (o)		√	√	√	√
Biology (b)			√	√	√
Animacy (a)				√	√
Mentality (m)					√

[b] The presence of a "√" indicates that an ontological category (listed across the top) intuitively assumes an expectation set (listed in left column), and no symbol signifies that that ontological category does not activate that expectation set.
Note. This table is modified from Barrett 2008.

Each intuitive expectation set provides a number of intuitive assumptions (here also termed *intuitive knowledge*) that come as a bundle for that domain. Once an object falls under the ANIMATES ontological category the intuitive expectation sets of spatiality, physicality, biology, animacy and universals are triggered. Focusing on the attribution of the biology expectation set alone, a child's intuitive understanding of biological kinds, or "folkbiology", develops around 4 to 5 years of age (Keil 1989; Atran 2001). After this point, a young child, having had a little exposure to animal kinds, possibly rabbits, dogs, cats, horses and a few others, given the imaginary example of, say, a "grounig", and advised that it is a real living animal, will without being explicitly told understand that grounigs give birth to baby grounigs, not to puppies, camels or anything else (Keil 1989; Springer and Keil 1989). The young child would know that a grounig is vulnerable to death (Slaughter 1995) and would understand that a grounig grows up and matures (Rosengren et al. 1991; Hatano and Inagaki 1994), and that if a grounig grew up with dogs it would not develop so as to bark like a dog, behave like a dog, or grow dog hair and develop dog paws (Sousa et al. 2002; Ross et al. 2003), but would retain its grounig-ness. Due to the categorisation of GROUNIG[9] under ANIMATES, young children have bestowed unto grounigs a wide range of expectations describing the general nature and behaviour of the animate object, even if they have neither seen nor been taught about the properties of grounigs. As dictated by Table 1, the concept GROUNIG attributed to the ontological category of ANIMATES triggers all intuitive expectation sets except the mentality set, which is mainly for objects such as humans (and maybe also other hominids, and possibly the family dog). You might also notice that objects falling under any of the ontological categories all trigger the expectation set of universals. Universals are intuitive expectations that apply to all reasoning in any domain (Barrett 2008). These include tacit intuitive assumptions such as that cause precedes effect, that time is unidirectional, and that spatiotemporality is an unbroken continuum (Carey 2009; Kahnemann et al. 1992). Table 2 summarises implicit intuitive assumptions actualised when an expectation set is triggered. Many have stressed the stabilizing effect of such domain-specific abilities on culture (e.g. Atran 2002; Boyer 1994, 2001; Hirschfeld 1996; Sperber 1996).

[9] Capitalization of the written word here is used in reference to a concept (as used with reference to the examples of a private representation of RABBIT and the imaginary creature GROUNIG), rather than merely the public production of the word itself—for which the underlying concept can differ among persons and even within persons (consider the polysemous utterance of "fire!"). Ontological categories are also conceptual (PERSONS, ANIMATES, LIVING THINGS, SOLID OBJECTS, SPATIAL ENTITIES); expectation sets (mentality, physicality, animacy, biology, and universals) are only categories of convenience for our understanding—they don't refer to objects of the mind.

Table 2. *Listing of constituent intuitive knowledge assumptions by expectation set.*

Expectation set	Individuated intuitive assumptions[a]	Reference(s)
Physicality	Cohesion (moves as a bounded whole) Contact (launching or changing direction of movement requires physical contact) Continuity (continuous movement in space) Solidity (cannot pass through solid objects) Tangibility Visibility	Aguiar and Baillargeon 1999; Leslie and Keeble 1987; Spelke 1990; Spelke and Kinzler 2007.
Biology	Development and growth	Hatano and Inagaki 1994; Rosengren et al. 1991.
	Like begets like	Keil 1989; Springer and Keil 1989.
	Natural composition	Simons and Keil 1995.
	Requires nourishment and possesses adaptive mechanisms to satisfy those needs	Ross et al. 2003.
	Parts serve the whole to sustain life	Keil 1989.
	Vulnerability to injury & death	Slaughter 2005.
	Kind-specific essence	Keil 1989; Sousa et al. 2002.
Animacy	Goal-directed behaviour Self-propelled (including moving in space, changing appearance, emitting sounds, etc.)	Leslie 1995; Premack 1990.
Mentality	Reflective and representational mental states (e.g. beliefs, desires) Self-awareness	Sperber 1997; Russell and Norvig 1995.
	Understands language and communication	Chomsky 1980, 2002; Pinker 1994.
Spatiality	Spatiotemporal location	Pylyshyn 2001; Pylyshyn and Storm 1998.
Universals	Spatiotemporal continuity Causation is unidirectional	Kahnemann et al. 1992.

[a] This summary of intuitive expectation sets and constituent intuitive assumptions. It may be expanded as more assumptions are discovered.
Note. This table was modified from Barrett 2008.

1.1.2 Violation of intuitive knowledge

Concepts such as LONG-EARED RABBIT, SPECKLED PEBBLE, and HAIRY GROUNIG are representations consistent with the intuitive assumptions contained in the domains attributed to them and most probably have no special psychological appeal, or anything above the ordinary mnemonic value. Experimental studies have shown that if any one of the intuitive assumptions, listed in Table 2, associated with an object and its ontological category are violated, such that the experienced object possesses a feature counter to one of these intuitive assumptions, it becomes more memorable and gains a transmission advantage over standard "intuitive–kind" concepts (e.g. Barrett and Nyhof 2001; Boyer and Ramble 2001). This type of violation has been termed a *breach* in the counterintuitive effect literature. There is also the *transfer* type of ontological violation, which involves the transferring of a complete expectation set to an ontological category that previously did not possess it (Barrett 2008). Returning to our imaginary animal example from Section 1.1.1, if any one intuitive assumption constituting the intuitional expectation sets attributed to the concept GROUNIG as falling under ANIMATES was to be violated, such as by one's entertaining the representation of "a grounig that runs through solid walls" (which would violate an intuitive knowledge structure corresponding to the physicality expectation set), evidence from free-recall experiments has shown that such a concept would gain a mnemonic advantage (Barrett and Nyhof 2001, Boyer and Ramble 2001, Norenzayan et al. 2006, Upal et al. 2007; Johnson et al. 2010). In this case, a breach violation of the physicality expectation set occurs because the concept is counter to the intuitive assumption of the boundedness of a grounig as a physical object (Spelke 1991). In contrast, the representation "a grounig that sings opera" is an example of a transfer violation, as it involves a transfer of the mentality expectation set, which is not normally attributed to objects in the ANIMATES ontological category. Both of these types of *counterintuitive* concept (breach and transfer) should possess a mnemonic advantage over commonplace intuitive concepts, and therefore have a greater chance of being communicated and thus proliferating through cultural transmission.

Often termed "cognitive optimum" theory (Sperber 1996) or "minimal counterintuitiveness" (MCI) theory (Barrett 2000, 2004), it is necessary to understand that the term "counterintuitive" is a technical term and not the same as the commonplace understanding of it, such as "strange", "inexplicable" or "extraordinary". Indeed, Pascal Boyer has suggested that "counter-ontological" or some similar term might bring about less confusion (Boyer 2001: 75). It is widely recognised that counterintuitive concepts are central components of religious traditions (e.g. Atran and Norenzayan 2004; Barrett 2004a, 2004b; Boyer 1994, 2001; Pyysiäinen, Lindeman and Honkela 2003)—omnipotent beings and spirits are good such examples. Counterintuitive representations have also been reported to be present in folktales, such as American Indian stories (Barrett & Nyhof 2001), random selections of folktales from around the world (Barrett, Reed-Burdett & Porter, 2009) and Grimm Brothers tales (Norenzayan et al. 2006), and also in historical texts such as Roman Prodigy lists (Lisdorf 2004), and in societies in general (Upal 2011).

To be counterintuitive, a concept must violate at least one of the intuitive properties (or "intuitive assumptions") that were bestowed on the concept in accordance with the ontological domain that the object was identified as falling under. These counterintuitive concepts that violate intuitive properties at the template level of cognition appear to cause a greater-than-average demand on the cognitive resources of the individual who entertains the concept. However, experimental research has shown that to enjoy this memorability and transmission advantage it is important that a counterintuitive concept be only *minimally counterintuitive*,[10] like the example of a "singing rabbit" that has only one intuitive property violation: a transfer violation. *Maximally* or *massively counterintuitive* (MXCI) representations (alternately termed), such as a "singing, dancing rabbit that lives forever and is a fish on Tuesdays" lack the memorability success of minimally counterintuitive items and have been shown to perform mnemonically like commonplace concepts consistent with domain-specific intuitive assumptions, or worse (Barrett & Nyhof 2001; Boyer & Ramble 2001; Johnson, Kelly and Bishop 2010; Norenzayan et al. 2006; Upal et al. 2007).

[10] This "cognitive optimum" for maximisation of concept memorability has actually been shown to lie somewhere between 1 and 2 counterintuitive properties (Barrett, Reed-Burdett and Porter 2009; Johnson et al. 2010).

Pascal Boyer's theory of the transmission advantages of counterintuitive concepts promised a new approach to explaining not just the proliferation of certain religious representations across cultures but also an understanding of the universal commonalities of these cultural ideas. Boyer's approach to explaining religion does not claim that the standard social science model for culture is completely wrong, and agrees that culture is not human psychology writ large, and also that it would make little sense to explain culture in psychologically reductionist terms. It does however claim that psychological factors play an essential role in culture, in its stability and the parameters for its diversity of representations, as outputs are anchored by the properties of our intuitive domains. The basis for the mnemonic advantages of these counterintuitive superstimuli, explained above, helps to explain the proliferation of specific types of concepts that violate our ontological assumptions. As all humans share the same psychological framework of ontological category attributes of intuitive expectation sets, it also explains the universal commonalities among the cultural representations associated with world religions. Indeed, supernatural agents, as attention-arresting and memorable counterintuitive concepts, have been revealed to be a universal component of world religions (Atran 2002; Atran and Norenzayan 2004; Barrett 2004a; Boyer 1994, 2000, 2001; Brown 1991; Pyysiäinen, Lindeman and Honkela 2003), and are one of the strongest candidates for a defining trait of "religion" (Barrett 2004a; Boyer 2001; Atran 2002). It would be misleading to claim that the transmission advantage of counterintuitive concepts solely explains the diversity we see in religious representations. However, a substantial number of breaches and transfers of intuitive expectation set are possible (see Table 2), which, when combined with unmodified concepts that refer to the furniture of our worlds, result in a potentially infinite (or at least extremely large) number of concepts that can have template-level violations. Although constrained by the modularity of our cognitive architecture, the potential diversity and number of these counterintuitive superstimuli is great and further boosted by other ecological, sociological and emotional behavioural factors endemic to cultural groups, through which they can acquire added culture-specific meanings (Sperber and Hirschfeld 2004).

1.1.3 Schemas and a posteriori *knowledge*

In contrast to templates, which are brute-causal, inference-generating mechanisms devoid of conscious reasoning and which (allegedly) recur cross-culturally and cross-individually, schema-level effects on memorability are acquired through particular experiences and the entertainment of a concept in differing contexts. A *schema* is a hierarchical *a posteriori* knowledge structure (derived from experience and subject to intuitive hierarchical organisation) that entails a reflective theory of the concept it refers to, exceptions to and exclusions of objects of its reference, emotional content associated with the concept gained through personal experience, and other visual memories and information (D'Andrade 1992, 1995; Brewer 2000). For example, due to the "default value", thinking of a "dog" is likely to bring to mind its "hairiness"; because of our schema of DOG, this is not a default inference of the ANIMATES ontological domain, nor is it specific to objects that this template informs (D'Andrade 1995: 126). With templates our minds can be seen as being ready-equipped to make sense of the world, whereas schemas are entirely cultural: all particular schema-level information for an object is acquired through the interaction of the mind and the particulars of a specific cultural environment. The relative rigidity of schemas and templates can also serve to differentiate between them. The intuitive knowledge structures of the inference-generating templates can be seen as "informationally encapsulated" in the Fodorian sense (Fodor 2000: 63): they are inaccessible, immutable and removed from conscious inspection. In contrast, a schema for DOG has to be extremely flexible to incorporate "Great Dane", "Chihuahua" and "Snoopy". There is also substantial cross-individual variability of schemas. For example, for one person DOG triggers associations of danger and aggression, whereas for another DOG conjures associations of loyalty, helpfulness and playfulness. The more semantic connections of these schema-level associations, and connections with other concepts, that are made with a concept in mind, the better the chance you have of committing the concept to long-term memory and of recalling it with greater ease. Practised memory techniques consciously applied to remembering lists of ideas recognise and employ this strategy of making semantic connections. For example, some successful and well-known memory techniques, such as "Method of Loci" and "Pegword", utilise associative mental imagery to better remember a concept. The ancient Greek Method of Loci asks the individual to visualise the concept he wishes to remember and also to place it in a corner of the space he is currently in, and to do the same with each subsequent idea, placing each idea in a different place in the room, thereby generating several semantic connections for each concept to be remembered.

For a schema-level concept to become *cultural* it must be commonly shared by persons in a cultural group, and not be an idiosyncrasy of the few. The schema-level concept must also reference a particular object or event (broadly construed). A schema-level concept of general reference such as HAIRY DOG, which refers to no specific animal, is not cultural (but HAIRY-DOG-NESS can be a constituent of a cultural concept). However, the concept DOG attributed all the schema-level information to form the complex modified concept of LAIKA THE FIRST DOG IN SPACE (test subject of Sputnik II, Soviet space program, 1957) is a cultural concept as it is widely shared and committed to memory, drawn from experience, and individuated in reference. The basic concept DOG, devoid of experience of dogs, is *non-schematic*. In addition the bundles of domain-specific intuitive assumptions that are triggered upon identifying DOG as falling under the ontological category of ANIMATES are also non-schematic (see Section 1.1.1). For a concept to be *schematic* it must have conceptual modifiers that are drawn from experience.

It is important to differentiate between something that is *counter-schematic* and a *counter-intuitive* idea. For example, a 300-kilogram dog would be surprising and counter-schematic, as it would violate most people's theory of DOG, but it does not violate any of its intuitive assumptions (see Section 1.1.1), and is therefore not counterintuitive. This example also provides a good demonstration of the difference between templates and schemas as they belong to distinct dimensions in what has come to be known as dual processing in psychological literature. There appears to be good evidence for the existence of these two independent levels of conscious reasoned and non-conscious brute-causal beliefs: often referred to as reflective and non-reflective beliefs, or, epistemology and intuitiveness, respectively (also see Gregory and Barrett 2009; Sperber 1997). Here, two arguments are presented for the existence of and also the interaction between these two batteries of beliefs. First, although we typically trust our intuitions to deliver to us truthful assumptions about the world, in the light of science and reality these psychological mechanisms are just fast and frugal guesses that are not infallible and can be falsified by reflective reasoning. Barrett (2004b) explains that there are many such cases in which epistemology and intuition conflict and are subsequently exposed and remarks that counterintuitiveness and counter-schematics are "not the same thing" (2004b: 731). One of the most striking and valuable features of science is its ability to demonstrate that the world around us does not always match our intuitive assumptions and is often counterintuitive (McCauley 2000). The strange spatiotemporal behaviour of electrons in quantum mechanics, or the animate and predatory behaviours of the Venus-flytrap plant are clearly counterintuitive, but also epistemically true. Second, counterintuitive concepts and epistemic statements have the same fundamental grammatical structure: a concept modified by a property. This makes minimally counterintuitive concepts applicable to epistemology by virtue of syntax. Every counterintuitive representation is essentially a central concept that is modified by a property, for example, "mischievous coat" (Norenzayan et al. 2006: 537); the concept COAT is being modified by the property MISCHIEVOUS. The same is also true for minimally counterintuitive (MCI) concepts with larger grammatical structures. Take for example "a being about the size of a young human that is impossible to move by any means" (Barrett and Nyhof 2001: 95); the concept of BEING is being modified by IMMOVABLE. Complex modified concepts[11] such as

[11] I use "complex concept" here to signify conceptual combination of more than one semantic component.

these examples ("complex" as opposed to a "simple" concept such as COAT alone) trigger in the mind of the human agent[12] doing the entertaining a mandatory epistemic judgement of that complex concept that a simple concept does not. Consider for example entertaining the simple concept of DOG. Alone, in a neutral state without context, it might trigger personal memories or emotions of a dog or dogs you have known but it instils no question of the legitimacy of the concept; a dog is a dog. Now entertain for yourself FEATHERED DOG. Instantly doubt of its legitimacy as an object of the world leaps to mind, an epistemic judgement. Even a banal concept such as BROWN DOG draws a few theories and semantic connections to mind; all dogs are not brown. The same can also be said of all statements: the concept and modifying property are the essential components of a subject-predicate statement.[13] However, this is not a thesis on epistemology.[14] To talk of reflective truth claims serves only as a useful demonstration of the dual-processing differences of schema- and template-level information. All schema-level information, whether theory, emotion or sense data, is subject to truth claims and the intrusion of our epistemic reasoning systems (because template-level processing is a fast and consciously inaccessible system, it may not, in fact, trigger epistemic judgements until it has manifested in the slow system of schema-level hierarchy).

In Section 1.5.3, I will introduce and evaluate the schema-level factors that have acquired empirical support for their mnemonic effect on the memorability of concepts. Section 1.5.3 will discuss the relevance of these schema-level mnemonic effects to MCI theory and will identify the confounds that can result if these schema-level mnemonic effects are not considered within a model of cultural transmission centred on the mnemonic advantages of concepts that possess a template-level violation.

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[12] The term "agent" is used in the sense as per artificial intelligence literature (Russell and Norvig 1995): an agent does not respond to mechanistic and environmental contingencies alone, but acts on the basis of the possession of internal mental states.

[13] This subject-predicate statement format is used for test items in free-recall Experiments #1 and #2.

[14] See Gregory and Barrett (2009) for an experimental investigation into the relationship between epistemology and counterintuitiveness.

1.1.4 *What counterintuitiveness is, and what it isn't*

As Boyer (2001) points out, everyday usage of the word "counterintuitive" is likely to cause comprehension problems with respect to the intended technical usage of the term described in Section 1.1.2. Here, "counterintuitive", with its particular formulaic meaning, does not mean surprising, unexpected, extraordinary, unusual, false, or funny, as many people commonly understand and use the term (indeed, Boyer has suggested "counter-ontological" might have been a better choice). True, counterintuitive ideas are often strange in kind or surprising, but this is not always the case. We are ourselves aware of counterintuitive ideas that have lesser levels of salience in our day-to-day lives, and we can also appreciate the lives of peoples in cultures quite different from our own that are also saturated in counterintuitive cultural representations that do not surprise on every occasion and yet are part of their everyday being. Surrounded as we are by scientific discoveries and the world of onscreen entertainment, talk of the subatomic behaviour of electrons or the appearance of Mickey Mouse does not always grab our attention, surprise us, or strike us as bizarre (although this isn't to say these concepts do not have memorability advantages!). Bastien (1978) provides a good such account of an alternative culture who also possess a distribution of proliferative counterintuitive representations (just like us!), with a description of the everyday lives of the Ayllu ("mountain ancestors"). The Ayllu are made up of Aymara and Quechua peoples of the Andes. The Ayllu interact with and mould their behaviours in accordance with a "live" mountain that has many counterintuitive attributes. The living mountain makes many demands on the organisation and habitual aspects of their everyday lives. They talk of the mountain they live on as having hair, a forehead, internal organs, two arms and a leg (the other was taken away), all of which serve different functions and which they interact with. In addition, these aspects of the mountain are so entrenched in their way of being that the linguistic terms of their language for these geographic and ecological features correlate with the mountain's body parts (e.g. *hair* = grass; *leg* = valley ridge). The mountain is described as possessing biological physiology, as it "bleeds" and requires nourishment from these peoples. Ritual sacrifices in the form of the fat and flesh of the llama that feeds on the "hair" of the mountain are left at special ritual-specific places in which the llama is "eaten" by the mountain. In return for their collective care of the mountain, the peoples on its slopes are provided for by the fertility of the land. Behaving in accordance with the complex interactions with the aspects of the live mountain is integral to the Ayllu's lives. These practices and everyday activities for the Ayllu are perhaps of comparable lower salience to the ritual of Easter (for most), or maybe to that of a cinema trip to watch a science-fiction film. The familiarity that both the Ayllu and we ourselves develop for these varieties of cultural objects and events means they have little salience in our everyday environments. We might also consider the ubiquitous concept of GOD to practitioners of the Abrahamic religions. The idea of an omnipotent being responsible for the creation of all being, overlooking your every action and constantly judging your moral aptitude, just falls seamlessly and coherently into the fabric by which believers make sense of the world. The concept of GOD is a very familiar one due to its frequency of entertainment and consequently is to the conscious mind not of remarkable salience, but is a counterintuitive concept. The same would be true for the world of disembodied spirits entwined and interacting with the Afro-Brazilian religionists (Belem, Brazil) through frequent and familiar ritualistic spirit possessions (Cohen 2007). Counterintuitive ideas well entrenched in cultural beliefs are often not salient to those persons operating within these cultural systems. These examples of familiar counterintuitive ideas are not surprising or unusual, nor do they have any *distinctiveness* from the commonplace, to persons who are part of that culture and who behave in accordance with them.

It appears easy to confuse the counterintuitive effect with the well-documented memory effect of *expectation violation*, otherwise known as the *distinctiveness effect* or the *relative distinctiveness principle*. For example, Upal et al. have asserted, "[T]here is nothing inherent or magical about minimally counterintuitive concepts. Rather than a property of the item itself, as most previous researchers have assumed, it is the properties of the item in a particular context that matter" (2007: 422). The relative distinctiveness principle asserts that the more an item stands outs the greater its mnemonic advantage, and as Surprenant and Neath add, "one of the determinants of whether an item is more or less distinct at the time of retrieval, relative to other items, is the relation between conditions at encoding and those at retrieval" (2009: 103). In other words, what is stored is determined by what is perceived and how it is encoded, and what is stored informs what retrieval cues are effective in providing access to what is stored; and what stands out "relative to the background of alternatives from which it must be distinguished" at the point of retrieval (Fisher 1981: 310). In contrast to the relative distinctiveness principle, the hypothesised memorability advantages of counterintuitive concepts are defined as *intrinsic* mnemonic properties of the concept, bestowed by the violation of intuitive assumptions at the template level (Boyer 1994; Sperber 1996). These adaptive and inherent mnemonic advantages attributed to templates derive from cognitive optimum theory and are fundamental to the original theoretical formulation of the counterintuitive effect. However, drawing from other areas of research in memorability, many psychologists such as Tulving have broadly proposed that: (1) as remembering appears to depend on the relationship between the condition at encoding and the conditions at retrieval, (2) items do not have intrinsic mnemonic properties, (3) processes do not have intrinsic mnemonic properties, and (4) cues do not have intrinsic mnemonic properties (1983: 239). As will also be discussed in Section 1.5.8, there are grounds upon which these two approaches to memorability could be seen as complementary, at least for MCI theory. For the intrinsic mnemonic properties of counterintuitive concepts the encoding-retrieval principle (Surprenant and Neath 2009) contributes by explaining the role contextual materials play in memorability. Surprenant and Neath (2009) note that it is worthless to talk of an item's distinctiveness without identifying the kinds of competing items involved and the conditions at the times of the retrieval and the encoding of the item—also applicable to explaining the differential transmission rates of counterintuitive concepts. A word item in red type is distinct when it is embedded in a list of word items in black type (von Restorff 1933); the word *cookies* is distinct when presented in a list of types of fish (e.g. herring, shark, catfish, etc.; Geraci and Rajaram 2004). There are very precise mathematical and computational models for this idea of distinctiveness. A model called SIMPLE, otherwise known as Scale Independent Memory and Perceptual Learning, is widely used (Brown, Neath and Chater 2007). These models relate memory to that of a discrimination task. Items are attributed one or more dimensions (e.g. fish kinds, or letter colouring), from which items that have fewer associative items in the relevant dimensions at the time of retrieval are predicted to be better recalled than items with a larger number of associative items (Surprenant and Neath 2009: 107). However, other studies illustrate that to conflate the formulation of the counterintuitive effect with the relative distinctiveness principle is erroneous. Waddill and McDaniel describe the effect of expectation violation this way: "One of the more robust findings reported in the memory literature is that stimuli that are in some way unusual are generally remembered better than stimuli that are not" (1998: 108). It has generated considerable empirical support using the measure of free-recall with adult subjects (Schmidt 1985; Hirshman et al. 1989; Hunt 1995; Waddill and McDaniel 1998). Consider the stimulus: "The boy found a huge diamond." McDaniel et al. (1988) found that when subjects encoded stimuli like these in a sense that was unusual relative to common experience (e.g. "The boy found a huge diamond in the applesauce") the stimuli were better recalled than when they were encoded in a more typical sense (e.g. "The boy found a huge diamond in the jewellery store"). These are not counterintuitive ideas, but enjoy recall advantages post-encoding due to their distinctiveness from background alternatives and comparative items at the time of retrieval. More recently, Sloan et al. have noted some of the overlapping aspects of expectation violation with the counterintuitive effect, and remarked that: "Experimental studies over the past two decades indirectly support the MCI hypothesis, showing that expectation-violating stimuli are better remembered than non-expectation-violating stimuli" (2007: 357). However, these similarities have led to the ready misunderstanding of the technical usage of the term "counterintuitive".

To conflate the counterintuitive effect with expectation violation and attribute the mnemonic effect solely to the relative distinctiveness principle is erroneous and a misunderstanding of counterintuitiveness theory. Even within published articles claiming to review the counterintuitive effect or purporting to test the MCI hypothesis by experimental means, there has been common confusion as to what exactly constitutes a counterintuitive concept. Upal's (2010) theoretical review paper, which claims to provide "an alternative account of the minimal counterintuitive effect", should be acknowledged as making this mistake of misunderstanding, conflating and mixing the counterintuitive and distinctiveness effects into what can only be described as *[neo]-expectation violation theory* (which shall be discussed further in Section 1.5.8).

There are other key differences between expectation violation and counterintuitiveness. Models of distinctiveness and expectation violation cannot accommodate the addition and interaction of schema-level effects in the same way the counterintuitive effect can. As illustrated with the previous examples in this section, counterintuitive items can be novel and unfamiliar (e.g. Hugo the all-seeing invisible orang-utan (I just made this up), but also familiar to a cultural group and in this respect would not violate expectations in any way for those individuals (e.g. Superman the comic-book hero) or the Andean mountain god, Bastien 1978). In this respect, expectation violation theory and the familiar counterintuitive representations conflict with each other and demonstrate that they are very different kinds of mnemonic effects. To credit the note of Sloan et al. (2007) above, they were undoubtedly making an "indirect" comparison between unfamiliar counterintuitive representations, which are almost always surprising and salient, and representations that violate our expectations that share the same effect on the entertainer: that could be understood as complimentary to MCI theory. However, it should now be clear that that this comparison is a dangerous one that could lead to confusion. It could be that expectation violation is a conflated effect, of which MCI theory provides further refinement and clarity. For example, there is no evidence that expectation violation theory can differentiate between expectation-violating, culturally unfamiliar counterintuitive ideas (e.g. an intangible snail that sucks chicken bones) and surprising "bizarre" ideas that do not violate intuitive ontological assumptions (e.g. a purple car tyre with your name on it), but both kinds of which are present in stimuli sets of expectation violation studies. As Barrett and Nyhof (2001) have demonstrated, bizarre ideas that are counter-schematic and violate our expectations such as "a pink newspaper" and "a dog that weighs 700 kilograms" are comparable to commonplace intuitive ideas in their free-recall performance, and are significantly outperformed by counterintuitive ideas.

1.2 Past research on cognitive optimality of minimally counterintuitive concepts

The early systematic studies of Sir Frederic Bartlett (1886-1969) focused on how concepts embedded in stories get transformed when passed from person to person. Bartlett compared distortions produced in memory and the retelling of narrative stories, examining the processes of omission, distortion and transmission that occurred in the telling and retelling of North American folktales (Bartlett 1932). For Bartlett memory was a dynamic process in which the individual's comprehension, existing schemas, interests, and needs worked together to affect which mental events and objects he or she remembered. Bartlett's studies, both their findings and approach, have influenced many MCI theory studies (Atran 2002, Atran and Norenzayan 2004, Barrett and Nyhof 2001, Boyer 1994, Boyer and Ramble 2001, Gonce et al. 2006, Norenzayan et al. 2006, Upal et al. 2007). Specifically, many of these studies have focused upon the content of narratives (including content from Bartlett's own folktale material) in their experimental design (Barrett and Nyhof 2001, Boyer and Ramble 2001, Gonce et al. 2006, Norenzayan et al. 2006, Upal et al. 2007). To date, studies investigating the counterintuitiveness effect have predominantly been free-recall experiments. Typically, data collection, in the form of recording participants' free-recall responses, is done immediately after presenting the stimuli to participants (normally following a short distractor task), and again after a one-week delay. Some studies have analysed the free-recall of target items from vignettes in the form of stories, and others from lists or sequences of short statements (e.g. Gregory and Barrett 2009; Norenzayan et al. 2006; Sloan et al. 2007). Some researchers have split these two approaches into what can be thought of as the *context-dependent* and the *item-centric* approaches, respectively, with regard to understanding the transmission of counterintuitive concepts (Gonce et al. 2006, Tweney et al. 2006, Upal 2010, Upal et al. 2007). They claim that the counterintuitive concept in isolation (concept plus modifier) without contextual information, possibly in the form of a narrative, does not possess the mnemonic advantages for counterintuitive concepts Boyer hypothesises. The item-centric approach is criticised for two reasons: it is inconsistent with Bartlett's original methodological insights, and it stakes a theoretical position that opposes the claim of intrinsic mnemonic properties attributed to the cognitive templates of Cognitive Optimum theory (Sperber 1996), in favour of more globalised mnemonic aspects. However, it is quite unclear just what these context-dependent mnemonic aspects are, and what the conceptual unit for the transmission of the counterintuitive cultural representation is, as descriptions are vague. In the words of Upal et al.: "memorability is not an inherent property of a concept; rather it is a property of the concept, the context in which the concept is presented, and the background knowledge that the comprehendor possesses about the concept" (2007: 415). More recently, Upal (2010) aimed to more comprehensively describe in his paper, "An alternative account of the minimal counterintuitiveness effect". The formulation he revealed, although very interesting, ended up closely resembling the *distinctiveness effect* or *relative distinctive principle*. To be more exact, Upal does not define counterintuitiveness as Boyer does. Upal's alternative account does not refer to violations of domain-specific intuitive assumptions—the central defining aspect of Boyer's *counterintuitive* theory. These context-dependent and item-centric approaches both attributed to counterintuitive theory are therefore quite different positions characterising different mnemonic effects, yet both undoubtedly benefit our understanding of cultural transmission. For instance, no one would deny the power contextual material has to shape the meaning of a representation, nor would anyone deny the importance that the pre-existing beliefs and desires of the "comprehendor" have in determining the private representation. Indeed, to disregard how these more global aspects shape meaning when designing a study would be to bring about confounding effects. Tweney et al. (2006) demonstrated how a counterintuitive concept can be transformed into an intuitive concept, or an intuitive concept into a counterintuitive concept, by the prior and posterior context it is surrounded by, or by what they refer to as *predictability* and *postdictability.* They provided the example of the public representation of "flying cow", which appears to be a minimally counterintuitive concept: "I had just woken up and gone to the kitchen to make some coffee" said the farmer. "That's when I saw the *flying cow*. The twister had lifted the 500-pound creature well over 50 feet above the ground" (2006: 486). This contextual semantic transformation applies to all public representations to some degree. The degree to which the meaning can be transformed depends upon the extent to which the reference to the object the public representation (the stimulus) designates is consistent for the representation independent of context. The relationship between a word and the object to which it refers is subject to the vagaries of language. For example, the sudden utterance of "fire!" without context can potentially *refer* to numerous objects and events (e.g. a firing squad; your house burning down; a source of heat and comfort; or a direct command). However, the reference of other utterances is more certain or *strict,* such as "Paris is the capital of France". These examples, if extreme, demonstrate the potential for variability in meaning that the person who entertains the utterance can be bestowed with. Sperber (1996) usefully describes the importance of the distinction between *public representations* and *private representations*. A public representation can be understood as a cultural idea, whether produced through utterance or written and visual symbolic materials, or by communication act with other sensory properties, etc. A private representation is the meaning, encoded in the mind, that the person in the communication act takes from the public representation. Private representations can vary wildly, depending on the public representation. To ensure that the reference to the object the stimulus (public representation) designates is consistent, confidence must exist that the public representation (stimulus) bestows in all participants a similar private representation (the intended meaning; for something to be an appropriate stimulus for the study, it must have a shared meaning for all participants). This is here referred to as the *strictness of reference*. The *strictness of reference* differs greatly between the utterances of different stimuli (as evident in the results of Pretest #1). It is very possible that a person's experiences and beliefs could also provide some prior context that could transform the intended meaning of the public representation into an unexpected private representation (Bartlett 1932). Section 1.5.8 contains further discussion of this item-centric versus context-dependent debate. It also identifies potential confounds and limitations that can result from disregarding the effect that contextual materials have in shaping meaning.

Evidence of the counterintuitive effect, and thus support for the MCI hypothesis, has been revealed by studies with context-dependent approaches (e.g. Upal et al. 2007) and with item-centric approaches (e.g. Barrett and Nyhof 2001, Boyer and Ramble 2001, Gregory and Barrett 2009, Norenzayan et al. 2006), albeit sometimes with mixed results suggesting that the hypothesis needs revision (e.g. Gonce et al. 2006, Gregory and Barrett 2009, Norenzayan et al. 2006, Tweney et al. 2006). Some item-centric studies followed the format of analysing the free recall of participants after they had read a narrative in which both counterintuitive and commonplace ideas consistent with our intuitive assumptions were embedded. However, the responses of the participants were coded per the correct recall of these counterintuitive or intuitive-assumption-consistent items—not according to their successful recall of larger components of the narrative itself (e.g. Barrett and Nyhof 2001, Boyer and Ramble 2001). Both of these seminal studies found support for the MCI hypothesis. However, narratives and similar story contexts it often seems are not ideal choices for experimental materials as they provide the potential for additional confounds when investigating the mnemonic advantages of particular embedded stimuli. Many factors identified in Bartlett's original work are highly subjective psychological variables, such as an individual's comprehension, existing schemas, interests and needs, combining in ways that affect which mental events and objects he or she remembers (Bartlett 1932). Very difficult to control for, these factors cause the *meaning* of the stimulus to change depending on the context in which it is presented. For example, in studies by Barrett and Nyhof (2001) and Boyer and Ramble (2001), participants not only brought amalgamations of personal biases to the test, but also were fully expecting "strange" concepts when told at the start of the test narrative of Mr. Wurg's plan to visit an intergalactic museum (Boyer and Ramble 2001), or a planned visit to the museum and zoo of the planet Ralyks (Barrett and Nyhof 2001). The potential confounding effect of conceptual priming is very difficult to eliminate.

Another item-centric study, that of Norenzayan et al. (2006), designed a unique experiment that did not incorporate the free recall of target items in narratives. In addition to a textual analysis of the Brothers Grimm tales, the study analysed participants' recall of stimuli contained in lists of stimuli, which were intended to represent narrative content. Similar to Barrett, Burnett and Porter (2009), who analysed folktales from around the world, Norenzayan et al. (2006) hypothesised that the most widely known of these tales would contain a cognitive optimum number of between one and two counterintuitive representations. This cognitive optimum number for narratives was also hypothesised for the best-remembered lists of stimuli. Norenzayan et al. (and Barrett, Burdett, and Porter) reported evidence to support this hypothesis. However, the absence of robust pretesting methodology (nothing of an appropriate kind was reported) for Experiment 1 of Norenzayan et al.'s study seems to have resulted in a confounding effect: too much potential for polysemic representations of individual stimuli contained in the lists of stimuli that the experimenters intended to represent narratives. In determining an appropriate stimuli set, the reference to the object the stimulus designates should always be closely controlled, so as to bestow a like private representation for all participants. To ensure the reference to the object the stimulus designates is consistent (its "strictness of reference"), confidence must exist that the public representation (stimulus), bestows in all participants a similar private representation (the intended meaning; it must have a shared meaning for all participants for it to be an appropriate stimulus). To use an example of a stimulus from Norenzayan et al. (2006), if for instance the public representation “thirsty door” (stimulus) does not evoke a similar private representation in all participants (here intended in the communication act of the researchers to be a template-level violation of DOOR with a transfer of the biological intuitive expectation set), but instead, in the flexible minds of some participants who seek out relevance and economy of meaning (Sperber and Wilson 1986), the participants are more often bestowed with the private representation of A DOOR THAT REQUIRES PAINT, or A DOOR THAT IS DRY AND WILL SOAK UP WATER, this resulting polysemy is a confounding effect. What the researchers intended to represent in their communication act as an MCI concept in the participants’ minds is instead represented as a commonplace intuitive concept in many subjects due to the concept’s potential for multiple meanings. If this confounding effect is not properly controlled, the expected mnemonic effect could be lost. Participants might transform a stimulus intended to be an idea that violates intuitive assumptions of the domains triggered to describe it into an idea *consistent* with its domain-specific intuitive assumptions. Section 1.5.7 discusses the relevance of *analogical reasoning* to MCI theory and the potential of its confounding effect.

Many studies that investigate the counterintuitive effect have utilised the readily available option of using university students as experimental subjects, most commonly in return for course credit. This dominance among subjects of recruited university students has led to restricted age ranges for participants in nearly all free-recall experiments designed to test the MCI hypothesis, limiting our understanding of the counterintuitive effect, as studies rarely consider demographically representative population samples.[15] This point is especially relevant

[15]Henrich, Heine, and Norenzayan (2010) have suggested that the mixed findings for predictions of many psychological studies could be due to the heavy recruitment of university students as subjects of psychological studies. Due to their reasoning that university students commonly study materials such as abstract theorems and models far removed from everyday reality (an activity that also contrasts sharply with the everyday pursuits of other persons), Henrich, Heine, and Norenzayan are widely known among psychologists for their reference to university students as “the weirdest people in the world”.

with regard to representative age ranges. The only exceptions to this trend have been the studies of Boyer and Ramble (2001) and Gregory and Barrett (2009). In Boyer and Ramble's 2001 study, participants' ages ranged from 15 to 34 years; the researchers recruited participants from a Tibetan monastery in Nepal, a street scene in Gabon, and university students in Paris, this last unfortunately within an age range as restricted as those in previous French studies. To underscore this previous trend in recruiting participants, Gregory and Barrett (2009) recruited subjects from the general Oxford public, from various socio-economic backgrounds. Participants' ages ranged from 17 to 61 years of age, with a mean age of 28.6 years (N = 49). Stimuli were presented onscreen in the form of a randomised sequence and uniform timed order of subject-predicate statements (e.g. "a Y that is X"). These sequences contained 24 stimuli: 12 minimally counterintuitive (MCI) stimuli, and 12 stimuli consistent with domain-specific intuitive assumptions (INT). The participants recalled what they remembered from stimuli immediately following a three-minute distractor task and again after a one-week period of delay. Gregory and Barrett's study (2009) applied Barrett's recently published (2008) coding and quantifying scheme to generating stimuli to ensure the understanding and definition of a "counterintuitive concept" were consistent throughout the stimuli set (the differential operationalization of "counterintuitive" has been common to previous MCI studies). Gregory and Barrett (2009) used thorough pretest methodology to ensure that all stimuli would consistently bestow a similar private representation in all participants. However, in testing the MCI hypothesis anew they failed to replicate the hypothesised recall advantage for MCI stimuli. Post-hoc analyses for this study revealed that MCI concepts were better recalled than ordinary INT concepts after a one-week delay, but only by participants under 25 years of age. The use of this age category was justified by the seminal paper of Barrett and Nyhof (2001), in which the participants were at most 25 years of age. This is to say, the additional analyses of Gregory and Barrett replicated the mnemonic advantage of MCI stimuli over INT stimuli when the age range of participants was restricted comparably to those used in most previous MCI studies. But these additional analyses revealed a finding new to MCI theory in regard to the recall rates of older adults in this sample (participants whose age was 25 years and above), an age group that had been ignored by previous MCI studies. Older adults were found to recall MCI concepts poorly, to the extent that INT were significantly better recalled than MCI ideas—an intriguing reversal of the recall advantage for MCI stimuli over INT stimuli seen in the younger age group.

MCI theory has enjoyed considerable theoretical and empirical attention from within scholarly communities in psychology, anthropology, religious studies and cognitive science (Barrett and Nyhof 2001; Barrett, Reed-Burdett and Porter 2009; Boyer 2003; Boyer and Ramble 2001; Gonce et al. 2006; Gregory and Barrett 2009; Harmon-Vukic and Sloan 2009; Johnson, Kelly and Bishop 2010; Norenzayan et al. 2006; Purzycki 2010; Pyysiäinen, Lindeman and Honkela 2003; Sloan et al. 2007; Tremlin 2006; Tweney et al. 2006; Upal 2010, 2011a, 2011b; Upal et al. 2007). It has also acquired empirical support for its central hypothesis from these same communities (Banerjee, Haque and Spelke 2013; Barrett and Nyhof 2001; Boyer and Ramble 2001; Johnson, Kelly and Bishop 2010; Norenzayan et al. 2006; Upal et al. 2007). Several articles, however, have recorded mixed results either inconsistent with the theory's predictions or suggesting the need for substantive modification (Gonce et al. 2006; Gregory and Barrett 2009; Norenzayan et al. 2006; Tweney et al. 2006). Barrett (2008) suggested that some of these "failures to replicate" might have been due to different operationalization of "counterintuitive". To address this problem, Barrett (2008) created a coding and quantifying scheme for counterintuitive concepts. This scheme has been widely used and initially appears to have had a beneficial impact, as subsequent empirical studies that have applied the coding scheme have been able to replicate the MCI effect among young adults (e.g. Johnson, Kelly and Bishop 2010). Sections 1.1.1 and 1.1.2 have outlined Barrett's coding and quantifying scheme. Sections 1.5.1 and 1.5.7 further discuss the confounding effect that might result from different forms of operationalization of "counterintuitive".

A few studies have recently begun investigating the impact of individual schema-level effects on the recall of counterintuitive representations. These have included: humour (Purzycki 2009), ease of mental visualisation, or *imagery* (Sloan et al. 2007), and *inferential potential* (Gregory and Barrett 2009), the last of which draws directly from Boyer's original formulation of the counterintuitive effect, as he originally proposed that counterintuitive concepts that are more "thought provoking" would enjoy better transmission success than those less provocative (Boyer 2000, 2001). Section 1.5.3 details this current work's identification of the schema-level factors to be considered for modelling in the thesis and the empirical justification for their inclusion. This section also identifies the potential confounds of not incorporating the mnemonic effects of schema-level factors into models of the counterintuitive effect and of cultural transmission.

1.3 Children's imagination and creativity

The faculty of imagining, or imagination, is the process of forming mental images and sensations from information not drawn directly from the senses. It identifies the process of revisiting in the mind's eye the precepts of objects previously acquired in sense perception. Imagination in humans plays a key role in integrating experiences with the process of learning (Egan 1992; Sutton-Smith 1988; Norman 2000). It enables persons to transcend the actual to form meta-representational knowledge to help solve human problems. Hanson (1988) writes: "Imagination is what allows us to envision possibilities in or beyond the actualities in which we are immersed" (138). Imagination is the facility to consciously entertain the unconventional; it is thought unshackled from familiar action and unconstrained by cultural norms (Norman 2000). Imagination is closely related to creativity. Immanuel Kant (1790/1952) remarks: "The imagination is a powerful agent for creating as it were a second nature out of the material supplied to it by actual nature" (134). From a very early age, children are able to engage with the alternative reality of creative imaginary worlds (Harris 2000). Listening to storytelling (narrative) has been regarded as basic training for the development of imagination, as children are free to engage with their imaginations by entertaining folk stories, fairytales, and fantasies (Frye 1963; Norman 2000). Narratives are purported to form the basis of pretend play and aid in developing and exercising the imagination. Goldman (1998) suggests that children progress through two phases when they engage in fantasy play. The first involves roleplaying, as they act out the ideas they have developed in their imagination, and in the second they reengage with this self-created fantasy until what is conceptualized resembles actual reality and persists in "narrative myth". These imagined narratives, it has been claimed, help us to develop our capacity to make sense of the world and our experiences. Sutton-Smith (1988) asserts that we better recall items in such simulated narratives than we do in logically structured lists of concepts. In addition to this, he claims that imagination is not only a vital component in creating narratives, but also in understanding narratives intrinsic to the world around us. Others have expounded on the important role of imagination and narrative context in education and have criticized its supposed contemporary neglect: "So much of the focus on students' cognition is in terms of logico-mathematical skills that our very concept of education becomes affected" (Egan 1992: 5). In a related point, Egan argues that human memories function quite unlike the memory of computers:

> The human mind does not simply store facts discretely when it learns. Perhaps it can do this, and we might occasionally use this capacity to remember a phone number or a shopping list in the absence of a piece of paper. More typically when we learn even the simplest fact—that Vasco de Gama set off from Lisbon to sail to Africa in 1497 or that spiders have eight legs—we do not simply lodge these as discrete data in our brains. When learned, they mix in with the complex of shifting emotions, memories, intentions, and so on that constitute our mental lives... Whether and how we learn and retain these particular facts is affected by the complex of meaning structures we already have in place, which in turn are affected by our emotions, intentions, and so on. (1992: 50)

The point here is that remembering is not a mere verbatim process. Memory is a mixing process from which pretty much nothing emerges in quite the same form as it was originally entertained. This combinatorial process adds new material for what we regard as imagining, but also plays a crucial role in this constantly shifting aspect of memory. With our addition of every new belief and new piece of information we encounter, we make various wide-ranging associations. These associations are constantly being taken apart, and blended with new and existing informational structures.

There is also a strong connection between imagination and children's understanding of abstract language. Metaphorical thinking, it appears, is intrinsic to the language of thought long before it becomes a way with words. Children are endowed with an intuitive disposition for the rich and vivid production of metaphor. Gentner (2003) suggests a child's ability to use and understand more complex metaphor takes place on a "sliding scale of increasing similes". In a study by Gentner (1977), five- to six- year-olds were found able to understand attributional similes based on physical similarities, such as "pancakes are like nickels". However, children are often completely dumbfounded by the metaphors used by adults. The same study of Gentner found that only older children aged nine to ten years were able to understand relational similes based on functional similarity, like "a roof is like a hat", and double similes, such as "plant stems are like drinking straws". This inaptitude for understanding common adult metaphors, coupled with children's instinctual skill in producing original metaphorical similes, shows that analogical reasoning is evolutionarily rooted but also depends on cultural constructs. The study of Savage-Rumbaugh et al. (1986) purports to show that bonobos—humans' closest genetic relatives—are also capable of constructing simple metaphors. Given years of training and interaction in human social environments, Kanzi the bonobo, by using a keyboard covered in pictorial lexicons, famously produced the communication act in the form of the metaphor of "water bird", while near a duck. Kanzi supposedly reproduced this use of combinatorial language in various forms on numerous occasions. However, it should be noted that the conclusions drawn by Savage-Rumbaugh et al. in regard to metaphorical reasoning in non-human primates are contentious.

Psychologists have explored the imagination with regard not only to creativity and artistic expression, but also to its hidden presence in everyday life (Ward et al. 1997). Byrne (2005) suggests that the cognitive mechanisms for everyday aspects of imagination, responsible for simulating counterfactual alternatives to reality, could rely on the same mechanisms as rational thought. Compared with other animals, humans are most probably unique in that we are able to imagine events and entities no-one has ever observed (e.g. aliens from other worlds, disembodied people, and abominable snowmen). Given the human capacity for simulating imaginary realities, it is then essential that humans have the ability to differentiate between the *improbable* and *impossible* (Shtulman and Carey, 2007). Prentice, Manosevitz, and Hubbs (1978) reported that most six-year-old children think that Santa Claus, the Easter Bunny, and the tooth fairy exist. Woolley et al. (2004) discovered that other preschool children were willing to think that "the Candy Witch" that visits during Halloween and exchanges unwanted sweets for toys was real, after being exposed to this counterintuitive agent concept only once or twice. This effect is not limited to children. Adults readily believe accounts of unseen hypothetical propositions attested to by particular authority figures in total absence of personal observation or sufficient inquiry to justify such beliefs (e.g. electrons, ultraviolet radiation, retroviruses). However, evidence suggests that by the time children enter preschool they have begun to distinguish objects and events belonging to alternative worlds from those of reality. Evidence has been presented that appears to show that four-year-olds can distinguish fantastical agents from real agents (Morrison and Gardner 1978, Scholnick and Bloom 2006, Wellman and Estes 1986), as well as the properties of fantastical agents from those of real agents (Sharon and Wooley 2004), and that preschoolers understand that pretending something is real does not mean that thing actually exists (Golomb and Galasso 1995, Woolley and Wellman 1993). In addition, four-year-olds, as well as discriminating between fantastical events and real events

(Samuels and Taylor 1994), concur that fantastical events that occur in stories are impossible in the real world (Shtulman and Carey 2007). Nonetheless, preschool children will accept the possibility of impossible events, such as when they witness the visual illusion of the passing of one solid object through another bounded object (Chandler and Lalonde 1994), and from other such illusory illustrations of events that violate an intuitive assumption of the physicality expectation set (Rosengren and Hickling 1994, Subbotsky 2004). In light of this evidence, Sharon and Wooley (2004) concluded that: ''young children have clear ideas about the kinds of things real entities can and cannot do'' (294), but are willing to retract these beliefs when presented with contradictory evidence. Indeed, in reviewing related materials, Rosengren and Hickling (1994) asserted: ''young children make a sharp distinction between possible and impossible events'' (1606). However, others have resisted such strong conclusions. Shtulman and Carey (2007) revealed that although the judgements of children of all ages match with those of adults in finding certain events impossible, there was a robust tendency in preschoolers to overattribute impossibility to events that adults judged merely improbable. Therefore, Shtulman and Carey (2007) argued for a more parsimonious answer: "children initially mistake their inability to imagine circumstances that would allow an event to occur for evidence that no such circumstances exist" (1015).

1.4 Description of the populations

The experiment sites of the studies of this thesis were located in Oxford, UK, and Beijing, China. Second in population after Shanghai, Beijing is China's political, cultural, and educational heart. In comparison to Oxford, Beijing clearly is a much larger urban area, its population recorded by the *Beijing Statistics Bureau* (2012) to be 20,693,000. Oxford, in contrast, was recorded in the 2011 census as having a metropolitan population of 244,000. Obtained from the sample survey on population changes in 2004, the *National Bureau of Statistics of China* (2005) breaks down the total population of Beijing into 9.96% children aged 0 to 14 years, 78.92% adults aged 15 to 64 years, and 11.12% adults aged 65 years and above. The vast majority of Beijing residents are of the Han ethnic group. According to the 2010 census, 97.9% of residents were Han, but Beijing's population also includes members of the ethnic groups Manchu (1.2%), Hui (0.3%), and Mongol (0.2%), with smaller fractions comprising other ethnic minorities. Of the two experiment cities, Oxford has the greater ethnic diversity. *National Statistics* (2009) measures Oxford's residents as including: White British (72.4%), Other White (6.7%), South Asian (8.5%), Chinese (4.3%), Black (3.7%), Mixed Race (3%), Other (2.5%), and White Irish (1.4%). Beijing's urban populace speaks a Beijing dialect belonging to the Mandarin subdivision of spoken Chinese. Also known in pinyin as *Putonghua* ("Common Tongue"), Mandarin is mainland China's most widely spoken language. Rural areas in the surrounding Beijing municipality, such as in Hebei province, also have distinct regional dialectics of Mandarin. The *World Bank* (2010) recorded China's literacy rate as 94% for the population over 15 years of age, compared with only 20% of the population in 1950. China's current literacy rate amongst 15- to 24-year-olds is 98.9% (females 98.5%; males 99.2%). The World Bank's figures put the literacy of UK citizens at 99% for those aged 15 years and above.

Although China's constitution permits freedom of religious choice, religious organisations that lack governmental approval can face persecution, especially if considered a threat to the government. (A famous example is the Communist Party's crackdown in 1999 on the religious practice of Falun Gong.) Historically pluralist, Chinese society has always been exposed to numerous religious practices and beliefs. Religious belief has enjoyed a steady resurgence in China since the official end of the Cultural Revolution in 1979. A 2006 study estimated that 450 million (46%) of the population in China over the age of 16 years considered themselves religious (Tao 2012), which at the time starkly contrasted with the official figure of around 100 million people.[16] However, a report in 2002 found 59.1% of the Chinese population

[16] These figures can be found on the official website of the central government of the People's Republic of China ('Religious Believers', http://english.gov.cn/2006-02/08/content_182603.htm, [accessed June 19, 2013]).

to be nonreligious, whereas nonreligious belief in the UK population was estimated at 22.1% (Zuckerman 2005). Chinese culture has been influenced by many religious movements and thought systems over the millennia. These have included Shenism (the folk religion of the Han), which overlaps with Taoism, Mahayana Buddhism, Islam, Christianity, Manichaeism, Zoroastrianism, and numerous others arising from ethnic minorities. Of these, Taoism (here synonymous with Shenism) and Mahayana Buddhism have been most important in shaping Chinese culture. Taoism is the most notable indigenous Chinese religion, whereas Buddhism arrived to China from India in the first entury CE. The joint practice of Shenism and Taoism entails customs and beliefs involving local ethnic gods and deities called "shens", but also heroes and ancestors and other historical characters of Chinese mythology. Today in China, Tao (2012) estimates that the marriage of Shenism and Taoism accounts for around 31.8% of the population's religious adherents, and Buddhism 10.9%. Ancestor worship and the ethical, moral, and social values of Confucianism have also deeply shaped Chinese thought and culture. Chinese ancestor veneration dates to prehistory, and the Confucian virtue of filial piety is fundamental for understanding Chinese society.

Both the UK and China have broad and rich histories in the transmission of folktales and the inscribing of fantastical fictional stories. Perhaps the most widely known Chinese work of fiction outside China is *Journey to the West* from the sixteenth century, a fantastical story involving the journey to India of monk *XuanZang* and his disciples *Sun WuKong* ("Monkey"), *Zhu BaJie* ("Pigsy"), and *Sha WuJing* ("Sandy"), who serve him to atone for their sins in their past lives (Wu Cheng'en 1977). Other notable fictional works include *Romance of the Three Kingdoms* and *Red Chamber Dream*. Another, *In Search of the Supernatural,* is a fourth-century CE compilation of short stories, legends and folktale hearsay about spirits, ghosts, and other supernatural phenomena. It contains 464 stories, popularly believed to have been written by Gan Bao (1996), a historian at the court of Emperor Yuan of Jin in 350 CE (Songling 2006). Relevant to this thesis, the MCI study of Barrett, Burdett and Porter (2009), *Counterintuitiveness* *in Folktales: Finding the Cognitive Optimum*, analysed a wide variety of folktales from around the world, including works of Chinese folk fantasy contained within *Chinese Myths and Legends* (O'Brien 1990). First, Barrett, Burdett and Porter's study aimed to test whether the counterintuitive coding and quantifying schema of Barrett (2008) could be applied to cultural materials with an appropriate level of coder reliability. Second, it explored the cognitive optimum for cultural transmission of counterintuitive concepts in several ways: (1) identifying the number of counterintuitive objects found in widely known, successful folktales, (2) quantifying the number of template-level violations that the counterintuitive objects identified within these texts possessed, and (3) totalling and comparing the proportion of these counterintuitive objects that were also counterintuitive intentional agents. Barrett, Reed-Burdett and Porter analysed 73 folktales from around the world to find that 79 percent of these successful folktales contained one or more counterintuitive objects. Of these counterintuitive objects, 98 percent were agent concepts. Ninety-three percent of these counterintuitive objects had only one counterintuitive modifying property.

1.4.1 An overview of motivations for the cross-cultural experiment sites

Among all experimental MCI theory studies until present, perhaps surprisingly only two, Boyer and Ramble (2001) and Hornbeck and Barrett (forthcoming), have recruited non-Western participants. Boyer and Ramble recruited participants and conducted free-recall experiments that presented written vignettes in a street scene in Gabon and also from within a Tibetan monastery in Nepal (as well to university students in Paris, France). Hornbeck and Barrett used a similar measure with visual stimuli presented to participants of Far Eastern origin within the confines of a virtual online laboratory located in *Second Life*.[17] Boyer and Ramble's findings revealed support for the typical formulation of the MCI hypothesis, whereas those of Hornbeck

[17]Launched June 23, 2003, Second Life is a virtual online world developed through Linden Lab. By creating resident avatars, participants may interact with each other in different ways (e.g. socialising, trading, and other group activities).

and Barrett did not support it, but did reveal a significant interaction between the age of participants and the recall rates for MCI stimuli. The mnemonic advantages of MCI concepts are hypothesised to be pan-cultural. Further, supplemental experimental research is still required to validate any claim as to the universality of the MCI effect. No experimental research conducted in East Asia has been published. Given appropriate motivations to conduct research in China, research there could help to test the purported universality of the MCI effect. The studies in this thesis and the choice to locate the experimental sites in the UK and China were motivated at least partly by the deficit of pan-cultural experimental data in investigation of the MCI effect described above. Other motivations included the ongoing mind-debate, endemic to cross-cultural psychology, concerning perceived differences in the thought processes and behavioural outputs of "Westerners" and "Far Easterners" (see Section 1.4.2), as well as the limited evidence for the universality of intuitive ontologies that is a concern of cognitive and developmental science (see Section 1.4.3). Furthermore, and of special interest to the cognitive science of religion, China has for most of the last 60 years been an imposing secular state that has heavily suppressed religious practice and belief. Consequently, this choice of experimental sites also had the potential to reveal whether having "religious belief" is necessary for people to reason theologically about the world, and in addition, to investigate whether persons pan-culturally possess a natural propensity to transmit religious-type representations even in the absence of formal religious instruction.

1.4.2 Holistic thinking versus analytic cognition

There exists a large body of cross-cultural psychology research (see Nisbett et al. 2001 and Nisbett 2003, for reviews), cognition-minded reviews of key Far Eastern philosophies (Moore 1967), and various ethnographic accounts that suggest that Far Eastern participants may employ conceptualisation processes that differ substantially from those of Westerners. To illustrate, some psychologists argue that the cultural norms, ideologies and social structures that characterise an agent's sociocultural milieu may determine that agent's intuitive metaphysics, tacit epistemologies, and perceptual schematics. For instance, in a comparison between "collectivist" ancient China and "individualist" ancient Greece, presented as the most influential ancient loci of contemporary "Far Eastern" and "Western" cultures, respectively, Nisbett et al. (2001) claim socio-historical examples illustrate the following:

- A Greek belief in *individual agency*, versus a Chinese belief in *collective agency*.
- A Greek tradition of *debate and power plays* (i.e. vying for control), versus a Chinese emphasis on *compromise and group harmony*.
- A Greek enthusiasm for *curiosity, speculation, and abstract rules* about the world (i.e. the Greeks invented physics, formal logic, axiomatic geometry, etc.), versus a Chinese genius for *practicality* (i.e. the Chinese were technologically superior to the Greeks, having invented irrigation systems, ink, porcelain, the magnetic compass, etc.).
- A Greek tendency to focus on *the properties of discrete objects,* versus a Chinese tendency to focus on *continuities and relationships between objects*.
- A Greek interest in *formal logic and non-contradiction,* versus a Chinese interest in *dialectical reasoning and acceptance of contradictions* (in the Tao tradition, for example, *A* can actually imply that *not A* is also the case).

These bipolarities are not meant to itemise a set number of discrete differences, in the ways that Westerners and Far Easterners cognize the world. Rather, these ancient Greek tendencies are presumed to emanate from different nodes or instances of an interacting system of cognitive processes most commonly described as privileging an "analytic" orientation towards the world. The ancient Chinese tendencies, on the other hand, accommodated a "holistic" orientation.

Nisbett et al. (2001) attempted to illustrate the continuity of these cognitive legacies in contemporary populations. For example, in one experiment (Masuda and Nisbett 2000) Japanese and American participants were presented with realistic animated scenes of fish and other underwater objects and asked to report what they had seen. Japanese participants tended to perceive and remember “relationships between objects” (i.e. statements about the general ecosystem, how the fish interacted with background elements, etc.) whereas American participants tended to perceive and remember a “single focal object” (i.e. the species, size, color of fish, etc.) (see Abel and Hsu 1949; Chalfonte and Johnson 1996; Park, Nisbett, and Hedden 1999; and Ji, Peng, and Nisbett 2000 for related experiments and results). In other experiments, these same perceptual tendencies can be traced into casual attribution and prediction biases, as Far Easterners, supposedly more cognisant of contextual factors, are less susceptible to the “fundamental attribution error”, or the tendency to see behaviour as a product of the actor’s dispositions and to ignore important situation determinants (Ross 1977). Americans, for example, tend to explain mass murders by reference to the mental instability or negative dispositions of the murderers, whereas Chinese accounts for the same events are more likely to reference situational, contextual, or societal factors (Morris, Nisbett, and Peng 1995, Morris and Peng 1994). (See also Cha and Nam 1985; Lee, Hallahan, and Herzog 1996; and Norenzayan, Choi, and Nisbett 2001 for related experiments and results.) Other experiments illustrate how this strong reliance on contextual factors gives Far Easterners a greater predisposition than Westerners to “hindsight bias,” or the tendency to assume one knew all along that a given outcome was inevitable (Choi 1998, Fischhoff 1975). From this stance, if one is always cognisant of context, and if cognitive processes support the view that multiple, interactive factors usually affect a given outcome, then “any outcome may seem understandable, even inevitable, after the fact” (Nisbett et al. 2001: 299). Indeed, Choi and Nisbett (2000) provide evidence to show that Far Easterners are less likely than Westerners to be surprised by unanticipated and contradictory outcomes.

These are just a few examples of a large body of empirical work in this area. Though some specific findings may seem provocative for MCI research (e.g. the observed Far Eastern coolness towards unexpected or contradictory phenomena), this thesis does not concern exactly how holistic thought processes might interact with the hypothesised MCI effect. Rather, China as an experiment site was chosen on the grounds that the above research at least suggests the possibility of Chinese cognitive dissimilarity with Westerners, thereby making Chinese participants a good resource to test for the asserted universality of counterintuitive mnemonic effects.[18] Chinese children also provide an excellent Western versus non-Western comparison because of significantly different societal expectations, parental practices, and expected differences in folk psychologies between Chinese and Western cultures (Nisbett, Pen, Choi, and Norenzayan 2001, Wang 2004), any of which could have a substantial impact on children's developing understanding of their environment.

1.4.3 The universality of intuitive ontologies

Evidence is emerging steadily for the pan-cultural role that intuitive ontologies play in developing everyday knowledge and folk theories. Many recurring patterns we see in representations across cultures may be attributed to cultural elaborations on the underlying prespecified intuitive ontologies. For example, the patterns we see in children as they develop their knowledge of biological kinds are very similar across cultures (Atran 2002).

All humans have a sophisticated understanding of their natural living environment. The Ketengan of Papua New Guinea possess a folk taxonomy of around 200 bird species that corresponds surprisingly well to Western taxonomical classifications (Diamond, Bishop, and Gilardi 1999). Even urban-based Western children with hardly any exposure to animals and plants have an irresistible attraction to them (Atran, Medin and Ross 2004), and fill their drawings with similar functionally biased depictions of them. Like Western children, Shuar children of the Andes focus on the functional parts of plants and animals (including goal-directedness) and classify them accordingly (Barrett 2004). Strong evidence exists that folk

[18] Although it may be tempting to suppose alleged Chinese tolerance for contradiction would bear on tolerance for counterintuitiveness, such a supposition would confuse counterintuitiveness with contradiction. For a concept to be counterintuitive is not to have it contradict some necessary aspect of its composition, but only (in the case of breaches) an *intuitively* expected aspect.

taxonomies and intuitive understanding of natural history emerge early and are domain-specific.

Starting at around four years of age, children around the world are bestowed with a bundle of rich inferences (Ahn et al. 2001) for kind-inheritance (or *like begets like*; also Keil 1989, Springer and Keil 1989) and expectations of growth and development, as the child would understand that an animal grows up and matures (also see Rosengren et al. 1991 for American children; Hatano and Inagaki 1994 for Japanese children) and that this is irreversible. As a consequence folk taxonomies share strong resemblances across cultures, and due to the attribution of kind-specific essences (Keil 1989, Sousa et al. 2002) to plant and animal objects, children of all cultures reason about their environments in similar ways. In cultures as distant as those of the Mesoamerican Maya (Atran et al. 2004) and the Yoruba of West Africa (Ahn et al. 2001) children will attest that even given quite severe changes to a living thing's physical properties, its core identity is not altered. Similarly, American children believe that surgically altering a dog to make it look like a raccoon will not change it from being a dog (Keil 1989). This unchangeable hidden essence of living kinds is causal in its final form and behaviour (Medin and Ortony 1989).

This kind-specific essentialism, adopted by children between ages three and six, can even apply to social categories. Initially, children often make the mistake of over-attributing this essentialist tendency for certain tricky objects and social categories—mistakes most adults have learned not to make. Gelman (2004) found that children around age five believe that if a French baby is raised by English-speaking parents, it will nonetheless speak French when it grows up. Similarly, it was found that although Indian adults did not believe this to be so, Indian children believed a Brahmin infant would remain a Brahmin, even if it was bought up by Dalits ("untouchables").

This intuitive belief that living kinds possess an unchangeable hidden essence may not even be uniquely human. The study of Philips, Shankar, and Santos (2010) presented rhesus monkeys with food that had the exterior shell of one fruit (e.g. a coconut shell), but was filled with the insides of another, different kind of fruit. They found that the monkeys would spend significantly more time in the feeding area when presented with the composite fruit than when given the whole unaltered fruit alone.[19]

When it comes to comprehensive experimental evidence to support the postulated intuitive assumptions of the biological domain in China (for example, similar studies about kind-specific essentialism among Chinese children), there still remains a dearth of comprehensive research (De Cruz and De Smelt 2007). However, a recent study by Legare, Zhu, and Wellman (2013) investigated Chinese children's understanding of contamination and illness. Intuitive biological explanation often depends on the attribution of causal relations with unobservable entities and processes (such as germs and pollutants). Our intuitive understanding of contamination can be illustrated by a layman's perspective, such as contact between a contaminated substance and an object such as a drinking vessel, making it untouchable and offensive (Fallon et al. 1984). Legare, Zhu and, Wellman found responses from children in Beijing in China consistent with findings from other cultural contexts (see Hejmadi et al. 2004; Raman and Gelman 2004, for US and India), including those concerning children in Japan (Inagaki and Hatano 2002, 2004, 2006). Although the specific kinds of substance, process, or contact considered to be polluting or contaminating vary with cultural context, the sensitivity to contamination itself based on physical causality is probably universal (Hejmadi et al. 2004, Raman and Gelman 2004, Rozin et al. 1985).

Similarly, children's expectation of being able to treat, prevent, and explain illness is also probably universal (Rozin 1996). A study conducted in Hong Kong found this held true for Chinese children's conceptions of illness (Au et al. 2008). In another study (Au and Romo 1999) with children aged five to 13 years from Hong Kong, children were asked to explain how more germs had entered wrapped-up food left on a table overnight. Most children explained these

[19]Here, Philips, Shankar, and Santos (2010) concluded that the extra time spent in the act of feeding indicated the monkeys' puzzlement at the fruit's failure to conform to its expected essence.

additional germs as having entered the food through cracks in the dish or air holes rather than having multiplied inside the package by themselves. Interestingly, they chose to attribute an explanation of animacy (bugs and germs are animate and move around) rather than a biological one (bugs and germs reproduce). A similar study has replicated this finding for American children (Garro 1988). It has been suggested that across cultures, children explain causal links among causes, symptoms, and treatments of illnesses, such as hypertension, cancer, and gastrointestinal issues, through similar naïve mechanics (Au et al. 2009).

This shortage of experimental evidence in China applies also to intuitive assumptions of other ontological domains. However, recently there has been an increase in cross-cultural studies of theory-of-mind (ToM) considering children of Western populations and China. Acknowledging significant differences in linguistic, historical, and cultural backgrounds has proven important for establishing similarities and differences in ToM development between populations, and especially for comparing children raised in China and in America. Experimental research has revealed that early ToM development has a similar trajectory in these and other cultural contexts (Wellman, Cross, and Watson 2001), and it has also been found that false-belief understanding in particular has a very similar developmental trajectory in America and China (Lane et al. 2013; Liu et al. 2008; Tardif, Wellman, and Cheung, 2004). However, studies have also concluded that although there are similarities between these cultures in emergence timing, there are also differences dependent on divergent sociocultural contexts (Wellman, Fang, Liu, Zhu, and Liu 2006), such as social disengagement (Lane et al. 2013).

1.5 Factors, confounds, and limitations

The aim of this section is to identify all factors for a model of cultural transmission, to the extent that without the inclusion of these factors a fuller understanding of the counterintuitiveness effect would be prey to confound. I evaluate the evidential justification for factors to be included in this model, and also point out the limitations of the current thesis and study design by identifying factors of further concern to MCI theory that are beyond the scope of this thesis.

1.5.1 Familiarity and signal detection theory

The importance and relation of familiarity to MCI theory should already be quite apparent. This is not the first MCI theory study to factor for the *familiarity* of stimuli. Boyer and Ramble (2001) first took a pretest measure of familiarity of their stimuli. Following their reading of the narrative story of Mr. Wurg's visit to the intergalactic museum, which contained the target stimuli, 18 pretest participants were issued these instructions: "The following sentences describe the different exhibits Mr. Wurg saw in the museum. Indicate whether each sentence describes an object or person that you have previously encountered either in reality or in film, stories, cartoons, and so forth". A mean survey score of familiarity was acquired for each of the stimuli. However, following the recall experiment, an additional analysis found no correlation between recall performance and these familiarity ratings.

Does an MCI concept that has been represented many times within the mind of an agent have the same salience, attention-grabbing ability, and memorability as an MCI idea that is uniquely novel and has never previously been entertained? Memory studies from declarative and recognition memory, such as free-recall experiments by Anaki and Bentin (2009) and Ingram et al. (2011), have shown that *familiar* concepts have a mnemonic advantage over ideas less frequently entertained. Similarly, other free-recall studies have shown that high-frequency words, such as "cat", are better recalled than low-frequency but known words such as "cloak" (Hall 1954, Sumby 1963). How successfully concepts are recalled also depends on the amount of time and the number of opportunities the agent has had to encode them (Baddeley 2009).

This effect of familiarity of memory has been modelled through the use of *Signal Detection Theory* (Green and Swets 1966, Ingram et al. 2011). Signal detection theory was originally developed from research in auditory perception (Green and Swets 1966) and has proved very useful in explaining recognition test findings (Tulving 1985, Baddeley 2009). Signal detection theory provides a way of thinking about recognition that comes with tools necessary to distinguish correctly encoded memories from guessing and judgement biases. It proposes that semantic units of memory have strength values that reflect their *activation level* (or "memory traces") in memory, which dictates how familiar they seem. According to signal detection theory, the higher-frequency and more familiar words that were significantly better recalled in the free-recall studies of Anaki and Bentin (2009) and Ingram et al. (2011) can be described as having a higher activation level that resulted directly from the increased frequency of entertainment of the concept (or, here, *sematic unit*). The activation level of these semantic units varies in its strength value, and its strength also depends on factors such as how many times the encoding process was repeated or the amount of attention received at encoding (Baddeley 2009). Therefore, according to signal detection theory, the activation level of semantic units of memory can range from the high activation level of frequently entertained concepts that received larger amounts of attention encoding to the low activation level of infrequently entertained concepts.

As the "familiarity" of concepts was a key component of Boyer's (2000, 2001) original formulation of the counterintuitive effect (see Section 1.1.4), given the shortage of empirical investigation regarding impact of familiarity on recall in the MCI literature, the inclusion of the schema-level effect of familiarity here as a factor is well motivated. The familiarity effect is not going to account for all the unexplained variance seen in MCI theory studies, and is only one schema-level effect on memorability amongst several to be identified that affect the transmission of cultural representations. Section 1.5.3 will identify these other schema-level effects included in the model in addition to familiarity.

1.5.2 *Familiar versus unfamiliar counterintuitive ideas*

At first glance, the epidemiological success of counterintuitive representations (those that are very familiar and integral to the day-to-day operations of a cultural group) might appear odd. We would be justified in believing that representations that are fully embedded in the workings of everyday lives, validated by everyone in the cultural group, and utterly commonplace would have no special salience. Whether your daily patterns are conducted in interaction with a living mountain, as for the Ayllu (Bastien 1978), or whether you live in a world created by an omnipotent Abrahamic god whose presence some believers locate in flowers, rivers, mountains, and even other people's eyes, such concepts might appear no more counterintuitive than the idea of "brother", "sister" or "rock". Theorising with regard to similar thoughts, Maurice Bloch (2005) made the entirely reasonable common-sense claim, in the absence of appropriate empirical research, that:

> Thus a representation, which a particular person might understand as counter-intuitive when they first come across it, out of the blue, so to speak, clearly does not have the same cognitive significance as it does when it has become totally familiar, and has been held as valid by oneself and everybody else around for as long as anyone can remember (2005: 114).

In this statement, poignantly, Bloch claims that familiar counterintuitive representations do not possess the "cognitive significance" of novel and unfamiliar counterintuitive representations. To demonstrate his point, Bloch uses the example of Malagasy perceptions of organ theft and probable witchcraft by Europeans that has been popularised and repeatedly communicated through reliable sources, Bloch writes: "the first time one hears such a story…one treats it as odd, but then, subsequently, one hears this story so often that every time it comes up, it requires less and less critical attention; in the end, it becomes exactly *like* an unexamined intuitive belief, in that its hearsay aspect has been eroded" (2005: 106). Bloch is not alone in this claim regarding the reduction of culturally familiar counterintuitive concepts to being mnemonically comparative to intuitive kinds. While theorising about the implications of his new formulation for his alternative account of counterintuitive effect, Upal asserts his agreement with Bloch's proposition: “the answer I believe lies in acknowledging Bloch’s criticism that MCI ideas do indeed lose their privileged status and do not have any memorability advantages once they become established as part of a culture” (2010: 200). Even McCauley’s (2000) distinction also shows why such an assumption might be credible: Bloch refers to intuitiveness deriving from practiced naturalness, whereas counterintuitive concepts cannot derive from maturational naturalness.

To assert that something “clearly does not have the same cognitive significance” (Bloch 2005: 114) in the absence of the appropriate experimental evidence is very bold. Given the empirical support for the familiarity effect, outlined in Section 1.5.1, this bold assertion could turn out to be quite incorrect. Even though preliminary reasoning appears to justify that such a familiar concept would have no cognitive salience to agents of a cultural group, there remains pressure upon us as researchers to provide an account for how such seemingly routine concepts can enjoy such cultural proliferation. Given the theoretical background detailed in the previous sections, a hypothesis counter to that of Bloch and Upal would predict that an interaction of the schema-level effect of familiarity and the template-level effect of counterintuitiveness could be accountable for this epidemiological success. This hypothesised mnemonic effect would be comparable in kind and interaction to the synthesis of the schema-level effect of mental imagery and the template-level violation found for the memorability advantages of high-imagery counterintuitive stimuli (Sloan et al. 2007), and also for concepts that are both humorous and counterintuitive (Purzycki 2010, 2011), reported to have the memorability advantages over concepts of template-level violation alone (see Sections 1.5.3.2 and 1.5.3.3, respectively, for further details). “Cognition” has deep and potentially misleading roots, if what we rely on is *a priori* reasoning about the very limited aspects of what we have conscious access to.

1.5.3 *Schema-level effects on memorability*

Putting template-level mnemonic considerations aside, consider the concept WOODEN TABLE. We are very familiar with this concept, having entertained it many times during our lives (see Section 1.5.1 for the *familiarity effect*). Now consider less frequently entertained concepts such as BLOODY PICK-AXE or ATOM BOMB. Given the stark difference in their psychological impact, could these latter ideas be more memorable? Are there other schema-level mnemonic factors that also effect memorability? Perhaps the quantity of thoughts and inferences that result from entertaining such provocative ideas? Or the idea's emotional significance to the entertainer?

A *schema* is a hierarchical *a posteriori* knowledge structure (derived from experience and subject to intuitive hierarchical organisation) that concerns the reflective associated information with the concept, including exceptions and exclusions of objects of its reference, emotional content associated with the concept gained through personal experience, and other visual memories and information (D'Andrade 1992, 1995; Brewer 2000). *Schema-level effects* on memorability are acquired through particular experiences as well as one's entertaining a concept in differing contexts. This section attempts to identify empirically justified schema-level effects that affect the memorability of ideas. To exclude a schema-level effect that significantly affects the memorability and recall of a representation into a model of cultural transmission could lead to powerful unexplained recall biases amongst the unbalanced stimuli, and hence have a confounding effect on our investigation of the counterintuitive effect. The schema-level effect of familiarity has already been identified and described in Section 1.5.1 as belonging to this group. The same is true when we conflate schema-level effects into one category, especially when the individual schema-level effects of which the category is composed have differential mnemonic effects. This could be the case in regard to Boyer's proposition of *inferential potential*. Boyer (2000, 2001), in his formation of the counterintuitive effect, proposed that the average MCI concept, in comparison with the average concept that adheres to its domain-specific intuitive assumptions (INT), is better able to generate thoughts, predictions, mental imagery and other inferences when entertained by the average person. He termed this greater-than-normal thought-provoking ability of MCI concepts as "inferential potential". Boyer postulated that ideas' inferential potential would vary considerably among ideas (he did not regard MCI ideas alone, but also INT ideas). He hypothesised that the number of thoughts, theories and other personal contextual associations triggered by one's entertaining the MCI concept would affect its memorability: the higher the inferential potential, the greater the mnemonic value; the lower the inferential potential, the lesser the mnemonic value. Consider the example "a marrow that eats people": interesting, no? Now, consider "a marrow with no spatial location": not so interesting. Whereas the first example triggered mental imagery of a large marrow possibly chasing after people, the second example was very difficult to visualise. It was possible that you wondered about the intentions and behaviours of this man-eating marrow: does it stalk its prey? Is it an ambush predator? It could also have had comedic value, or reminded you of some silly film about killer vegetables you had seen. The second example, at its most interesting, which is not very, could have led you to consider a marrow that is nowhere.

Gregory and Barrett (2009) provided the first MCI study to control for the mnemonic effect of inferential potential on the free recall of stimuli. They recruited participants from the general Oxford public, from various socioeconomic backgrounds. Participants' ages ranged from 17 to 61 years of age, with a mean age of 28.6 years (N = 49). Stimuli were presented onscreen in the form of a randomised sequence and uniform timed order of subject-predicate statements (e.g. "a *Y* that is *X*"). These sequences contained 24 stimuli: 12 minimally counterintuitive (MCI) stimuli, and 12 stimuli consistent with domain-specific intuitive assumptions (INT). In a pretest, all stimuli were rated on a five-point Likert scale, anchored by "thought provoking" at number 5 and "boring" at number 1. Participants recalled what they remembered from stimuli immediately following a three-minute distractor task and again after a one-week delay. In addition to hypothesising recall advantages for MCI stimuli over INT stimuli, consistent with Boyer's (2000, 2001) hypothesis, Gregory and Barrett (2009) also predicted that stimuli of higher inferential potential would be better recalled than stimuli of low inferential potential. Analyses revealed a significant relationship between inferential potential and the recall rate of stimuli. Stimuli of higher inferential potential were significantly better recalled in both the immediate period of recall and after the one-week delay, supporting Boyer's hypothesis. However, when we consider recent evidence compiled from other MCI studies that have already begun to consider how differing schema-level effects and counterintuitiveness interact (e.g. Purzycki 2009; Sloan et al. 2007), it now appears that Boyer's "inferential potential" is possibly several conflated schema-level effects. The ease with which a concept can be pictured in the mind's eye (mental imagery) has been found in free-recall studies to promote mnemonic advantages (e.g. Paivio 1990, Sloan et al. 2007), as has a higher level of associated emotional valence when a concept is entertained (especially negative emotion valence; e.g. Doerksen and Shimamura 2001, Kensinger and Corkin 2003). The current definition of "inferential potential" includes both schema-level effects of mental imagery and emotional valence. All concepts possess a level of mental imagery and a level of emotional valence. However, large variation in the levels of emotional valence compared with the level of mental imagery that can occur for a particular concept. It is possible that two different concepts can be exemplars of both extremes of the range for emotional valence and mental imagery. For example, consider, the differences in the range of emotional valence compared with the range of mental imagery that occur between the previous example of a marrow and eats people (high emotional valence; low mental imagery), and a marrow on a supermarket shelf (low emotional valence; high mental imagery). To conflate several schema-level effects each with potentially differing influences on the memorability of a concept into a single category of "inferential potential" could confound a model. Further experimental studies exist to show that there might be several better defined schema-level effects that affect the memorability of concepts currently packed into Boyer's "inferential potential". I propose that these individuated schema-level effects on memorability are: *imagery* (e.g. Naine et al. 2013; Sloan et al. 2007); *humour* (e.g. Purzycki 2010, 2011; Schmidt

2002); and the associated valence of *emotion* (e.g. Kensinger and Corkin 2003; Naine et al. 2013), especially of *negative* emotional stimuli (e.g. Baumeister et al. 2001; Rozin and Royzman 2001). The following sections consider each of these schema-level effects individually (including a revised *inferential potential* under the proxy of "interest") and review their empirical contributions and my motivations including them in this model.

1.5.3.1 Positive and negative emotion

One of the most common frameworks in the study of emotion proposes that affective experiences are best characterized by two main dimensions: valence and arousal. The dimension of valence ranges from highly positive to highly negative, whereas the dimension of arousal ranges from calming or soothing to exciting or agitating (Russell 1980; Lang et al. 1993). Most studies so far have focused on arousal as the critical factor in determining the effects of emotion on memory, but a growing body of research is dedicated to ways emotional valence affects memory (Cahill and McGaugh 1995). It has been claimed that research into positive and negative emotional valence is an essential step towards a more complete understanding of the effects of emotion on memory, and, by extension, its effects on transmission (Kensinger 2004). However, several experimental studies have shown that when determining appropriate stimuli it is very difficult to separate arousal from emotional valence effects (i.e. to choose arousing items that have a neutral valence) (e.g. Kensinger 2004; Kensinger and Corkin 2003). Taboo items have commonly been used as stimuli as they are suggested to be typically arousing (Kensinger 2004; Kensinger and Corkin 2003; Ochsner 2000). Although it seems possible to have items with emotional valence that are not arousing (e.g. sorrow), it appears much more difficult to locate taboo items to which we do not have positive or negative responses (e.g. murder). There is also evidence to show a strong relationship between arousal and emotional valence in general (see Kensinger 2004; Kensinger and Corkin 2003). For these reasons, for the purpose of this study the dimensions of arousal and valence have been combined into the categories of *positive emotion* and *negative emotion*—as has been the case with many of the studies referenced below.

Substantial empirical evidence suggests that the emotional response associated with a concept or experience has a large impact on its memorability. Emotional narratives are remembered better than comparable neutral narratives (Laney et al. 2004, Heuer and Reisberg 1990, Ochsner 2000), and emotional words are remembered better than neutral words (Doerksen and Shimamura 2001, Kensinger and Corkin 2003, Kleinsmith and Kaplan 1963, Sharot and Phelps 2004). A number of studies have shown that over time, memory for neutral stimuli decreases but memory for stimuli with emotional association remains the same or improves (Baddeley 1982; Kleinsmith and Kaplan 1963). Other studies have found a mnemonic advantage for emotional stimuli only in the delayed testing period, not in the period immediately after exposure to stimuli (Heuer and Reisberg 1990; Kleinsmith and Kaplan 1963; Sharot and Phelps 2004). Other evidence suggests that negative stimuli have greater mnemonic advantages than positive stimuli and pack a greater "psychological punch" (Baumeister, Bratslavsky, Finkenauer, and Vohs 2001; Rozin and Royzman 2001).[20]

1.5.3.2 Imagery

Several successful and well-known memory techniques commonly used for remembering and recalling lists of words (e.g. "Method of Loci" and "Pegword") have historically been derived from the use of mental visualisation to better remember concepts or object words. For example, the ancient Greek "Method of Loci" is a technique that makes concepts more memorable by assigning an agent's mental visualisation of it to a spatial locality in the brain unique to that agent.

[20] Related research suggests that negative stimuli and prospects draw a disproportionate amount of attention and thought to themselves. This tendency is reflected in the phenomenon of loss aversion (Kahneman, Knetsch, and Thaler 1991; Kahneman and Tversky 1979); in the propensity for scowling faces to "pop out" of arrays of happy faces (Hansen and Hansen 1988; see also Dijksterhuis & Aarts 2003); and in the longer latency to name the colour of negative adjectives in a Stroop task (Pratto & John 1991).

A few empirical studies have shown that memorability is strongly correlated with a concept's imagery level, understood as the ease with which an agent can picture it in the mind's eye (Paivio 1990; Sloan et al. 2007). The impact of this schema-level effect on recall has already gained support in the MCI literature with regard to its interaction with template-level violations. Sloan et al. demonstrated that a concept's imagery level is an alternative to Boyer's proposition of inferential potential. They found that concepts that are high in imagery (e.g. "meowing furry cat") are "almost always" better recalled than concepts that are low in imagery (e.g. "loud yellow tendency") (2007: 361). Barrett and Nyhof also acknowledged the potential effect of mental imagery on recall. As a control precaution, they used independent groups of participants from each recall experiment to rate each stimulus on the basis of "how easy it is for you to form a vivid mental image of [it]" (2001: 78). Counterintuitive concepts were found to be significantly harder to form mental images of than intuitive stimuli (therefore, if anything, there would be a bias against the recall of counterintuitive stimuli). The significant findings of Sloan et al. with regard to the interaction of counterintuitiveness and imagery (template- and schema-level effects, respectively), motivate the inclusion of imagery in the model.

1.5.3.3 Humour

Several empirical studies have found that ideas are better remembered when they yield a humorous response (Purzycki 2010, 2011; Schmidt 1994; Schmidt and Williams 2001; Schmidt 2002). Schmidt (2002) investigated the effects of humorous cartoons on memory. Subjects better remembered humorous cartoons to a significant degree when compared with literal translations and "weird" cartoons, which were equally well remembered. Humorous cartoons were recalled at the expense of non-humorous cartoons. More relevant to MCI theory, Purzycki (2010) compared the performance of intuitive-humorous, intuitive-non-humorous, counterintuitive-humorous and counterintuitive-non-humorous concepts, to find that counterintuitive-humorous ideas were significantly better recalled than the other three categories. Purzycki (2010, 2011) also reported similar findings as to template-level and schema-level interaction.

While it is clear that one's "sense of humour" varies widely among individuals and groups, Sultanoff (2002) suggests that certain universal characteristics of humour make events more likely to be perceived as funny by the observer. Among these universal characteristics are the experiences of: incongruity; absurdity, ludicrousness, or ridiculousness; an unexpected future; a pleasant surprise; being startled; "getting it"; and emotional chaos remembered in retrospect (see Deckers and Kizer 1975; Deckers and Devine 1981; Suls 1972).

1.5.3.4 Inferential potential

From its earliest formulation (Boyer 1994), MCI theory has been subject to additions and refinements. Boyer himself (2001) later added the proposition of inferential potential to the theory. He intended inferential potential to refer to the potential of a concept or idea to generate explanations, predictions, and other inferences in a broad range of personal contexts, including imagery and emotional outputs. However, as has been argued in Section 1.5.3, new evidence suggests that inferential potential is itself a conflated proposition that is open to further refinement.

That said, Boyer's (2000, 2001) proposition of inferential potential will still be present in the models of this thesis under the proxy of "interest". The central defining aspect of inferential potential is its *thought provoking-ness*, and this element shall remain. This thesis conceives of inferential potential, or the proxy of "interest" (the term used in materials presented to participants in Experiment 2), as the inferences that result from entertaining an idea, in the form of theories or ideas that are both nonvisual and non-emotional in kind. The theoretical proposition of *semantic nets* might be a useful way to evaluate the extent of the inferential potential of a given representation (Carley 1993, 1994). We can think about semantic nets as a network connecting *semantic units* (concepts, or "symbols"). Inferential potential then refers to the number of connections between semantic units in the network that are triggered when a concept (a public representation) is entertained. Boyer (2001) notes that not all MCI ideas hold the same inferential potential. The higher the inferential potential, the more connections the mind has forged among these semantic units; the lower the inferential potential, the fewer connections in the mind between semantic units. The relative degree of inferential potential tempers the general prediction that MCI concepts are more readily remembered and communicated than other concepts. People are less able to remember an MCI idea with low inferential potential. Let us entertain the idea of an undead monster that roams the mountains and eats hikers. Enough to set the mind racing, no? Now, let's compare the ideas of a tree that grants people's wishes (high inferential potential) and a tree that is intangible (low inferential potential). A tree that grants people's wishes generates more predictions, explanations, and other inferences in a broad range of contexts than does a tree that is intangible. If the tree can grant wishes, is it alive? Does the tree have thoughts and intentions? Is the tree a god? How many wishes can this tree grant? What would be the best wish to ask for? In comparison, the intangible tree triggers very few connections beyond what might follow from a layman's thinking of the location of nothing. Here, *inferential potential* refers only to the multiple connections to these different theories and ideas (network connections of semantic units), without regard to any positive or negative emotional valence (see Section 1.5.3.1), triggering of mental imagery (see Section 1.5.3.2), or humorous aspect (see Section 1.5.3.3).

1.5.4 Age effects in memory and cultural epidemiology

Given the preliminary age-related findings of Gregory and Barrett (2009) and Hornbeck and Barrett (forthcoming), failure to consider the complete range of the age demographic within a population could lead to confounded results. Gregory and Barrett's additional analyses found that findings for the counterintuitiveness effect only held in the younger adults in the sample (under 25 years of age), and not for the older adults in the sample (25 years of age and above), for whom a reversal of the counterintuitive effect was revealed, due to a recall advantage of stimuli consistent with domain-specific intuitive assumptions (INT) over minimally counterintuitive (MCI) stimuli in this older age group. Given that this age-effect replicates in future studies, it is easy to see how the predominant use of university students subjects (who straddle this threshold of 25 years of age) explains the mixed findings of several MCI studies (e.g. Gonce et al. 2006; Norenzayan et al. 2006; Tweney et al. 2006). It would seem a sample with a more representative age demographic is of utmost importance. These preliminary studies point toward the possibility of a sensitive window early in our lives in which we are more freely able to grasp, are better able to remember, and are more willing to communicate MCI concepts. It is relevant here to reiterate that MCI ideas are not always religious in kind. MCI representations have been found in secular historical texts (Lisdorf 2004) and folktales and children's stories (Barrett and Nyhof 2001; Barrett, Reed-Burdett and Porter 2009; Norenzayan et al. 2006), and contained in more general acts of communication such as commercial advertisements (Upal 2007, 2011b). However, I am comfortable with referring to MCI representations as *religious-type* representations, especially when the material of concern is the communication acts of children prior to formal religious instruction. To extrapolate the age-related findings in studies by Gregory and Barrett (2009) and by Hornbeck and Barrett (forthcoming) with respect to the cultural epidemiological framework of cognitive anthropology that attempts to model the transmission of these religious-type representations, we can ask, Do younger persons remember more counterintuitive cultural ideas, and are therefore more likely to transmit them, than older persons within the population? The answers to this age-specific question might radically affect our understanding of the role children and adolescents play in the distribution of cultural representations in all cultures, and point towards future research to clarify and attribute the significantly different roles adults and children play in the introduction, spread, and maintenance of religious ideas in our cultures.

The impact of age on memory, and more specifically that of age on the recall of concepts due to the deterioration of declarative memory as we get older, has been well documented in laboratory tests of free recall and cued recall of lists of words (e.g. Guttentag 1985; Howe 1988; Hultsch, Masson and Small 1991). Whereas semantic memory actually appears to improve with age (Nilsson 2003; Verhaeghen 2003)—usefully attributed to the enlargement of our vocabularies generally as we age—episodic memory, which plays a key role in retrieving memories due to the utilisation of temporal cues in recall, also degrades in quality over a person's lifetime (Kahana et al. 2002, Light 1991, Nilsson 2003). Potential theoretical explanations for the impact of age on the memorability of counterintuitive concepts emerge from research on the decrease in how much information our short-term working memory can hold as we age. The effect the limited capacity of working memory has on the encoding and subsequent retrieval of items was originally demonstrated in the seminal paper, "The magical number seven, plus or minus two" (Miller 1956). The subsequent related area of research that came to be known as cognitive load theory (Sweller 1988, 1994) grew to encompass wider aspects of the functionality of cognition that limit memorability. More recently, several studies have reported the degradation of our working memory as we get older, due to a reduction in capacity (Hultsch, Hertzog, Dixon, and Small 1998; Salthouse and Babcock 1991; Van Gerven et al. 2000, 2002; Wingfield, Stine, Lahar, and Aberdeen 1988) and due to overall decreases in processing speed (Chaytor and Schmitter-Edgecombe 2004; Cerella 1990; Fisk and Warr 1996; Salthouse 1993, 1996), thereby limiting the amount and potentially the type of information that the brains of older persons can encode into constructs and store. Good evidence shows that counterintuitive concepts make more demands on working memory resources than do commonplace concepts consistent with our domain-specific intuitive assumptions (INT). Although indirect, the impact on cognitive load due to the recall of counterintuitive stimuli has been reported, illustrated by the poor mnemonic performance of counterintuitive stimuli with more than one counterintuitive property, known, problematically, [21] as maximally

[21] It is unclear, if at all possible to determine exactly, where the "maximum" level of counterintuitiveness lies. At best current estimates, given the available empirical evidence, the "cognitive optimum" for

counterintuitive (MXCI) concepts (e.g. a rabbit that sings opera, is invisible on Tuesdays, and gives birth to tiger cubs). MXCI stimuli also have poor mnemonic performance when compared with MCI stimuli (which have only one counterintuitive modifying property), as well as with commonplace INT concepts with a single conceptual modifier (Banerjee, Haque and Spelke 2013; Barrett and Nyhof 2001; Johnson, Kelly and Bishop 2009; Norenzayan et al. 2006; Upal et al. 2007). Therefore, the greater demand that MCI ideas place on cognitive resources than do commonplace INT concepts with a comparable number of conceptual modifiers makes encoding MCI concepts into constructs and storing them less viable in older adults with degraded working memory capabilities. To fully appreciate the content of this thesis, one must take care not to confuse or conflate psychological research on memory systems with that of research within the cultural epidemiology framework of cognitive anthropology. In light of age-related findings in the recall of MCI representations (Gregory and Barrett 2009; Hornbeck and Barrett, forthcoming), which is here shown to be supported by psychological experimental research on the degradation of working-memory functionality with age (e.g. Chaytor and Schmitter-Edgecombe 2004; Van Gerven et al. 2000, 2002), and in conjunction with prior evidence for the greater cognitive demands of MCI concepts over INT concepts (e.g. Banerjee, Haque, and Spelke 2013; Johnson, Kelly, and Bishop 2009), we can deduce that the amount of information persons of different ages are able to encode into constructs and store has a relationship with the types and quantities of concepts (with differing template-level characteristics) persons of differing ages are able to transmit. This explanation and formulation for the *MCI age-effect* has the potential to increase the complexity of our understanding of the epidemiology of cultural representations. It supports the idea that a relationship between age and cognitive load can at least partly account for differences among persons of varying ages in the ability to recall counterintuitive ideas. Furthermore, it has the potential to predict and

number of counterintuitive elements a representation should have for an optimum transmission advantage lies between 1 and 2 violations of intuitive assumption (e.g. "an invisible cat" would have one counterintuitive element; "an invisible cat that writes science-fiction screenplays" would be a concept with two counterintuitive elements), either by breach or transfer of expectation set (Banerjee, Haque & Spelke 2013; Barrett and Nyhof 2001; Barrett, Reed-Burdett, and Porter 2009; Johnson, Kelly and Bishop 2010).

explain the differential transmission rates of counterintuitive ideas by persons of different ages. Accordingly, a number of new, exciting hypotheses may arise. For example, we might infer that the variation of cultural representations within the distribution of a cultural group has a direct relationship with the cultural group's age demographic—the younger the mean age of the population, the greater the ratio of MCI representations to INT representations for a cultural group. However, this higher ratio of MCI representations to INT representations could become manifest in many different ways for a society with a lower mean-age demographic, perhaps explaining, for example, the proliferation of ideas concerning witchcraft, oracles, and magic for particular cultural distributions (e.g. the Azande people of north central Africa; see Evans-Pritchard 1976).

1.5.5 Hypersensitive agency detection device x counterintuitiveness

Guthrie (1993), Boyer (2001), and Barrett (2000, 2004a) have hypothesised that a psychological mechanism hypersensitive to agency detection would be adaptive since having a strong perceptual bias toward interpreting ambiguous events as having been caused by an agent makes it far less likely that our ancestors would have been killed by predators. It would have been far less costly for our ancestors to perceive too many agents in their environments than too few. (See also H. C. Barrett 2005.) The cognitive science of religion community sees in the interaction of the counterintuitive effect and the *hypersensitive agency detection device* (HADD), with its oversensitivity to the presence of unseen agents, an explanation for the universal proliferation of god and deity concepts. Supernatural agents are reported to be a recurrent universal of world religions (Brown 1991) and the primary defining factor of religion (Atran 2002; Barrett 2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and Honkela 2003). This important theoretical proposition has not previously been experimentally investigated.

Humans are hardwired to distinguish things in our environment that are alive from those that are not alive. Human babies can distinguish faces from the surrounding environment and imitate the expression of the gazer less than a day after birth (Meltzoff and Moore 1983, 1989, 1992, 1994). At as early as four months of age, infants can distinguish between animate and inanimate objects in important ways. They recognize that animate agents are self-propelled, whereas inanimate objects move only after contact with another object that has force (Poulin-Doubois, Lapage, and Ferland 1996; Rakison and Poulin-Doubis 2001; Spelke, Phillips and Woodward 1995), and while infants will imitate the actions of a human figure, they will not imitate the movements of an inanimate object (Meltzoff 1995). Infants have intuitive expectations about the behavior of humans, such as for sociality and goal-directedness (Baldwin, Baird, Saylor, and Clark 2001; Carpenter, Aktar, and Tomasello 1998; D'Etremont, Hains, and Muir 1997; Phillips, Wellman, and Spelke 2002; Woodward 1998), and most of the time (correctly) do not attribute these qualities to inanimate objects. The intuitive assumption for humans to reason about objects differently from agents is well documented. Even as young children, we attribute an unseen life force or essence to agents (e.g. Bloom 2004; Hood 2009; Keil 1989; Sousa et al. 2002). For children objects are inert interchangeable things, but agents have a unique essence. For some children the attribution of agency to objects of the world is sufficiently hyperactive that they are able to attribute these domain-specific intuitive assumptions for human mentality to their favourite soft toy (a transfer of the mentality expectation set to a concept of SOLID OBJECTS) in child's play, or to an *imaginary friend* unseen by anyone else (see Section 1.3 for further details on children's creativity and imagination).

Under certain conditions humans of all ages interpret two-dimensional moving geometric shapes as having the goal-directed properties of animacy. This widely demonstrated effect with very simple visual displays that feature geometrical shapes devoid of the usual markers of agency, such as eyes or limbs, suggests that movement alone can be sufficient to ascribe goal-directedness, and thus agency, to an object (e.g. Michotte 1963). Scholl and Tremloulet (2000) have reviewed many studies dealing with the attribution of intentionality and animacy to visual displays. Barrett and Johnson's (2003) experiment consisted in having participants place ball bearings in divots on a board while providing a running commentary. At a specified time, the electromagnets under the board were surreptitiously activated, causing the metallic balls to move across the board and to collide with each other. Participants who lacked control over the movements of the ball bearings were significantly more likely to include attributions of agency in the descriptions of the objects' motion. Guthrie (1993) describes this human tendency to interpret ambiguous stimuli as having been produced by agents. Guthrie (1993) suggests that this perceptual bias is adaptive, in that it makes humans more wary in their interactions with the environment and therefore reduces the risk of unexpected encounters with predatory others. Understanding the intentions of agents and being oversensitive to their presence might have helped our ancestors to survive. There is a sound in the bushes. You spin around, attributing the noise to the presence of an agent. Most of the time it is just the wind. But this fast and frugal oversensitivity to the possible presence of agents may have saved your life: it is far better to locate and avoid imaginary predators at a low cost than be eaten by the real thing. Barrett (2000, 2004a) has tried to specify what the cognitive mechanisms that produce this perceptual bias might look like. Barrett has coined the term HADD (hypersensitive (in some earlier publications hyper*active*) agency detection device), which he characterizes in the following way: "When HADD perceives an object violating the intuitive assumptions for the movement of ordinary physical objects (such as moving on non-inertial paths, changing direction inexplicably, or launching itself from a standstill) and the object seems to be moving in a goal-directed manner, HADD detects agency" (2004a: 31). HADD can contribute to the *formation* of religious concepts in scenarios where the sensory information the person receives is of poor quality, leading him to identify the ambiguous or indeterminate object as an intentional agent (e.g. a ghost or spirit) or to attribute agency to objects integral to events in which the relationship between cause and effect is unclear or poorly understood (e.g. understanding a thunderstorm as product of a deity's will). In addition, HADD can *reinforce* religious concepts. For example, people who experience salient but surprising, unexpected, or extraordinary events (e.g. surviving a shipwreck or a serious illness) often report the presence of non-natural agency in their accounts of those events. Guthrie places this finding in the context of a broader theory of religion, in which "Gods or god consist in seeing the world as humanlike." Atran and Norenzayan also place this hyperactive propensity within an explanatory religious framework. They suggest "widespread counterfactual and counterintuitive beliefs in supernatural agents" can be explained by the fact that they "trigger our naturally selected agency-detection system, which is trip-wired to respond to fragmentary information, inciting perception of figures lurking in shadows and emotions of dread and awe" (2004: 714). Barrett (2004a) suggests:

> Part of the reason people believe in gods, ghosts and, goblins also comes from the way in which our minds, particularly our agency detection device (ADD) functions. Our ADD suffers from some hyperactivity, making it prone to find agents around us, including supernatural ones, given fairly modest evidence of their presence. This tendency encourages the generation and spread of god concepts. (31)

There is, however, virtually no available experimental evidence for the role of HADD in the acquisition and maintenance of religious concepts, or for the existence of dispositional or situational factors that may affect HADD's deployment. In isolation, HADD is not particularly relevant to the scientific exploration of religion. So, how do HADD experiences facilitate the transmission of religious agent concepts? It is HADD's interaction with the counterintuitive effect that has explanatory power for religious phenomena. A recent study has found evidence that remembering tends to overattribute towards animates. Nairne et al. (2013) demonstrated that words for animates were significantly better recalled than words for inanimates, even when all things were equal along other mnemonically relevant dimensions (e.g. imagery, familiarity, and semantic coherence). This relationship of HADD with memorability opens up opportunities to test a hypothesis. The interaction of HADD x counterintuitiveness is the explanatory tool, not just for the mnemonic advantages of religious agent concepts, but also for the ubiquity of supernatural agency concepts in world religions. This is a central tenet of the cognitive science of religion. It has never previously been experimentally investigated. This as a topic is in particularity urgent need of evidential support.

1.5.6 Written versus oral transmission of materials

Prior to the arrival of written symbols, the cultural transmission of stories and folktales has been dominated by the oral mode of transmission, whether by means of epic, ballad, or counting-out rhyme (Rubin 1995). Ong describes the different relationship between memory and recall in a primarily oral culture:

> In a primary oral culture, to solve effectively the problem of retaining and retrieving carefully articulated thought, you have to do your thinking in mnemonic patterns, shaped for ready oral recurrence. Your thought must come into being in heavily rhythmic, balanced patterns, in repetitions or antitheses, in alliterations and assonances, in epithetic and other formulatory expressions, in standard thematic settings… in proverbs which are constantly heard by everyone so that they come to mind readily and which themselves are patterned for retention and ready recall, or in other mnemonic form. (1982: 34)

Various studies have looked at the changing relationships between oral and written communication when societies from different historical periods move from a primarily oral culture with limited use of written materials to a "document-minded" culture (Thomas 1989: 36). These document-minded cultures have been described as having a different "literate mentality" (Clanchy 1979). Other studies concern the changes imposed by the increased use of printing technology (e.g. Eisenstein 1979; Kernan 1987; McLuhan 1962). It has been inferred from observations of the characteristics of document-minded societies, and characteristics found primarily within oral contexts, that written texts are often primarily used as mnemonic aids rather than as works of reference (e.g. Person 1993). Claiming that oral and written language affect human memory differently, Hildyard and Olson report:

> In oral language, the point, intention or significance of the language, the "speaker's meaning" is preserved in the mind of the listener; as the actual words, syntax, and intonation are ephemeral, they are rapidly exchanged for those interpreted meanings which can be preserved. In written

> language, the words and syntax, the "sentence meaning," is preserved by the artifact of writing, and mental recall becomes the precise reproduction of that artifact. (1982: 20)

The suggestion is that in a culture of primarily oral language, written documents function as mnemonic aids to the "speaker's meaning" (e.g. Grice 1989). In contrast, in a document-minded culture, written documents serve as a lasting reference to the "actual" words themselves. Are these purported differences relative to cultural artifacts of traditional societies versus modern "document-minded" societies? Will these differences in the memorability of oral versus written language exist in large contemporary world societies? Recruiting participants from contemporary America, the free-recall experiment of Brimer and Mueller (1979) found no significant differences for recall rates of sequences of written and oral items, which also incorporated words and pictures as stimuli. No investigation of these potentially differing oral versus written modes of transmission has previously been considered specifically for materials containing concepts with template-level violations. Exploring memorability advantages for written versus oral ideas may help us to understand transmission biases in communicating folktales, many of which have counterintuitive concepts (Barrett and Nyhof 2001; Barrett, Reed-Burdett and Porter 2009; Norenzayan et al. 2006). This exploration might also cast light on transmission biases for traditional stories (and other materials) in current "document-minded" societies and point toward differences in transmission biases for epics, ballads, and counting-out rhymes in prehistoric societies.

1.5.7 Analogical reasoning

The study of Norenzayan et al. (2006) provides a commendable contribution to MCI theory, but could also be used to demonstrate not only the power of analogical and metaphorical reasoning as a confounding effect but also the importance of the distinction between *public representations* and *private representations* (Sperber 1996). These notions are very relevant to MCI studies and other experiments where the strict conceptual reference of stimuli is crucial, or confounding effects can otherwise result. To ensure the strict reference of a stimulus (the object in the world that the utterance or communication act refers to), confidence must exist that the public representation (stimulus; utterance or communication act), evokes in all participants a similar private representation (the concept encoded in the mind of the recipient when entertaining the utterance or communication act). To be appropriate for an MCIC study, a stimulus must have a shared meaning for all participants who receive it. Most MCI studies present strange-type ideas (possibly even concepts that no one has ever entertained) to participants in the guise of stimuli. This can be problematic for these studies, as the flexible minds of most people presented a context-poor communication act will seek relevance and economy of meaning (Sperber and Wilson 1986), which can lead to deviations from the author's intended meaning. For example, Norenzayan et al. (2006) presented the stimulus "thirsty door" to study participants, with the intent to evoke a template-level violation of DOOR due to the transfer of the biological intuitive expectation set—an MCI concept. But "thirsty door" may not evoke a similar private counterintuitive representation in all participants, but rather a private representation of a door that requires paint, or is especially dry and will readily soak up water. The resulting polysemy provides a potent confound. What the researchers intended in their communication act to represent an MCI concept in the minds of the participants now merely represents a commonplace intuitive concept.[22] Such free-recall experiments must use robust pretesting methodology to generate and select stimuli to be used in the study so as to guarantee the strictness of reference of stimuli and to avoid the confound of polysemy described above. This robust pretesting methodology has not always been present in previous MCI studies.

[22] Unfortunately for Norenzayan et al. (2006), this "thirsty door" stimulus was not the only victim of this potentially confounding effect—there were other ambiguous stimuli that could easily lead to analogical reasoning and thus polysemy (e.g. "sobbing oak", "confused table", etc.). In addition, the "rigorous matching" methodology for stimuli by Norenzayan et al. (e.g. "Closing Door, Thirsty Door, Thirsty Cat, Closing Cat") most probably served only to provide a further vehicle for participants to create analogies and metaphors (2006: 537).

1.5.8 *Item-centric versus context-dependent transmission*

Section 1.2 covers past research conducted by researchers on both sides of this debate. Some authors (Gonce et al. 2006; Upal et al. 2007, 2010) have suggested that simple grammatical structures, lacking the context provided by a narrative, are insufficient to communicate MCI concepts and provide memorability advantages for them over concepts consistent with domain-specific intuitive assumptions. Three steps that establish common ground should shut down this debate:

(1) Recognizing the mechanisms and effect by which metaphor and analogical reasoning can shape the meaning of a public representation (as covered in the previous section). Reaching agreement on the operations of these mechanisms and the establishing of appropriate quantitative measures for them would greatly benefit the investigation of mnemonic biases that affect cultural distributions of representations by providing the means to control for a potentially confounding effect.

(2) Clarifying a common scheme for understanding the role that contextual information the public representation is entertained in has to shape private representations. Both the contextual information prior to and after entertaining the public representation must be considered, for both the actor and receiver entertaining speech acts, and also in entertaining written materials and sensory experience.

(3) Establishing the basis for the cognitive locality of the semantic information responsible for the counterintuitive effect—about which Upal (2010) is quite vague and reluctant to be precise due to the nature of his argument. This is not to say the *neural locality* of the effect, but the identification of the conceptual and memory components that constitute the mnemonic advantage (however, this final point is of lesser importance than the first two, and is also largely beyond the scope of this thesis, as in itself it bears no consequence to understanding the counterintuitive effect, or the transmission of cultural representations).

The foregoing conclusion reveals that the premise of this debate is unfounded. In the main, both parties in this debate already consider the important factors identified above. However, both parties do appear to talk past each other using slightly different language and concepts with regard to the same mechanisms. Previous studies that have failed to observe the potentially confounding effects contained in the above points have suffered due to this weaker approach: for example, the polysemous stimuli of Norenzayan et al. (2006).

Upal's (2010) formulation of a context-based alternative account of the counterintuitiveness effect is misleading due to explication of the counterintuitive effect as the violation of expected schemata (or as what could be termed "neo-distinctiveness effect"). Upal has a well-founded framework in regard to modelling the role of context in determining meaning, but it is ultimately ineffectual, as no one on either side of the debate would sensibly deny the role of contextual narrative materials in shaping the private representation of a public representation (Sperber 1996; see Section 1.5.7). Indeed, as illustrated by Maurice Bloch's discussion of indeterminacies of ethnographical accounts and translations as problematic when identifying counterintuitive elements, Bloch recognises that Sperber and Boyer do take into account the importance of context in establishing the meaning of counterintuitive representations and other cultural ideas, and supports their key point that "before we consider the rationality, or otherwise, of representations we need to grasp how they are meant to be understood in real situations" (2005: 105-07). Bloch also argues that many "belief-type" statements have been wrongly mistaken by ethnographers and others to be straightforward affirmations about how the world is; for example, the famous Nuer assertion that "Twins are birds" (Evans-Pritchard 1956: 77), and "we are red Macaws" (Crocker 1985). Tweney et al. (2006), who identify with the context-based approach, aimed to show how a counterintuitive concept could be transformed into an intuitive concept, or an intuitive concept into a counterintuitive concept, by the prior and posterior context it is surrounded by, with what they refer to as *predictability* and *postdictability.* They provided the example of the public representation of "flying cow", which at first appears to be a minimally counterintuitive concept: "I had just woken up and gone to the kitchen to make some coffee" said the farmer. "That's when I saw the *flying cow*. The twister had lifted the 500 pound creature well over 50 feet above the ground" (2006: 486). However, it is apparent that this is nothing specific to the counterintuitive effect, or to MCI theory, but to an understanding of the role of context in shaping private representations in any contextual scenario. It should be noted that the potentially metaphorical use of language in this example ("flying cow") and the indeterminacies of the reference of this statement lead easily to polysemy. However, to see a cow suspended in mid-air, whether or not you can establish a schema for the natural laws and forces that explain its current state of being, debate still remains as to whether such an event is counterintuitive. This can be resolved only by further empirical exploration.

With the appropriate robust means of pretesting stimuli to control for the confounding effect of analogical reasoning, the present study aims to show that this debate is unfounded by use of a comparison between two experimental conditions: first, the presentation of stimuli in a *minimal condition* in the form of a subject-predicate statement, and second, an *elaborated condition* of stimuli presentation for that additional descriptive contextual material that is added to the original statement (while still retaining meaning within uniform grammatical constraints). No differences are predicted for the findings from the recall of stimuli between these two conditions.

1.5.9 Why are MCI concepts a minority of cultural representations?

This section presents a question that remains to be answered by further MCI studies, but could draw some direction from the age-related analyses in this thesis. Intuitive concepts (INT), which violate no template-level intuitive assumptions about the properties of a particular thing, have been reported to be the most widely spread and proliferous cultural representations (Barrett 2004b; Norenzayan 2006). However, given the recall success of representations that violate our template-level intuitive assumptions reported in previous memorability studies, researchers have demanded explanations for why MCI ideas are not the most widely distributed variety (e.g. Atran and Norenzayan 2004; Tweney et al. 2006). Norenzayan et al. (2006) hypothesised that the small proportion of MCI concepts contained within a narrative with a larger proportion of INT concepts was the unit of mnemonic advantage: cognitive optimality at the narrative level. This explains the higher proportion of INT concepts in the cultural environment. Although Norenzayan et al. (2006) admirably attempted to provide experimental evidence for this claim, due to a problematic experimental design, it is very difficult to interpret this memory experiment, as discussed in Section 1.5.7. Justin Barrett has suggested a simpler answer: "Intuitive concepts will always remain in the vast majority as long as (1) the things that people typically experience (like rocks and daisies) fit intuitive assumptions (which they seem to do); (2) intuitive assumptions serve as defaults for unknown properties, thereby producing intuitive concepts; and (3) conceptual load problems of reasoning with multiple counterintuitive concepts in any given contexts lead to those concepts degrading" (2004b: 732). One possible contribution this thesis could make towards this unanswered question could arise from its observations about the interaction of age and counterintuitiveness, in that older people do not remember many template-level violating representations.

1.6 Thesis outline

Further chapters in this thesis (to be detailed below) consist of a chapter detailing hypotheses and predictions, two chapters containing separate pretests, two chapters describing full-scale studies of free-recall experiments, a chapter that provides an additional analysis of all recorded data produced by participants, a chapter describing an additional experimental study that investigated template- and schema-level biases in authoring representations, and a concluding chapter.

Chapter 2 recapitulates and highlights the research questions and lists a series of hypotheses and predictions in regard to the template-level effect and the schema-level effects identified as promoting mnemonic advantage (and therefore greater potential for cultural distribution) for a given cultural representation, which include: familiarity (activation level) and other schema-level effects of positive and negative emotional valence, imagery, humour, and inferential potential. Hypotheses and predictions in regard to an age effect in the recall of counterintuitive stimuli, familiar counterintuitive ideas versus unfamiliar counterintuitive ideas, template-level preferences in the authorship of schema-level ideas (Study #2), the transmission advantages of supernatural agent concepts (Study #3), and the ecological validity of the stimuli and differential modes of transmission are also formulated. The main hypothesis and prediction is that, all other factors being equal, minimally counterintuitive (MCI) ideas will be better remembered and recalled than ideas consistent with domain-specific intuitive assumptions (INT)—a template-level effect.

Chapters 3 and 4 describe two independent pretests. The first aims to establish a robust and appropriate stimuli set, and the second aims to produce representative cultural norms for the amount of schema-level effects acting on each of the stimuli. Chapter 3 describes the methodology for the first pretest, resulting in the best fit of 32 stimuli from an original pool of 48 stimuli. As stimuli of previous studies in the area had suffered from ambiguity of reference and ease of analogical reasoning, rigorous methodology was applied to reduce the effect of this confound to a minimum. Resulting stimuli were the best-fit exemplars corresponding to four stimuli categories (eight stimuli in each) of: *familiar intuitive* (fINT), *unfamiliar intuitive* (uINT), *familiar counterintuitive* (fMCI), and *unfamiliar counterintuitive* (uMCI). Twenty participants in Oxford, UK, and again 20 participants in Beijing, China, completed a questionnaire to establish a score for how familiar (or how often entertained) each of the 48 stimuli was to each participant, with the aim to acquire a mean value for each stimulus from the sample, representative of the cultural group as a whole. The same participants then completed a task to establish if the stimuli's intended references were strict; any stimulus suffering polysemy due to analogical reasoning was discarded.

Chapter 4 reports the findings of the second pretest for which 40 participants in Oxford and 50 participants in Beijing surveyed each of the 32 stimuli according to how well they exemplified the schema-level effects of positive emotion, negative emotion, imagery, humour, and interest (a proxy for *inferential potential*). This experiment was preceded by a statement authorship and free-recall task in which the same participants, by completing the task, acquired an understanding of the five schema-level effects (positive emotion, negative emotion, imagery, humour, and interest) according to provided instructions. From this task they also learned to judge the level at which a concept exemplified these categories (or not) for themselves. (The experiment is reported in Chapter 8 as an additional stand-alone study that investigates template- and schema-level biases in the self-authorship of representations.)

Chapter 5 reports the results of two free-recall experiments of Study #1 that tested the main hypotheses and predictions. Experiment #1 concerned the *minimal condition* for presentation of stimuli, which entailed presenting each stimulus in the form of a grammatically uniform subject-predicate statement, in a written or oral mode of presentation. Three hundred and sixty-five participants completed this "memory task": 184 from sites in Oxfordshire and 181 participants from sites in Beijing, China. Ages ranged from 13 to 86 years. Participants were presented with 32 stimuli on a screen at 7-second intervals. Approximately half the sample was assigned to a written presentation of stimuli and the other half to an oral presentation of the same stimuli (in Mandarin language in China, and in English language in the UK) with identical timings. Participants were asked to recall the stimuli after completing a 3-minute distraction task and again following a one-week delay. A preliminary hierarchical linear model (HLM) of fixed factors detected a significant cross-cultural difference in recall rate. Consequently a split comparative analysis was conducted for the China and UK samples. A significant difference was found between the mean recall rates for counterintuitive and intuitive stimuli, from which subsequent investigation revealed a recall advantage of stimuli consistent with domain-specific intuitive assumptions (INT) over minimally counterintuitive (MCI) stimuli, in both cultural groups. A significant interaction of counterintuitiveness x age was discovered for both the cross-cultural samples, which upon further enquiry revealed that a greater ratio of MCI stimuli to INT stimuli was recalled by younger adults and adolescents than by older adults. In addition to a significant recall advantage found for stimuli that were culturally familiar and epidemiologically successful over those that were unfamiliar and poorly culturally distributed, an interaction of familiarity x counterintuitiveness was also discovered, revealed to be a recall advantage of familiar counterintuitive stimuli over unfamiliar counterintuitive and INT stimuli. This finding was also replicated cross-culturally. Apart from familiarity, no other schema-level effects were found to impact on the recall of counterintuitive or intuitive stimuli.

Experiment #2 concerned the second of the two free-recall experiments of Study #1. Stimuli were presented to participants in both the UK and China in a manner comparable to that of Experiment #1, but for this *elaborated condition* of stimuli presentation they were presented with stimuli centred on a subject-predicate statement, but surrounded with additional descriptive material that still adhered to a strict grammatical structure. Presentation timings for stimuli in this condition were extended to 12-second intervals. Younger children participated in this free-recall experiment; ages ranged from 3 years and 2 months to 82 years of age. A total of 399 participants completed this "memory task": 198 participants in the UK and 201 participants in China. Participants were again asked to recall the stimuli following a 3-minute distraction task and again after a one-week delay. The HLM model detected no significant cross-cultural difference in the recall of stimuli. Unlike the results of the minimal condition experiment (Experiment #1), Experiment #2 found support for the central hypothesis as participants recalled significantly more minimally counterintuitive (MCI) stimuli than stimuli consistent with domain-specific intuitive assumptions (INT). A significant interaction of counterintuitiveness x age was again observed, again revealed due to proportionally larger amounts of MCI stimuli recalled over INT stimuli in the younger age-range of the sample. This model also revealed an interaction of familiarity x counterintuitiveness from which contrasts revealed that familiar counterintuitive stimuli were better recalled by participants than unfamiliar counterintuitive stimuli and intuitive stimuli varieties. Other than the finding that the schema-level effect of familiarity was a significant predictor of stimuli recall rate, the schema-level effects of negative emotion, humour, and interest were also found to have a significant impact on the recall of stimuli. The findings of Experiments #1 and #2 suggest that under our current understanding of the counterintuitive effect, the theory has shortcomings and requires radical revision. The detection of the interaction of familiarity x counterintuitiveness in both studies would justify further research in this area, as well as of further schema-level and template-violation interactions. These age-related findings in both studies suggest that further research in the area should engage with the impact of age on the epidemiology of counterintuitive representations. The widening of the age-range to include young children (3 to 12 years of age) perhaps facilitated the discovery of a significant counterintuitiveness main effect. This age effect suggests that the continued widespread distribution of religious representations in world religions may be facilitated by the transmission of religious materials to the young. Further research might also shed light and provide a cognitive basis for the attention demand on children made by fantastical folktales and stories.

Chapter 6 describes the experiment in Study #2 that investigates template- and schema-level biases in the self-authorship of representations. (This experiment used the same participants as Pretest #2, and as a precursor to it, aimed to contribute to the understanding of the requirements for Pretest #2 for participants involved, as reported in Chapter 4.) Forty participants in the UK and 50 participants in China took part in a two-stage task. First, to determine the stimuli the participants were themselves to generate, the participants selected components for a total of 20 stimuli from predetermined adjective and noun listings. They were instructed to select an adjective plus noun combination to make ideas they personally considered to best exemplify the categories of positive emotion, negative emotion, ease of ability to see the idea in the mind’s eye (imagery), humour, and ideas they felt were interesting.

(They selected 4 stimuli for each of these schema-level categories.) Second, the same 20 personalised stimuli were then recalled by the same participants after a 3-minute distraction task, then again after a one-week delay. Stimuli in the first stage were coded as intuitive, counterintuitive, or "discard" (using the same procedures to be replicated for the analysis of brute recall in Chapter 10). Findings revealed an interaction of counterintuitiveness and age, as a significantly greater number of counterintuitive stimuli were self-authored by younger adults and adolescents than by older adults. However, these counterintuitive representations were not significantly better recalled than intuitive counterparts. As the majority of counterintuitive stimuli were generated for the schema-level category of humour (and to a lesser degree inferential potential), it could be suggested that the schema-level effects associated with a counterintuitive representation can affect its memorability and cultural success. This leads to speculation that prestige bias—say, a connection with a religious leader or other respected person—may be a necessary associative mnemonic for the successful transmission of counterintuitive representations via wide epidemiological distribution, a mnemonic that self-authorship cannot provide. (For a discussion of prestige bias, see Chudek et al. 2012; Henrich and McElreath 2003; McElreath and Henrich 2007.)

Chapter 7 contains the free-recall experiment of Study #3. It investigates the interaction of counterintuitiveness x familiarity x ontological category and the covariate of age. It explores the transmission advantages of supernatural agents—a central tenet of the cognitive science of religion that nonetheless has little experimental support. The supernatural agency hypothesis predicted an interaction of the outputs of HADD (hypersensitive agency detection device) and the counterintuitive effect (counterintuitiveness x ontological category). Analyses for Study #3 considered an amalgamation of the data sets of Experiment #1 (N = 365) and Experiment #2 (N = 399) of Study #1. Therefore, participants, measures and protocol were identical to those of Study #1. However, the only schema-level effect was familiarity, and ontological category was included within the new model. Analyses were conducted for UK and China samples (both, N =

382). Mixed results were found in regard to the MCI hypothesis when the whole sample was considered. However, an interaction of counterintuitive x age was revealed. In both samples younger adults and adolescents recalled a greater ratio of MCI stimuli to INT stimuli than did older adults, and this effect that was reversed for older participants. Support was found for the HADD hypothesis in both UK and China, as animate stimuli (PERSONS and ANIMATES concepts) were significantly better recalled than inanimate stimuli (SOLID OBJECTS and LIVING THINGS concepts). In addition, support was also revealed for the supernatural agency hypothesis in both UK and China. After finding a significant interaction of counterintuitiveness x ontological category, contrasts revealed the superior memorability of counterintuitive PERSONS concepts over other possible combinations of ontological category and MCI or INT stimuli. This central tenet of CSR had not previously been experimentally investigated. This study provides the first experimental evidence to test the predicted interaction of HADD and counterintuitiveness, and provides support for the hypothesis.

Chapter 8 is Additional Analysis #1, which tests the item-centric hypothesis. In addition to the investigation of this hypothesis, Additional Analysis #1 also serves as a preliminary study for Study #3 used to determine whether the participants who completed the minimal condition of stimuli presentation and those participants subjected to the elaborated condition of stimuli presentation should be seen as two independent samples or should be conflated. Participants, measures, and protocol were identical to those in Study #3, with the exception of the exclusion of children ages 3 to 12 years. The item-centric hypothesis predicted no difference in the recall of MCI stimuli for the samples. Analysis revealed no interaction of counterintuitiveness x presentation condition (minimal condition versus elaborated condition). Findings refute the claims of Gonce et al. (2006) and Upal et al. (2007, 2010) that grammatical structures lacking context provided by a narrative cannot offer the hypothesised mnemonic advantages of MCI concepts (Boyer 1994, 2000, 2001).

Chapter 9 concerns Additional Analysis #2, which considers further testing arising from the significant interactions of age x counterintuitiveness and age x ontological category revealed in Study #3, in Chapter 7. Participants, measures, and protocol for Additional Analysis #2 were identical to Study #3, with the exception that Additional Analysis #2 separately analysed each of the seven age-groups that constituted the sample. The age groups, by which the study recruited participants to provide representative age demographics for the samples, were ≥3<5 years, ≥5<8 years, ≥8<13 years, ≥13<20 years, ≥20<28 years, ≥28<50 years, and ≥50 years. It aimed to provide descriptive statistics for each the seven age groups, and due to the age effects revealed in Study #3 provided the opportunity to reveal greater detail with regard to age through further tests of the main hypotheses. Comparing the results of these analyses for test of the MCI hypothesis revealed an inverted U-shaped effect distribution in regard to the relationship between age and the recall of counterintuitive versus intuitive stimuli.

Chapter 10 reports Additional Analysis #3, which, in a manner similar to Study #2 in Chapter 6, investigates template-level biases in the generation of original counterintuitive and intuitive representations. Additional Analysis #3 consists of an additional coding and further analysis of the data that takes into account the intuitive or counterintuitive status of all representations recalled by participants, regardless of whether the representation is correctly or incorrectly recalled (judged by its presence in stimuli set). This analysis has come to be known as *brute recall*. A rigorous coding scheme comparable to that of Pretest #1 (Chapter 3) and Study #2 (Chapter 6) was applied to the new data with the intent to remove any ambiguity of reference or potential for analogical reasoning that would render the intuitive or counterintuitive status of a representation uncertain. Through a process of reasoning and empirical tests it was deemed reasonable to combine both cross-cultural samples and both stimuli presentation conditions (minimal and elaborated) into one sample for analysis. Analysis by general linear model (GLM) for this conflated UK and China dataset revealed that participants recorded significantly more counterintuitive statements than intuitive statements.

An interaction of age x counterintuitiveness was also revealed as younger participants recorded proportionally more counterintuitive representations than intuitive representations than older persons of the sample. These results can be seen as providing secondary support for the main hypotheses. They also suggest that future research should be directed towards the impact of age on the counterintuitive effect.

Chapter 11 re-examines the central claims of the thesis in light of the empirical evidence reported. The chapter discusses the implications of the thesis for cognitive anthropology and psychology, for the scientific study of religion, for understanding the demands that narrative materials make on children's attention, creativity, and imagination, and for a wider understanding of the epidemiology of cultural representations. In light of these findings, the concluding discussion addresses some outstanding questions for MCI theory and makes suggestions for future research. The appendices feature the coding schemes and experimental procedures given to research assistants, as well as other materials.

2 Hypotheses and rationale

This chapter aims to form a bridge of rationale between the theoretical material of the previous chapter and the experimental chapters and design to follow. To minimize grounds for misunderstanding, here is a technical clarification of the main terms and acronyms as used in the coming hypotheses and subsequent studies:

- *Intuitive concept* (INT). This is a concept consistent with the domain-specific intuitive assumptions triggered due to pre-conceptual categorisation as falling under a particular ontological category (see Section 1.1.1 for further details). Although all of the stimuli in these studies have schema-level associations in the way of conceptual modifiers (adjective plus noun) and the personalised contextual information of the entertainer (here, the participant), they are still referred to as INT due to consistency with this body of intuitive assumptions. This definition of INT concepts is blind to schema-level information. An example of an INT concept could be LONG-EARED RABBIT. RABBIT is pre-conceptually categorised as falling under ANIMATES. With the addition of the LONG-EARED modifier, this is an INT concept, as it violates none of the intuitive assumptions about a RABBIT derived from the domains of physicality, animacy, biology, and universals.
- *Minimally counterintuitive concept* (MCI). This definition refers to a concept with a single conceptual modifier. As a modified concept it violates a single domain-specific intuitive assumption. These intuitive assumptions, grouped into domains, were triggered by pre-conceptual categorisation (of the unmodified base concept) as falling under a particular ontological category (see Section 1.1.1 for further details). This violation is specific to one of the domains of intuitive assumptions, by way of *breach* or *transfer* (see Section 1.1.2). Although all of the stimuli in these studies have schema-level associations in the way of conceptual modifiers

> (adjective plus noun) and the personalised contextual information of the entertainer (here, the participant), the term "MCI concept" refers only to the template-level of cognition. This definition of MCI concept is blind to schema-level information. An example of an MCI concept could be INVISIBLE RABBIT. RABBIT is pre-conceptually categorised as falling under ANIMATES, which triggers intuitive assumptions arising from the domains of physicality, animacy, biology, and universals. The addition of the INVISIBLE modifier makes this an MCI concept, as the conjoined INVISIBLE RABBIT violates the single intuitive assumption of *visibility* bestowed from the domain of physicality.

Several hypotheses can be extrapolated from the background materials of Chapter 1:

Hypothesis #1

Are minimally counterintuitive (MCI) ideas more memorable and more likely to be transmitted than intuitive (INT) ideas that do not violate any ontological category? The hypothesis below represents the typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies, which asserts that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence are attention-demanding and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). The outcome is the following central hypothesis:

- The *MCI hypothesis* predicts that MCI stimuli will be significantly better recalled than their INT stimuli counterparts. Therefore, the H_0 to be rejected is that there is no difference between the recall rates of intuitive and minimally counterintuitive ideas, or that intuitive stimuli have a recall advantage.

Several hypotheses were drawn from these supporting research questions to be tested in Studies #1 and #3:

Hypothesis #2

If we extend Boyer's original account of the mnemonic advantages of counterintuitive ideas, the question arises, Are concepts that are both counterintuitive and highly familiar more memorable than counterintuitive concepts that are culturally unfamiliar? With relevance to Boyer's (2001) description of the transmission advantages of "familiar" counterintuitive ideas, Bloch (2005) and Upal (2010) have both assumed that an MCI representation that becomes commonly communicated and culturally familiar to a cultural group will not have the same mnemonic advantage as a novel and unfamiliar counterintuitive (uMCI) representation, due to a loss of saliency as a successful cultural representation. The theoretical background detailed in Section 1.5.1 illustrates that this supposition is unlikely to be correct due to the predicted interaction of the schema-level effect and the template-level violation: familiar, minimally counterintuitive (fMCI) stimuli possess a greater mnemonic effect both on the schema level (due to frequent previous entertainment of the stimulus leading to greater likelihood of retrieval) and on the template level (due to the MCI effect) than uMCI stimuli. The following hypothesis ensues:

- The *familiar-MCI hypothesis* predicts that familiar minimally counterintuitive stimuli (fMCI) will be significantly better recalled than unfamiliar minimally counterintuitive stimuli (uMCI). Therefore, the H_0 to be rejected is that there is no difference to be revealed between the recall of uMCI and fMCI stimuli, or that uMCI has a recall advantage.

Hypothesis #3

Does age affect the memorability and transmission of minimally counterintuitive (MCI) ideas? Given the findings of Gregory and Barrett (2009) and Hornbeck and Barrett (forthcoming) Studies #1 and #3 consider the analysis of larger samples that are more representative of population age ranges than utilised in previous MCI studies. Due to the degradation of cognitive load capacities into older age (Van Gerven et al. 2000, 2002; see Section 1.5.4 for further details) and the greater demands that counterintuitive concepts make on working memory capacity than do concepts consistent with domain-specific intuitive assumptions, it is here predicted that when the numbers of conceptual modifiers are equated (Barrett and Nyhof 2001; Johnson, Kelly and Bishop 2009; Norenzayan et al. 2006; Upal et al. 2007), younger persons will better attend to and remember MCI stimuli than older persons. Extending Boyer's original description of the mnemonic advantages of counterintuitive ideas,

- The *MCI age-effect hypothesis* predicts that there will be a significant interaction between age and recall of MCI stimuli, as younger persons will recall proportionally greater numbers of MCI versus INT stimuli than older persons in the sample. Therefore, for the H_0 to be rejected, no relationship will be detected between age and the recall of MCI stimuli.

Hypothesis #4

What impact do other schema-level effects have on memorability, likelihood of cultural transmission, and epidemiology of representations? Is there any interaction between schema-level effects and template-level violation? The MCI studies of Purzycki (2010; 2011) and Sloan et al. (2007) that revealed the interaction of counterintuitive conceptual components and schema-level effects (humour and imagery, respectively) in promoting a memorability advantage, in combination with other empirically justified background material in this area (see Section 1.5.3 for further details), have culminated in the following hypothesis:

- The *schema-level effect hypothesis* predicts that stimuli with a higher survey score for any of the schema-level effect categories of positive emotion (POS), negative emotion (NEG), imagery (IMA), humour (HUM), and interest (IP) will affect the recall success of a stimulus. Therefore, the H_0 to be rejected is that no schema-level effects will significantly predict the recall rates of stimuli.

With respect to Study #2 only:

Hypothesis #5

"Children's worlds" have been reported to contain more works of the imagination than those of adults (Harris, 2000). In addition to better remembering and recalling minimally counterintuitive concepts (Gregory and Barrett 2009), do younger persons given the opportunity produce more MCI ideas than older persons do? Given the task of combining an adjective plus a noun to form statements to represent each of five categories of schema-level properties, blind to the definition of and potential for generating both minimally counterintuitive (MCI) concepts and concepts consistent with our domain-specific intuitive assumptions (INT), what will be the result?

- The *MCI production age-effect hypothesis* predicts that a significant interaction of counterintuitiveness and age will be revealed, as younger persons will freely produce more MCI concepts than do older persons of the sample. Therefore, the H_0 to be rejected that is no significant interaction of counterintuitiveness and age will be found, as production rates of MCI for younger and older persons are comparable.

With respect to Study #3 only:

Hypotheses #6 and #7

Supernatural agents are reported to recur universally in world religions (Brown 1991) and are the primary defining factor of religion (Atran 2002; Barrett 2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and Honkela 2003). Guthrie (1993), Boyer (2001), and Barrett (2000; 2004a) have hypothesised that a psychological mechanism hypersensitive to agency detection would be adaptive, since having a strong perceptual bias to interpret ambiguous events as caused by an agent greatly reduces the likelihood that our ancestors would have been killed by predators. It would have been far less costly for our ancestors to detect too many agents in their environments than too few (also H. C. Barrett 2005). The interaction of the counterintuitive effect and the *hypersensitivity agency detection device* (HADD), due to its oversensitivity to the unseen presence of agents, has been hypothesised to explain the universal proliferation of supernatural agent concepts.

- The *supernatural agency hypothesis (Hypothesis #6)* predicts a significant interaction between counterintuitiveness and ontological category, as MCI concepts that fall under the PERSONS ontological category will be better recalled than MCI and INT concepts in other ontological categories. Therefore, the H_0 to be rejected is that no recall advantage of MCI PERSONS concepts over other MCI and INT concepts in other ontological categories will be revealed.

Also,

- The *HADD hypothesis* (*Hypothesis* #7) predicts that animate stimuli will be significantly better recalled than inanimate stimuli. Hence, a group containing stimuli falling under the PERSONS and ANIMATES ontological categories ("animates") will have a significantly better mean recall rate than a second group containing stimuli falling under the SOLID OBJECTS and LIVING THINGS [23] ontological categories ("inanimates"). Therefore, the H_0 to be rejected is that there is no recall advantage of animate stimuli over inanimate stimuli.

With relevance only to Experiment #1 of Study #1 (presentation of the minimal condition of stimuli):

Hypothesis #8

Prior to the emergence of written symbols, the cultural transmission of stories and folktales was

[23] The ontological category LIVING THINGS captures inanimate, but living, plants and like kinds. LIVING THINGS does not include living, animate/goal-directed entities such as animals, which fall under the category ANIMATES.

dominated by the oral mode of transmission, whether by means of epic, ballad, or counting-out rhyme (Rubin 1995). Various studies have looked at the changing relationships between oral and written communication when societies from different historical periods move from a primarily oral culture with limited use of written materials to a "document-minded" culture (Thomas 1989: 36). These document-minded cultures have been described as having a different "literate mentality" (Clanchy 1979). It is claimed that oral and written language have different effects upon human memory, as written texts are often primarily used as mnemonic aids rather than as works of reference (e.g. Hildyard and Olson 1982; Person 1993). However, Brimer and Mueller (1979) found no significant differences for recall rates of sequences of written and oral items.

- The *transmission mode equality hypothesis* predicts that no significant differences between recall rates of stimuli presented in either the oral or written presentation modes will be revealed. Therefore, the H_0 to be rejected is that significant differences will be revealed between the recall rates of written and orally presented stimuli.

Considered in Additional Analysis #1 of Chapter 8 only:

Hypothesis #9

Some authors have suggested (Gonce et al. 2006; Upal et al. 2007, 2010) that simple grammatical structures, lacking the context provided by a narrative, are insufficient to successfully communicate MCI concepts and provide memorability advantages for them over concepts consistent with domain-specific intuitive assumptions. How is contextual material important to the transmission of counterintuitive ideas? Are concepts embedded with more contextual materials more likely to be remembered and communicated than concepts presented with less contextual information? As thorough pretesting methodology was used to ensure semantic coherence, and the reference to the object the stimulus designated was consistent for all stimuli, no theoretical reason remains to suggest that additional contextual material will aid the memorability and transmission of counterintuitive ideas (see Sections 1.2 and 1.5.8 for details). With regard to the grammatical formulation of stimuli presented to participants, the presentation modes that were contrasted consisted of a *minimal condition* (a subject-predicate statement) and an *elaborated condition* (an enlarged descriptive narrative):

- The *item-centric hypothesis* predicts that there will be no significant interaction of counterintuitiveness and presentation mode, either minimal or elaborated, as no differences in the recall rates of intuitive (INT) stimuli versus minimally counterintuitive (MCI) stimuli between participants under the minimal condition and under the elaborated condition of stimuli presentation will be revealed. Therefore, the H_0 to be rejected is that an interaction between counterintuitiveness and presentation mode will be revealed.

2.1 *Overview: Free-recall experiments*

Studies #1 (Chapter 5) and #3 (Chapter 7) comprised free-recall experiments designed to test the hypotheses motivated by and drawn from the theoretical background and review of empirical materials covered in Chapter 1 (outlined below). Study #1 contained two experiments, whereas Study #3 comprised one experiment. All these experiments considered the free-recall of stimuli by participants immediately after exposure to the stimuli and again after a one-week delay. For both studies, thirty-two stimuli corresponding to template-level by schema-level component categories of *familiar counterintuitive* (fMCI), *unfamiliar counterintuitive* (uMCI), *familiar intuitive* (fINT) and *unfamiliar intuitive* (uINT) were presented sequentially to individual participants in both the UK and China. In Study #1, Experiment #1 considered stimuli presented in the form of subject-predicate statements, to be known as the *minimal condition*. A between-subjects design had participants presented with oral and written stimuli. In Experiment #2, the *elaborated condition* presented mixed-media stimuli consisting of an elaborated form of the subject-predicate statement, so construed by way of the additional descriptive elements incorporated into the structure, which still obeyed a uniform grammatical formula. Study #3 consisted of one free-recall experiment amalgamating elements from both of these conditions. Studies #1 and #3 investigated the typical formulation of Boyer's hypothesis of the transmission advantage of counterintuitive representations that has dominated prior experimental MCI studies as well as several additional hypotheses of key interest to research in MCI theory. Study #1 aimed to contribute by explaining broader conceptual biases in the distribution of cultural representations, including those of the impact of schema-level effects on memorability and cultural transmission (Hypotheses #1 to #5, and #8). Study #3 was primarily concerned with exploring the mnemonic biases of supernatural agents, the inclusion of which in world religions many have regarded as a defining characteristic of religion (Hypothesis #7). Furthermore, both studies also investigated the relationship between age and mnemonic biases in the transmission of cultural representations (Hypothesis #3). All experiments were conducted in both the UK and China, and were all between- and within-subjects designs. Participant ages ranged from 3 years to 50 years and above, in all experiments. Participants were informed that they were to take part in a "cognitive task". Stimuli conformed to the stimuli categories of fMCI, uMCI, fINT and uINT. Each participant was presented with 32 individual stimuli listed sequentially on a computer screen, each accompanied by an image representative of the noun component of the statement. However, this accompanying image did not directly depict the meaning of the modified concept with reference to the subject-predicate statement; in all cases the image displayed lacked any modifiers, even though the actual stimulus included a modifier (e.g. the image for "a cabbage that is rotting" would show not a rotting cabbage, but the fresh cabbage that persons would typically entertain upon encountering CABBAGE). The full stimuli sets for the experiments in Studies #1 and #3 appear in Chapter 3 (Pretest #1). The experiments were conducted in ecologically valid locations such as sports centres, restaurants, cafes, parks and other such areas where the communication and transmission of such ideas could naturally occur. However, the trained experimenters made maximum effort to keep ambient stimuli to a minimum in all test areas to retain the greatest context neutrality possible. Typically, at least one experimenter would always "guard" the test site from the potential interruptions of other persons not taking part. After a 3-minute distractor task, the immediate recall of test items took place. In a second testing period under the same conditions, one week after the original test, the participant provided a delayed recall of the stimuli. This delayed recall period is regarded as more meaningful to understanding processes of cultural transmission, as it may reveal which representations have a greater potential to propagate within a culture due to their greater mnemonic resilience over time. The following efforts were made to avoid potentially confounding factors during the experiments:

(1) The stimuli presentation length was controlled so that participants could not spend more time encoding some types of items over others.
(2) The experimental design ensured that the test items appeared in an order that was semi-randomly determined for each participant according to a rotating block sequence of cognitive template categories so as to avoid any confound that would occur if the same strict repeated order of stimuli were replicated for all participants.[24]
(3) Lexicon size and syntactic structure of test items had a rigid common format so as not to induce bias incurred by differing levels of cognitive effort needed for processing individual test items.[25]
(4) Efforts were made to minimise the potential for analogical reasoning and creation of metaphor when participants entertained a stimulus item.

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[24] Surprisingly, fully randomised ordering in regard to the presentation of stimuli has not been reported in previous MCI theory studies prior to Gregory and Barrett (2009).

[25] Gonce et al. (2006) remarked that this had no effect on test items, but reported no experimental evidence for this claim. Such a claim might appear doubtful. It is as if to say the fidelity in recall of an entire book is comparable to remembering a short utterance.

(5) Pretesting of items ensured that these public representations minimised differences of inferential potential and potential triggering of mental images in private representation across all participants.

(6) Several assistants blind to the hypotheses assisted with conducting the study to reduce researcher bias.

The remaining study central to this thesis did not use the measure of free recall. Study #2 utilised a generation task to address an outstanding concern of research on the transmission of counterintuitive concepts, as cultural transmission is constrained not only by recall, but also by the emergence of representations (Hypothesis #5). Chapter 6 provides a detailed study overview for Study #2.

2.2 *Ethical procedures, implementation of the design, and fieldwork access issues*

The Central University Research Ethics Committee (CUREC) reviewed this research using human participants. Due to considerations given to the inclusion of both adult and child participants in these studies, the review process required the completion of both a CUREC/1 and a CUREC/2 application form. On separate occasions, this procedure was undertaken and approval received from CUREC for the UK and China periods of experimentation. All procedures conformed to the ethical codes prescribed by Oxford University. This ethical practice was consistent at both the UK and China experiment sites. Parental consent forms were produced and given to parents to complete prior to a child's participation. A document disclosing the nature and theme of the study was prepared and given to adult participants, and another modified version was given to parents of child participants that aimed to be comprehensible to each child with the aid of the parent. The experiments were designed to minimise the likelihood of distress or ill feeling on the participant's part. Experimenters were fully trained. At no point was any person put under duress by the experimenter, neither in the process of recruitment or testing. Before agreeing to participate, every participant was made fully aware that he or she could opt out of completing the experiment at any time.

Two units of project funding were secured to complete these studies. The first parcel of funding for the UK-based half of the study was funded by a grant from the Cognition, Religion, and Theology (CRT) Project, supported by the Templeton Foundation. It was received in February 2009. The second, also granted by the CRT Project during the funding of the succession of experiments in China, was received in December 2009. Both projects were scheduled for completion in December 2010. In each case, the grant covered costs of materials and participant recruitment (N = 940) and provided financial support for research assistants. Maintenance costs were also covered for time spent in Beijing. The design for the UK study and the subsequent China study was established with the support and feedback of staff and fellow students at the Institute of Cognitive and Evolutionary Anthropology (ICEA) at Oxford University. Collection of data in the UK was well underway before work on the study in China was begun. In early 2010, with the help of Professor Kelly Clark of Calvin College, USA, and my DPhil supervisor Dr Justin Barrett, I developed a relationship with Professor Zhu Liqi of The Academy of Sciences, Beijing, and Professor Huangfu Gang of Beihang University, by means of a period of teaching in Oxford for the Chinese Cognitive Science of Religion conference. Professor Zhu and Professor Huangfu were willing to support me in conducting the Chinese half of the study. They kindly aided me in gaining access to the Chinese Academy of the Sciences and acquiring office space within. I was also provided initial accommodation at Beihang University. Both Professor Zhu and Professor Huangfu were invaluable in providing me with suitable research assistants from those they were supervising on Master degree programs. These research assistants were both eager and capable. Prior to arriving in Beijing my knowledge of the Chinese language was quite basic, since I had previously spent only two months in China in 2006, which included several weeks in Beijing, and had undertaken only a short period of language instruction through the Oxford Language Centre. In this respect the support of the research assistants, most of whom spoke good English, was essential. In total, I assembled a team of seven experimenters and three coders, of whom two were also involved in translating materials from the UK study. All experimenters received a full day of training in procedures required for recruitment and testing prior to starting. Under my oversight, these experimenters worked in teams of two. I assessed all experiment sites for their appropriateness prior to testing. The data from adults participating in these experiments was collected from the area surrounding Beihang University and included private businesses with which the research assistants had associations. Adult participants were otherwise recruited and tested in supermarkets, restaurants, canteens, and parks. Participants were not limited just to students, but also included persons from a wide range of socioeconomic backgrounds and ethnicities. Testing in a quiet corner of the test locations was felt to provide some level of ecological validity in respect to the environment in which these ideas (stimuli) would naturally be communicated. The snowballing method of recruitment was often successful in acquiring new participants through those who had already been recruited. The site at which they had completed the immediate period of recall was also the same as the site used for the subsequent recall of stimuli again after a one week delay, in observance of the potential memorability biases inherent in location. Access to child participants was obtained through the resources of Professor Zhu and her students. Recruiting and testing of children took place at numerous kindergartens and schools throughout Beijing. In all, this period of data collection in China was highly successful. I spent a total of nine months living in Beijing (in a traditional *hutong* in the *Xi Si* ("West Four") district of Beijing; far from the madding [expat] crowd). The kind support of Professor Zhu and Professor Huangfu was of initial vital importance. My regular meetings with the research assistants, their training, their eagerness to help, and the relationships I formed with them were all constituents of this success and made it enjoyable—I hope for all of us.

The next chapter, Chapter 3, concerns the pretest methodology used to establish the final 32 stimuli used for the experiments in both Study #1 and Study #3 (Pretest #1). Chapter 4 follows with a discussion of another pretest specific to Study #1 (Pretest #2), detailing the methodology and results by which survey scores representing the mean level of schema-level mnemonic effects impacting on each of these final 32 stimuli (for all five schema-level effect categories of: negative emotion, positive emotion; imagery, humour, and inferential potential).

3 Pretest #1: Establishing the stimuli set

This first pretest (1 of 2) had two central aims. One goal was to guarantee that the intended meaning of a stimulus was the same meaning that would be represented in the mind of the participant—to ensure that the public representation of a stimulus was consistently the same as the private representation. This equating of the public and private representations of a stimulus also aimed to minimise the potential for participants to reason analogically and to think metaphorically about the items—an issue that has had a confounding effect on particular previous MCI theory studies. The second goal of pretesting was to establish epistemic-familiarity scores for the stimuli and to ensure the final selections of items were appropriate for the stimuli categories of *familiar intuitive* items (fINT), *familiar minimally counterintuitive* items (fMCI), *unfamiliar intuitive* items (uINT), and *unfamiliar minimally counterintuitive* items (uMCI).

3.1 Method

3.1.1 Generation of pre-stimuli for the UK-based study

Forty-eight pre-stimuli were generated in the form of subject-predicate statements that obeyed in equal numbers fMCI, uMCI, fINT, and uINT category criteria. The syntax of each statement conformed to the rigid governance of the following grammatical formula:

[indefinite article] + [noun (*subject)*] + [conjunction (that) + verb (to be)] + [adjective/participle]

The use of a subject-predicate statement for stimuli was chosen as an alternative to the more simple grammatical forms, such as *participle* + *noun* (e.g. "listening tree"), used in other MCI theory studies (e.g. Norenzayan et al. 2006). It was chosen to reduce the unwanted and confounding effect of analogical reasoning, or the potential for the creation of metaphor in the mind of the participant entertaining the stimulus.[26] The subject-predicate structure of "a tree that is listening" reduced the potential for deviation from its intended meaning—and the item's intended membership in a corresponding category. In addition, prospective stimuli were selected by virtue of clarity of reference, that is, that their meanings were not excessively ambiguous, which could lead to polysemy. These measures were implemented with the aim that the public representation of a particular stimulus should evoke a similar private representation in the minds of all agents entertaining that particular stimulus.

3.1.2 *Generation of stimuli for the China-based study*

It was ensured that the China-based pre-stimuli, pretest procedure, and selection criteria resembled that of the UK-based study as closely as possible, given the differences in grammatical and concept familiarity considerations relative to the chosen population.

The Chinese philosophical tradition has differed from the analytic approach of Western philosophy with regard to exploring certain well-defined grammatical structures (such as the subject-predicate statement), the truth claims of these statements, and their reference to the furniture of the world. The absence of this variety of philosophical inquiry in Chinese philosophy might be attributed to the lack of an equivalent to the subject-predicate statement, which has been obsessed over by particular Western analytic traditions. Consequently, minor alterations to the grammatical structure of stimuli used in the China-based study had to be made. It was necessary to give additional consideration to the nature and use of verbs in Chinese language, as in English a verb in its present participle denotes behaviour identical to that of an adjective, whereas in Mandarin this facility does not exist. Extensive dialogue with research assistants and several Chinese academics helped to determine that no such single

[26] See Section 1.5.7, for more on the effects of analogical reasoning.

equivocal statement existed in Chinese language. However, there were two similar grammatical structures that could encompass semantic equivalents of all the UK-based stimuli and function as subject-predicate statements with the same nature of truth claim and strict reference to satisfy the requirements of the study:

Grammatical formula for statements containing an adjective:

yī tā shì de
一 + [measure word] + [noun (*subject*)] 它 + 是 + [adjective (*predicate*)] + 的

Grammatical formula for statements containing a verb:

yī tā zài le
一 + [measure word] + [noun (*subject*)] 它 + 在 + [verb (*predicate*)] + 了

The primary differences in grammatical structure are highlighted in red, where the character 是 translates as the verb *to be*, and 在 acts as a conjugation of the following verb denoting the present participle. Roughly, half the pre-stimuli in the Chinese stimuli set contained adjectives and the other half verbs. As a consequence of the differences between the two statement types, the number of characters contained in each stimulus was closely controlled and recorded. Coding for the grammatical differences is displayed and detailed in Table 4 containing the final test-item selections for the China-based study.

3.2 *Materials and procedure*

For both the UK and China studies, to ensure the successful creation of stimuli set items, each of the pretest participants was presented with a unique sequential random order of 48 prospective test items. The China pretest materials were directly translated from the UK materials, although five test items were exchanged or modified due to the research advisory team's prejudgements of differences in the populations' familiarity with some test items and of other aspects of suitability. At both the UK and China study sites, participation in the pretest entailed two parts. First, the participants were presented with the question, "How many times during your lifetime do you judge you have mentally encountered each item?”[27] They were then requested to rate each of the prospective stimuli on a nine-point scale. Each increment of the rating scale was headed by a quantification of “number of times represented” and was bounded by “never” at point 1 and “every moment” at point 9. Participants were given as much time as they required to complete this task. Second, after completing the rating scales, participants were each asked to return to the start of their answer sheets (hereafter called “Answer Sheets,” or “Answer Sheet” in the singular) and then in the spaces provided to rewrite each stimulus in their own words, using different words than contained in the original, according to their own “primary understanding of it”. For example, “a cat that is silent” could have been rewritten as a “feline mammal that is not making any noise”. To ensure the private representation of the final stimuli was comparable for participants, any pre-stimulus that wasn’t judged to have achieved 100-percent agreement amongst participants was excluded. See Appendix 1 for full details of instructions given to the UK participants.

3.3 *Pretest #1: UK*

3.3.1 Participants for UK study

Twenty members of the Oxford public were recruited by means of “snowballing”.[28] There were 8 females (40%) and 12 males (60%). Ages ranged from 6 to 62 years, with a mean age of 31.95

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[27] Participants were provided detailed background information for the understanding of the question. They were told ‘mental encountered’ could entail: (i) encountering a representation of the idea direct from real life experience; (ii) watching/reading/hearing/entertaining representation of idea through books, films, cartoons, animation, magazines, music, news, etc, etc….in the form of general/particular characters, animates, objects, things, etc; (iii) it could be an character/object of fiction or non-fiction; (iv) an item of oral communication—an item within plain old conversations— oral communicated stories or folktales; (v) seeing it represented as a photo-image or piece or art, etc.; (vi) or, as a item of thought/creation of your own mind and imagination. They were also provided a quantifying chart with amounts of days and hours based on age to better judge ‘how many times during your lifetime…’.

[28] Individuals within Oxford University anthropology department, Oxford Judo Club, Oxford Cherwell School, and the village of Elsfield were instigative in the snowballing process. The sample was evenly composed of students, non-academic staff and other members of the working public.

years (*SD* = 15.8). All participants considered themselves to be fluent in English, and 18 participants spoke English as a first language.

3.3.2 Results: UK

Any item that on one or more occasion was rewritten in a form not synonymous with the intended meaning of the original pre-stimulus was discarded. Of the remaining items, items were selected for exemplifying "familiarity" or "unfamiliarity" in their corresponding INT or MCI template, but also according to their suitability for inclusion in a balanced design of ontological categories (see Table 3 and Table 4). Sixteen items in total were eliminated from proceedings; 32 test items remained to be selected. Figure 1 illustrates the pretest results and displays the mean rating scores of pre-stimuli, including the scores of discarded items. A full listing of the pre-stimuli can be seen in the "UK Pretest Answer Sheet" in Appendix 1.

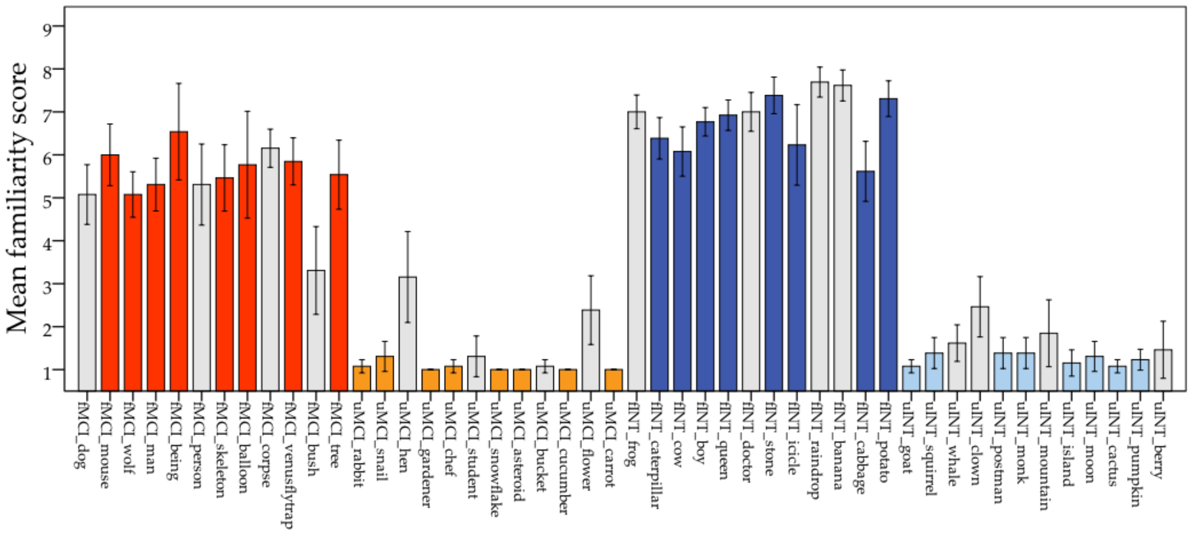

Figure 1. The mean familiarity rating scores for the 48 pre-stimuli of the UK study. (Dark orange = fMCI, light orange = uMCI, dark blue = fINT, light blue = uINT, grey = discarded items) (Error bars indicate +/- 2SE).

To ensure appropriate difference was attained between familiar and unfamiliar test-categories (both fMCI and uMCI, fINT and uINT), a paired samples t-test was used to analyse the mean rating scores of all test items belonging to the fMCI and uMCI item categories revealed a significant difference, $M = 5.51$ ($SD = 0.79$) versus $M = 1.26$ ($SD = 0.38$), respectively; $t(19) = 19.61$, $p < .001$. A significant difference was also revealed for fINT and uINT categories, $M = 6.43$ ($SD = 0.7$) versus $M = 1.62$ ($SD = 0.62$), respectively; $t(19) = 18.99$, $p < .001$. Figure 2 illustrates the comparative performance of the test categories. A one-way ANOVA considering familiarity scores for the FMCI, uMCI, fINT, and uINT categories and the factor of age revealed no significant effect of age for any category (all $p > .05$).

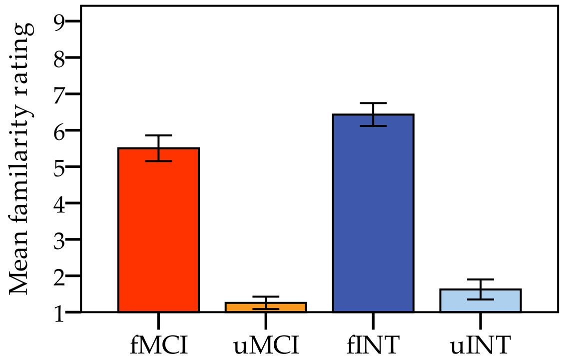

Figure 2. Pretest mean familiarity rating scores of final stimuli for UK-based study by category. Bars correspond to familiar minimally counterintuitive (fMCI), unfamiliar minimally counterintuitive (uMCI), familiar intuitive (fINT) and unfamiliar intuitive (uINT) categories (error bars indicate +/- 2SE).

3.4 *Pretest #1: China*

3.4.1 *Participants in China study*

Twenty members of the Beijing public were recruited by means of "snowballing".[29] There were 11 females (55%) and 9 males (45%). Ages ranged from 12 to 70 years, with a mean age of 27.2 years ($SD = 14.6$). All participants considered themselves to be fluent in Chinese, and all participants identified themselves as of the Han ethnic group.

[29] Research assistants and students from the Chinese Academy of Science instigated the snowballing process within the institute itself and surrounding businesses and residential areas of the Olympic village area of Beijing. The sample was evenly composed of students, non-academic staff, and other members of the working public.

3.4.2 Results: China

The criteria for item selection were identical to those in the UK-based pretest (see section 3.2.2). Figure 3 illustrates the mean rating scores for pre-stimuli, and includes the performance of the discarded items.

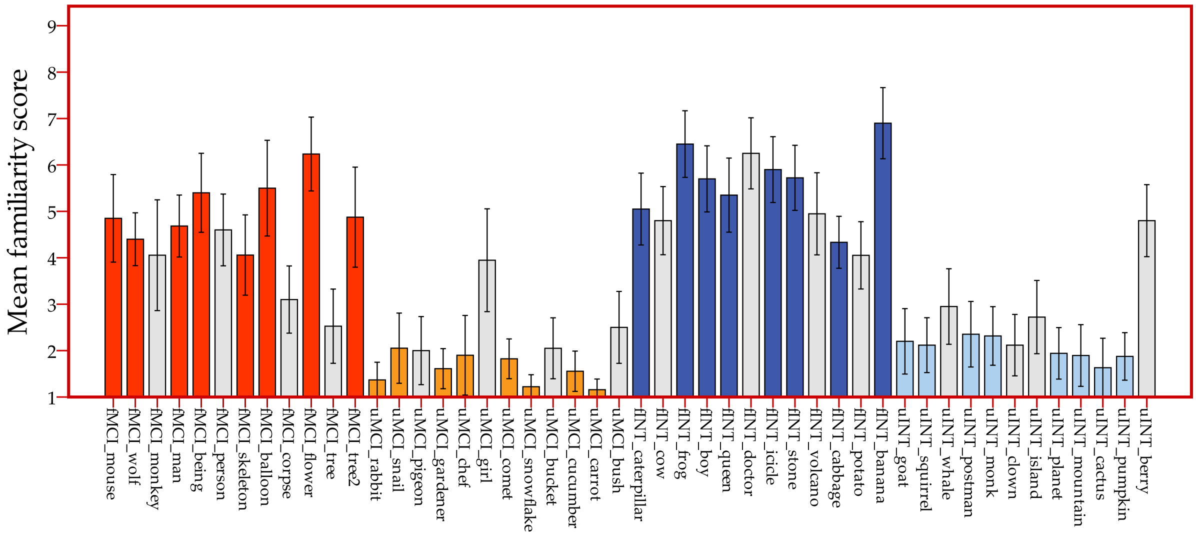

Figure 3. The mean familiarity rating scores for the 48 pre-stimuli of the China study. (Dark orange = fMCI, orange = uMCI, dark blue = fINT, light blue = uINT, grey = discarded items) (Error bars indicate +/- 2SE).

As with the UK pretest data, paired samples t-tests were used to guarantee adequate differences between the familiar and unfamiliar categories. A significant difference between fMCI and uMCI item-categories was revealed, M = 4.81 (SD = 1.4) versus M = 1.71 (SD = 1.11), respectively; $t(19) = 12.45$, $p < .001$. In addition, a significant difference was also determined to exist between the fINT and uINT categories, M = 5.62 (SD = 1.18) versus M = 2.16 (SD = 1.17), respectively; $t(19) = 11.81$, $p < .001$. The differences between these categories are illustrated in Figure 4. A one-way ANOVA considering familiarity scores for the FMCI, uMCI, fINT, and uINT categories and the factor of age revealed no significant effect of age for any category (all $p > .05$).

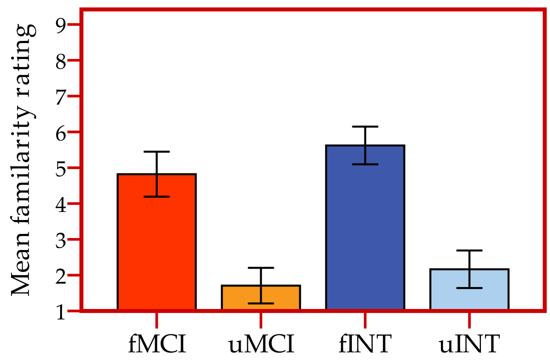

Figure 4. Pretest mean familiarity rating scores of final stimuli for China study by category. Bars correspond to familiar minimally counterintuitive (fMCI), unfamiliar minimally counterintuitive (uMCI), familiar intuitive (fINT), and unfamiliar intuitive (uINT) categories (error bars indicate +/- 2SE).

3.5 *Final selections for stimuli sets: UK and China*

Table 3 lists the final stimuli set of 32 selected items resulting from the pretesting process of the UK-based pretest experiment:

Table 3. *Final stimuli set for the UK study, comprised of familiar intuitive items (fINT), unfamiliar intuitive items (uINT), familiar minimally counterintuitive items (fMCI) and unfamiliar minimally counterintuitive items (uMCI), in a balanced design. Corresponding ontological categories for stimuli are listed as determined by the subject noun in obedience with the categorical definitions of Keil (1979) and respective counterintuitive (CI) coding applied using the quantifying and coding scheme of Barrett (2008).*

fINT item	Ontological Category	fMCI item	CI coding[30]
A caterpillar that is eating	ANIMACY	A mouse that is talking	^{M}MOUSE
A cow that is lying down	ANIMACY	A wolf that is acting	^{M}WOLF
A boy that is dirty	PERSONS	A man that is invisible	MAN$_{P}$
A queen that is rich	PERSONS	A being that is everywhere	BEING$_{U}$
An icicle that is dripping	SOLID OBJECTS	A skeleton that is fighting	^{A}SKELETON
A stone that is smooth	SOLID OBJECTS	A balloon that is hovering	BALLOON$_{P}$
A cabbage that is rotting	LIVING THINGS	A venus-flytrap that is grabbing	^{A}VENUS-FLYTRAP
A potato that is muddy	LIVING THINGS	A tree that is thinking	^{M}TREE
uINT item	**Ontological Category**	**uMCI item**	**CI coding**
A goat that is deaf	ANIMACY	A rabbit that is egg-laying	RABBIT$_{B}$
A squirrel that is swimming	ANIMACY	A snail that is reading	^{M}SNAIL
A postman that is hiding	PERSONS	A gardener that is bodiless	GARDENER$_{P}$
A monk that is skipping	PERSONS	A chef that is immortal	CHEF$_{B}$
An island that is four-sided	SOLID OBJECTS	A comet that is sad	^{M}COMET
A moon that is hollow	SOLID OBJECTS	A snowflake that is hungry	^{B}SNOWFLAKE
A cactus that is greasy	LIVING THINGS	A cucumber that is listening	^{M}CUCUMBER
A pumpkin that is poisonous	LIVING THINGS	A carrot that is ticklish	CARROT$_{B}$

30 As per the counterintuitive coding and quantifying scheme of Barrett (2008).

The coding and scoring of counterintuitive items obeyed the quantifying and coding scheme of Barrett (2008). The 16 selected MCI items were approximately equally representative of both types of counterintuitive violation specified by Boyer (2001): 7 had *breaches* of an intuitive expectation set, and 9 had *transfers* of an expectation set. All MCI items had a counterintuitiveness score of 1. Sections 1.1 to 1.1.4 explain the basis for Barrett's counterintuitive coding and quantifying formulation in detail. The "CI Coding" in the right-hand columns of Tables 3 and 4 refers to transfer or breach of intuitive assumption, in accordance with expectation set. For example, the concept SKELETON as falling under the SOLID OBJECTS ontological category should trigger only the expectation sets of Universals, Spatiality, and Physicality (see Table 1). However, if the skeleton is attributed the animate ability to fight, then properties of the Animacy expectation set have been transferred. It is here then represented thus with a prior capitalized superscript prefix "A" as ^{A}SKELETON. The superscript lowercase suffixes represent the breach of intuitive assumptions of the specified expectation set. For example, MAN falls under the ontological category of PERSONS and therefore we intuitively assume all intuitive assumptions of the expectation sets of Universals, Spatiality, Physicality, Animacy, Biology, and Mentality. However, a man that does not satisfy all of these expectations (e.g. an invisible man) would be counterintuitive by virtue of a breach (of Physicality, in the case of an invisible man). An invisible man would be coded MAN$_{P}$. Unlike transfers, a breach does not necessarily presume that the entire intuitive expectation set has been violated.

Table 4 contains the final selections resulting from pretesting for the China-based study:

Table 4. *Final stimuli set for China study, comprising familiar and unfamiliar, minimally counterintuitive items (fMCI and uMCI) and intuitive items (fINT and uINT), in a balanced design. The constituent subject noun determined ontological categories for stimuli in obedience with the ontological categorical definitions of Keil (1979) and attributed counterintuitive (CI) coding with the coding and quantifying scheme of Barrett (2008).*

fMCI item English	fMCI item Chinese (including Pinyin)	Ontological Category	Notes
A mouse that is talking	yīzhīlǎoshǔtāzàishuōhuàle 一 只 老 鼠 它 在 说 话 了	ANIMATES	^{M}MOUSE 9 (2+4)z
A wolf that is disguising	yīzhīlángtāzàiqiáozhuāngle 一 只 狼 它 在 乔 装 了	ANIMATES	^{M}WOLF 8 (1+4)z

A man that is invisible	yīgènánréntāshìyǐnxíngde 一个男人他是隐形的	PERSONS	MAN$_{P}$ 9 (2+4)s
A being that is everywhere	yígèshēngwùtāshìwúchùbùzàide 一个生物它是无处不在的	PERSONS	BEING$_{u}$ 11 (2+6)s
A skeleton that is fighting	yīgèkūlóutāzàidǎjiàle 一个骷髅它在打架了	SOLID OBJECTS	^{A}SKELETON 9 (2+4)z
A balloon that is hovering	yīgèqìqiútāzàiáoyóule 一个气球它在遨游了	SOLID OBJECTS	BALLOON$_{P}$ 9 (2+4)z
A flower that is smiling	yīduǒhuātāzàiwēixiàole 一朵花它在微笑了	LIVING THINGS	^{M}FLOWER 8 (1+4)z m.
A tree that is money-laden	yīkēshùtāshìguàmǎnleqiánde 一颗树它是挂满了钱的	LIVING THINGS	TREE$_{b}$ 10 (1+6)s m.
uMCI item English	uMCI item Chinese (including Pinyin)	Ontological Category	Notes
A rabbit that is egg-laying	yīzhītùzǐtāzàixiàdànle 一只兔子它在下蛋了	ANIMATES	RABBIT$_{b}$ 9 (2+4)z
A snail that is reading	yīzhīwōniútāzàidúshūle 一只蜗牛它在读书了	ANIMATES	^{M}SNAIL 9 (2+3)z
A gardener that is bodiless	yīgèyuándīngtāshìwúxíngde 一个园丁他是无形的	PERSONS	GARDENER$_{P}$ 9 (2+4)s
A chef that is immortal	yīgèchúshītāshìyǒngshēngde 一个厨师他是永生的	PERSONS	CHEF$_{b}$ 9 (2+4)s
A comet that is sad	yīkēhuìxīngtāshìbēishāngde 一颗彗星它是悲伤的	SOLID OBJECTS	^{M}COMET 9 (2+4)s
A snowflake that is hungry	yīduǒxuěhuātāshìède 一朵雪花它是饿的	SOLID OBJECTS	^{B}SNOWFLAKE 8 (2+3)s
A cucumber that is listening	yīgēnhuángguātāzàitīngle 一根黄瓜它在听了	LIVING THINGS	^{M}CUCUMBER 8 (2+3)z
A carrot that is ticklish	yīgēnhúluóbotāshìpàyǎngde 一根胡萝卜它是怕痒的	LIVING THINGS	CARROT$_{b}$ 10 (3+4)s
fINT item English	fINT item Chinese (including Pinyin)	Ontological Category	Notes
A caterpillar that is eating	yīzhīmáomáochóngtāzàichī le 一只毛毛虫它在吃了	ANIMATES	9 (3+3)z
A frog that is jumping	yīzhīqīngwātāzàitiàole 一只青蛙它在跳了	ANIMATES	9 (2+3)z
A boy that is dirty	yīgènánháitāshìzāngde 一个男孩他是脏的	PERSONS	8 (2+3)s
A queen that is rich	yīgènǚwángtāshìfùyǒude 一个女王她是富有的	PERSONS	9 (2+4)s
An icicle that is dripping	yīgēnbīngzhùtāzàidīshuǐle 一根冰柱它在滴水了	SOLID OBJECTS	9 (2+4)z
A stone that is smooth	yīkuàishítoutāshìguānghuáde 一块石头它是光滑的	SOLID OBJECTS	9 (2+4)s
A cabbage that is rotting	yīkēbáicàitāzài fǔlànle 一棵白菜它在腐烂了	LIVING THINGS	9 (2+4)z
A banana that is curved	yīgēnxiāngjiāotāshìwānde 一根香蕉它是弯的	LIVING THINGS	8 (2+3)s m.

uINT item English	uINT item Chinese (including Pinyin)	Ontological Category	Notes
A goat that is deaf	yīzhīshānyángtāshìlóngde 一只山羊它是聋的	ANIMATES	8 (2+3)s
A squirrel that is swimming	yīzhīsōngshǔtāzàiyóuyǒngle 一只松鼠它在游泳了	ANIMATES	9 (2+4)z
A postman that is hiding	yīgèyóudìyuántāzàiduǒcángle 一个邮递员他在躲藏了	PERSONS	10 (3+4)z
A monk that is skipping	yīgèhéshangtāzàitiàoshéngle 一个和尚他在跳绳了	PERSONS	9 (2+4)z
A planet that is hollow	yīgèxíngxīngtāshìzhōngkōngde 一个行星它是中空的	SOLID OBJECTS	9 (2+4)s m.
A mountain that is soft	yīzuòshāntāshìróuruǎnde 一座山它是柔软的	SOLID OBJECTS	8 (1 +6)s m.
A cactus that is greasy	yīkēxiānrénzhǎngtāshìyóunìde 一棵仙人掌它是油腻的	LIVING THINGS	10 (3+4)s
A pumpkin that is poisonous	yīgènánguātāshìyǒudúde 一个南瓜它是有毒的	LIVING THINGS	9 (2+4)s

m = modification from UK stimuli set; s = statement containing adjective; z = statement containing verb

MCI items included in the China-based stimuli set represented both types of counterintuitive violation in equal proportions: there were 8 stimuli with *breaches* and 8 *transfers* of an expectation set. The "notes" column to the right of Table 4 contains notation detailing the number of characters used to form the statement and the number of characters used to form the noun and adjective/verb components. In explanation using the following notation:

$t(n+x)s$ or $t(n+x)z$

Where,

t = total number of characters in statement;

n = number of characters expressing noun;

x = number of characters involved in expression of adjective/verb.

Also, to differentiate the two grammatical varieties:

s = statement variety containing an adjective;

z = statement variety containing a verb

Although every effort was made to maintain the same stimuli set as in the UK study, due to differences in the ideas with which people in these two very different cultural populations were familiar, modifications from the UK stimuli set had to be made. For example, “a moon that is hollow” had to be changed to “a planet that is hollow” (一个行星它是中空的), because it was found that many people in the general Beijing population are rather surprisingly not aware that other planets have *moons*, and the word “moon” (月亮) functions only as a pronoun. There were also familiarity issues with the typically strange ideas of the fMCI category. Knowledge of the existence and behaviour of Venus-flytraps, popularly represented and familiar to many in British culture, and other familiar ideas from folktales exemplified by statements such as “a tree that is thinking” were not found in the Chinese distribution of representations to the same widespread degree. This disparity should be attributed to due to differing folktale traditions and variations in the furniture of the Chinese world. Therefore, such ideas were substituted prior to pretesting for Chinese equivalent suggestions of the same ontological category and with similar conceptual components. Two other items present within both China and UK pretesting lists were differentially selected as a result of pretesting, as more appropriate alternative were determined for the different populations. A total of five test items differ or were modified from those within the UK-based stimuli set.[31]

To test for parity in the ratings of UK and China participants, a one-way between subjects ANOVA was conducted to compare the effect of country of experiment site on the mean rating scores by stimuli category (fMCI, uMCI, fINT, and uINT). No significant differences were found between the mean scores of UK and China participants at the $p > .05$ level for the stimuli categories of fMCI, $F(1, 38) = 2.586$, $p = .116$; uMCI, $F(1, 38) = 2.968$, $p = .093$; and uINT, $F(1, 38) = 3.893$, $p = .056$. However, the country of the experiment site significantly affected the mean ratings of the fINT category, $F(1, 38) = 6.706$, $p = .014$. This was considered to

[31] Changes from the UK stimuli set are denoted by *m* in the notes column of Table 3.

be an acceptable level of parity between the UK and China stimuli sets, especially as the fINT category had no impact on any of the central hypotheses listed in Chapter 2.

It is worth noting that this pretest chapter describes the *minimal condition* of stimuli. An *elaborated condition* derived from this minimal condition characterizes all of the stimuli of Experiment #2 of Study #1, the grammatical formulation of which shall be described in Chapter 5. The next chapter is a second pretest chapter (Pretest #2) detailing the methodology and results by which survey scores representing the mean level of schema-level effects acting on each of these final 32 stimuli in both the UK and China. These five schema-level effects consist of: negative emotion, positive emotion, imagery, humour, and inferential potential.

4 Pretest #2: Survey of schema-level effects on stimuli

This second pretest was essential to establish further mean ratings for each of the final 32 stimuli determined in Pretest #1. Drawing from the discussion and empirical justification in Section 1.3, five schema-level effect categories were identified as having empirical support for the potential to promote mnemonic advantage. The nature of the experimental design for the main free-recall experiments (Experiments 1 and 2: Chapters 5 and 6, respectively), which were centrally concerned with the relationship between counterintuitiveness and familiarity, also provided the opportunity to investigate the impact of these additional schema-level effects on the recall of the stimuli. To do this, it was necessary to establish comparable scores for each of these schema-level effects for each of the stimuli by means of a questionnaire. The five schema-level effect categories were (see Section 1.3 for further explanation):

- Negative Emotion (NEG)
- Positive Emotion (POS)
- Imagery (IMA)
- Humour (HUM)
- Interest[32] (IP)

4.1 Method

This survey of the 32 stimuli, scored according to how well they exemplified each of these five schema-level effects, used the same participants as Addition Analysis #1 (Chapter 8). The participants gained a thorough understanding of what each of the schema-level effect categories represented by completing a stimuli authorship and subsequent free-recall task. This indoctrination period enabled them to understand the criteria for membership in each schema-level effect category and to form judgements about category membership. See Chapter 8 for further details and explanation.

[32] "Interest" is here used as a proxy for inferential potential (IP).

4.2 *Materials and procedure*

The participants were presented with the 32 stimuli, each with the five accompanying rating scales representing each of the schema-level effects, and the instructions to complete the task, on 11 sheets of white A4 paper (see Appendix 2 for the UK example of "Answer Sheet 2b"). The pretest was conducted in an empty restaurant on the Beihang University campus in Beijing, China, and in empty seating areas at the Oxford University Sports Centre and at High Wycombe Judo Club in the UK. The participants, seated at separated tables, were all then asked to fill in their personal details on the top sheet. When all participants had completed this preliminary task they were instructed, "Please turn over the first page of Answer Sheet. The next page contains the instructions for the task ahead. You have as much time as you require for completion of this task. Please take great care to consider each statement and what it represents very carefully." For each of the 32 stimuli the participant was presented with five 9-point rating scales corresponding to each of the schema-level effects. Each scale was bounded by "strong affect" at point 9 and "no affect" at point 1 with regard to the rating of an emotional response on the part of the participant. All participants were requested to entertain each statement and to rate how well it exemplified each of the five schema-level effects for them personally. The order of presentation was randomised for each participant. Participants had unlimited time to complete the task. As the instruction page provided for this task was extensive, it was estimated that the time participants took to complete the task ranged from 15 to 25 minutes. When participants individually signalled that they were finished, they were directed to approach the researcher, at which point each was reimbursed £10 (UK) or 50 Yuan (China) for his or her cooperation and the Answer Sheet collected.

4.3 *Pretest #2: UK*

4.3.1 *Participants of UK Study*

Forty participants were recruited from the general public and sporting societies in the populations of Oxfordshire and Buckinghamshire. Researchers indiscriminately approached persons at the Iffley Road Sports Centre in Oxford and the High Wycombe Judo Centre and within the working public from the village of Elsfield in Oxfordshire. The age of participants ranged from 16 to 52 years old with a mean age of 30.32 (*SD* = 9.99) years. Twenty-six participants were male (65%) and 14 female (35%). All participants considered themselves to be fluent in English. Twenty-six members of the sample spoke English as a natural language. Participants were compensated £10 for their participation in a "cognitive task".

4.3.2 Results: UK

Table 5 contains the mean ratings scores for UK Pretest #2 corresponding to the schema-level effect categories of positive emotion, negative emotion, imagery, humour, and interest.[33]

Table 5. *The mean rating scores for schema-level effect categories of UK Pretest #2.*

Stimulus	POS	NEG	IMA	HUM	IP
A mouse that is talking	5.47	2.25	6.64	5.97	5.33
A wolf that is acting	4.81	2.97	6.03	5.14	5.06
A man that is invisible	4.28	4.00	5.47	3.61	6.36
A being that is everywhere	4.28	3.42	3.89	2.08	6.44
A skeleton that is fighting	3.61	4.17	7.28	4.67	5.36
A balloon that is hovering	5.16	2.16	6.70	2.84	4.43
A venus-flytrap that is grabbing	3.54	3.32	6.83	2.30	5.33
A tree that is thinking	5.67	1.83	5.42	4.00	6.42
fMCI mean scores	**4.6**	**3.02**	**6.03**	**3.83**	**5.59**
A rabbit that is egg-laying	4.14	2.65	5.84	5.49	5.78
A snail that is reading	5.03	1.78	6.86	6.53	5.81
A gardener that is bodiless	2.75	3.58	4.81	3.61	4.69
A chef that is immortal	4.03	3.22	4.36	3.97	5.26

[33] An additional analysis investigated Boyer's (2000, 2001) claim that counterintuitive ideas on average have greater inferential potential than intuitive (INT) ideas. The mean rating scores acquired for the complete stimuli sets of Pretest #2 facilitated the opportunity to test this prediction (see Table 7 for UK figures; Table 8 for China figures). Drawing from the UK mean rating scores, a paired sample t-test found that MCI items had significantly higher mean IP ratings than the INT items, M = 5.24 (SD = 0.771) and M = 3.96 (SD = 0.84), respectively; $t(15) = 3.59$, $p = .003$. The same analysis was run for the mean rating scores produced in Pretest #2 for the China study. Significantly higher mean IP ratings were again revealed for MCI over INT ideas, M = 5.22 (SD = 0.634) and M = 3.89 (SD = 1.09), respectively; $t(15) = 3.81$, $p = .002$.

Support here for this claim is of interest, because if what Boyer suggests is correct, the mnemonic advantage that MCI ideas enjoy could be partly due to the higher than average inferential potential they typically possess, which in itself promotes a mnemonic advantage.

A comet that is sad	2.16	4.44	4.03	2.89	4.06
A snowflake that is hungry	3.97	2.53	4.94	4.89	4.28
A cucumber that is listening	3.74	1.89	4.71	5.49	4.66
A carrot that is ticklish	4.86	1.67	5.17	5.89	4.50
uMCI mean scores	**3.84**	**2.72**	**5.09**	**4.85**	**4.88**
A caterpillar that is eating	3.72	2.86	6.06	2.67	4.06
A cow that is lying down	4.44	1.86	6.64	2.89	3.64
A boy that is dirty	4.06	3.67	6.81	3.78	3.64
A queen that is rich	3.00	4.72	5.69	2.03	3.00
An icicle that is dripping	3.97	2.78	6.95	1.81	3.53
A stone that is smooth	5.08	1.94	6.69	2.17	4.39
A cabbage that is rotting	1.47	5.00	5.83	1.92	2.47
A potato that is muddy	3.64	2.08	6.31	2.36	2.78
fINT mean scores	**3.67**	**3.11**	**6.37**	**2.45**	**3.44**
A goat that is deaf	2.39	3.94	4.03	3.08	3.74
A squirrel that is swimming	5.50	1.94	6.53	4.61	5.00
A postman that is hiding	3.08	3.14	6.35	5.00	4.58
A monk that is skipping	5.36	2.11	6.94	6.08	4.75
An island that is four-sided	3.22	1.57	6.19	2.81	4.89
A moon that is hollow	3.19	3.11	5.17	3.03	5.31
A cactus that is greasy	2.28	3.14	4.25	3.03	3.25
A pumpkin that is poisonous	1.83	5.47	4.31	2.11	4.31
uINT mean scores	**3.36**	**3.05**	**5.47**	**3.71**	**4.48**

Columns represent: positive emotion (POS); negative emotion (NEG); imagery (IMA); humour (HUM); and interest (IP). Stimuli are colour-coded according to stimuli category: dark orange = fMCI; orange = uMCI; dark blue = fINT; light blue = uINT.

4.4 *Pretest #2: China*

4.4.1 *Participants in China study*

Fifty participants were recruited from the general public surrounding Beihang University in Beijing. Researchers approached persons employed at and within the local catering services, shops and supermarkets as well as other students and non-academics in the complex to instigate a snowballing method of recruitment. A sample composed of students and academics, skilled workers and non-skilled workers in a variety of industries, and unemployed persons was gathered. The age of participants ranged from 10 to 58 years old with a mean age of 22.22 (*SD* = 10.42) years. Forty participants were male (80%) and 10 female (20%). All participants considered themselves to be fluent in Chinese. Forty-seven members of the sample identified themselves as being of Han ethnicity. Participants were compensated 50 Yuan for their participation in a "cognitive task".

4.4.2 *Results: China*

Table 6 contains the mean rating scores from the questionnaires given to participants in the China study corresponding to the schema-level effect categories of positive emotion, negative emotion, imagery, humour, and inferential potential:

Table 6. *The mean rating scores according to schema-level effect for China Pretest #2.*

Stimulus	POS	NEG	IMA	HUM	IP
A mouse that is talking	4.76	3.43	4.94	5.76	5.39
A wolf that is disguising	4.45	5.45	5.22	5.59	4.88
A man that is invisible	4.35	3.96	4.52	3.55	5.57
A being that is everywhere	4.06	3.73	3.56	2.55	4.12
A skeleton that is fighting	4.18	3.98	5.33	5.18	5.67
A balloon that is hovering	6.27	3.29	6.37	3.78	5.41
A flower that is smiling	7.51	2.33	6.53	3.88	5.88
A tree that is money-laden	6.51	2.96	5.67	3.88	5.82
fMCI mean scores	**5.26**	**3.64**	**5.26**	**4.27**	**5.34**
A rabbit that is egg-laying	4.24	2.88	4.02	6.63	5.96
A snail that is reading	6.35	2.35	4.71	6.69	5.86
A gardener that is bodiless	4.08	2.92	3.83	3.65	5.22
A chef that is immortal	4.20	2.61	3.24	3.84	4.02
A comet that is sad	3.51	5.65	4.57	4.00	4.57
A snowflake that is hungry	3.18	4.12	4.27	4.86	4.41
A cucumber that is listening	4.90	2.73	4.29	5.82	5.47
A carrot that is ticklish	4.90	2.53	3.73	7.14	5.24
uMCI mean scores	**4.42**	**3.22**	**4.08**	**5.32**	**5.09**
A caterpillar that is eating	3.35	4.16	5.69	3.37	2.86
A frog that is jumping	4.65	2.51	6.39	3.65	3.63
A boy that is dirty	3.39	5.20	5.80	2.84	2.94
A queen that is rich	4.18	3.55	6.00	2.43	3.43
An icicle that is dripping	4.02	3.59	6.52	2.73	3.63
A stone that is smooth	5.06	2.67	6.35	2.82	3.84
A cabbage that is rotting	1.98	5.43	5.41	1.94	2.16
A banana that is curved	4.02	2.00	6.45	2.45	3.31
fINT mean scores	**3.83**	**3.64**	**6.08**	**2.78**	**3.22**

A goat that is deaf	2.86	5.14	4.39	3.59	3.96
A squirrel that is swimming	5.55	2.43	5.24	5.92	6.45
A postman that is hiding	3.10	4.47	4.75	3.45	4.65
A monk that is skipping	5.51	2.92	5.35	6.59	4.76
A planet that is hollow	3.69	3.39	4.82	3.55	5.39
A mountain that is soft	4.61	3.16	4.27	4.86	4.84
A cactus that is greasy	2.54	5.31	4.65	3.67	3.14
A pumpkin that is poisonous	2.78	5.71	3.49	2.49	3.18
uINT mean scores	**3.83**	**4.07**	**4.62**	**4.26**	**4.55**

Columns represent: positive emotion (POS); negative emotion (NEG); imagery (IMA); humour (HUM); and interest (IP). Stimuli are colour-coded according to stimuli category: dark orange = fMCI; orange = uMCI; dark blue = fINT; light blue = uINT.

4.5 *Inter-sample agreement*

To test for inter-sample agreement in the ratings of UK and China participants, a one-way between subjects ANOVA was conducted to compare the effect of the country of experiment site on the mean rating scores by stimuli category and schema-level effect (40 categories in total; see Tables 5 and 6 for mean values). A significant difference was found between the mean rating scores of UK and China participants at the $p > .05$ level for humorous uMCI stimuli (M = 5.09, SD = .89, and M = 4.08, SD = .48, respectively), $F(1, 88) = 7.87$, $p = 0.14$. No other significant effect of the country of experiment site on the mean ratings was found for the remaining categories (all p > .05). These mean rating scores will be used in Study #1 that follows (Chapter 5) to test a hypothesis predicting the impact of these schema-level effects on recall and therefore the epidemiology of cultural representations (*schema-level effect hypothesis*). They will also facilitate investigation of the interaction of these schema-level effects and the template-level violation of counterintuitiveness. Chapter 5, to follow, considers the results of a free-recall test for stimuli obedient to the minimal condition (subject-predicate statements) and elaborated condition (added descriptive context) of stimuli presentation and tests of the predictions of the main hypotheses, including those of the schema-level effect hypothesis.

5 Study #1: Template- and schema-level effects: mnemonic biases and interactions

This chapter reports the results of analyses from two free-recall experiments. Experiment #1 presented stimuli in the *minimal condition*: stimuli obedient to the grammatical form of a subject-predicate statement (see below). Participants in this experiment, in both the UK and China, were randomly assigned to either an oral or a written presentation of stimuli. In contrast to the minimal condition of the first experiment, Experiment #2 presented stimuli in the *elaborated condition*: a mixed-media format of presentation with an expanded descriptive structure of the stimulus. The stimuli set and methodology were otherwise identical to that of Experiment #1. These experiments were designed with the aim of testing the main hypotheses centred on Boyer's theory of the mnemonic and transmission advantages of counterintuitive ideas (see Chapter 2 for a full detailed listing of the hypotheses). As an expansion of the typical formulation of the MCI hypothesis that had dominated prior experimental MCI studies, the interaction of the counterintuitive template-level effect with schema-level mnemonics was investigated, as per Boyer's original assertion of the epidemiological advantages of "familiar" counterintuitive ideas (Boyer 2001: 58-105). In this regard, the *familiar MCI hypothesis* predicts that familiar-counterintuitive stimuli will be significantly better recalled than novel, unfamiliar-counterintuitive stimuli. The *schema-level effect hypothesis* predicted that mnemonic advantages for stimuli exemplifying any of the five schema-level effects (positive emotion, negative emotion, imagery, humour, and inferential potential) would be revealed. The impact of age on the recall of counterintuitive representations was also investigated, facilitated by means of samples representative of the age demographics of the populations. As predicted by the MCI age-effect hypothesis, younger persons were expected to recall a significantly greater number of counterintuitive representations than the older adult participants. In addition, the cross-cultural experiment sites of UK and China facilitated the testing of the claim of the universality of the counterintuitive effect. The inclusion of both an oral and written mode of presentation in Experiment #1 permitted predictions regarding the ecological validity of presentation media in such free-recall experiments of the *transmission mode equality hypothesis* to be tested as well. Prior to the arrival of written symbols, the cultural transmission of stories and folktales has been dominated by the oral mode of transmission, whether by means of epic, ballad, or counting-out rhyme (Rubin 1995). Various studies have looked at the changing relationships between oral and written communication when societies from different historical periods move from a primarily oral culture with limited use of written materials to a "document-minded" culture (Thomas 1989: 36). These document-minded cultures have been described as having a different "literate mentality" (Clanchy 1979). It is claimed that oral and written language have different effects upon human memory, as written texts are often primarily used as mnemonic aids rather than as works of reference (e.g. Hildyard and Olson 1982, Person 1993). However, Brimer and Mueller (1979) found no significant differences for recall rates of sequences of written and oral items. The transmission mode equality hypothesis predicts that no significant differences for recall rates of stimuli presented in either the oral or written presentation modes will be revealed.

5.1 Experiment #1: Recall of minimal condition stimuli

5.1.1 Method

Thirty-two stimuli adhering to the familiarity x counterintuitiveness categories of *familiar minimally-counterintuitive* (fMCI), *unfamiliar minimally-counterintuitive* (uMCI), *familiar intuitive* (fINT), and *unfamiliar intuitive* (uINT) were presented sequentially to individual participants in a free-recall experiment using either a written or oral presentation to participants in both the UK and China. The complete stimuli sets for both the China and UK studies can be viewed in Section 3.5 of Chapter 3. All stimuli obeyed the grammatical structure of subject-predicate statements, referred to as the *minimal condition* of presentation:

Minimal condition formula for stimuli of the UK study:
A [X] that is [Y]

e.g. "a frog that is jumping" or "a doctor that is invisible"

Where X = noun and Y = adjective

Minimal condition formula for stimuli of the China study:

Grammatical formula for statements containing an adjective:

yī 一 + *[measure word]* + *[noun(subject)]* tā 它 + shì 是 + *[adjective (predicate)]* + de 的

Or,

Grammatical formula for statements containing a verb:

yī 一 + *[measure word]* + *[noun(subject)]* tā 它 + zài 在 + *[verb (predicate)]* + le 了

5.1.2 Design

Thirty-two stimuli were selected according to the pretesting methodology and results of Pretest #1, detailed in Chapter 3. The same stimuli were presented to participants for free recall in both Experiments #1 and #2 (Chapters 5 and 6, respectively). For both experiments, a random order of the 32 stimuli was assigned to each participant, according to another randomly determined alternating-sequence of the four stimuli categories (fMCI, uMCI, fINT, and uINT). The following are examples of complete alternating sequences to which stimuli were randomly selected and assigned by stimuli category:

fMCI ⇒ uINT ⇒ uMCI ⇒ fINT ⇒ fMCI ⇒
uINT ⇒ uMCI ⇒ fINT ⇒ fMCI ⇒ uINT ⇒
uMCI ⇒ fINT ⇒ fMCI ⇒ uMCI ⇒ uINT ⇒
fINT ⇒ fMCI ⇒ uINT ⇒ uMCI ⇒ fINT ⇒
fMCI ⇒ uINT ⇒ uMCI ⇒ fINT ⇒ fMCI ⇒
uINT ⇒ uMCI ⇒ fINT ⇒ fMCI ⇒ uINT ⇒
uMCI ⇒ fINT

or…

uINT ⇒ fINT ⇒ uMCI ⇒ fMCI ⇒ uINT ⇒
fINT ⇒ uMCI ⇒ fMCI ⇒ uINT ⇒ fINT ⇒
uMCI ⇒ fMCI ⇒ uINT ⇒ fINT ⇒ uMCI ⇒ …etc.
fMCI ⇒ uINT ⇒ fINT ⇒ uMCI ⇒ fMCI ⇒
uINT ⇒ fINT ⇒ uMCI ⇒ fMCI ⇒ uINT ⇒
fINT ⇒ uMCI ⇒ fMCI ⇒ uINT ⇒ fINT ⇒
uMCI ⇒ fMCI

However, strictly speaking the procedure yielded only a semi-random presentation order, because the presentation sequences were constrained so that more than one category member in a row was disallowed and the occurrence of each category at the beginning or end of the list was balanced. This ordering aimed to avoid the bias incurred by conceptual priming, order effects, or other related biases.

5.1.3 *Materials and procedure*

Within language constraints, materials and procedure were identical for the UK and China studies. Participants were tested individually. Testing was conducted in a quiet corner of the same sports centre, park, place of work, café or restaurant in which each participant had been recruited. Participants were assigned either to a written presentation of stimuli or oral presentation of stimuli. Ear defenders were given to participants in the written presentation to use, to ensure that ambient stimuli were minimised, and also to mirror the use of headphones in the oral presentation. Research assistants, blind to the hypotheses, were provided with a strict procedure to follow (see Appendix 5 for details). Procedures and the setup of the testing areas were thoroughly rehearsed several times prior to actual testing. After recording their anonymous personal details (age, sex, ethnicity, and natural language), participants were led to the corner of the site (restaurant, sports hall, place of work, etc.), were asked to take a seat approximately 1 metre from a 19-inch laptop screen, and were each given a pair of ear defenders. At the UK site the participant was then told[34]: "You're about to take part in a memory task. The following video clip will contain a series of short sentences. Each sentence will remain on the screen for 9 seconds. You will see a total of 32 sentences. Please take care to consider each sentence carefully. Please now put on your ear defenders".[35] A slideshow of the randomly generated sequence of the 32 stimuli was then presented in accordance with the format that follows.

For the written presentation of stimuli in both the UK and China studies the stimulus was displayed on the laptop screen. For the UK study, the stimulus was presented in Calibri 48-point type in white on a contrasting blue background, along with a central image representing a *normal* state of the noun component of the statement. The stimuli for the China study had an equivalent presentation. All the images were comparable in size, and all were presented on a

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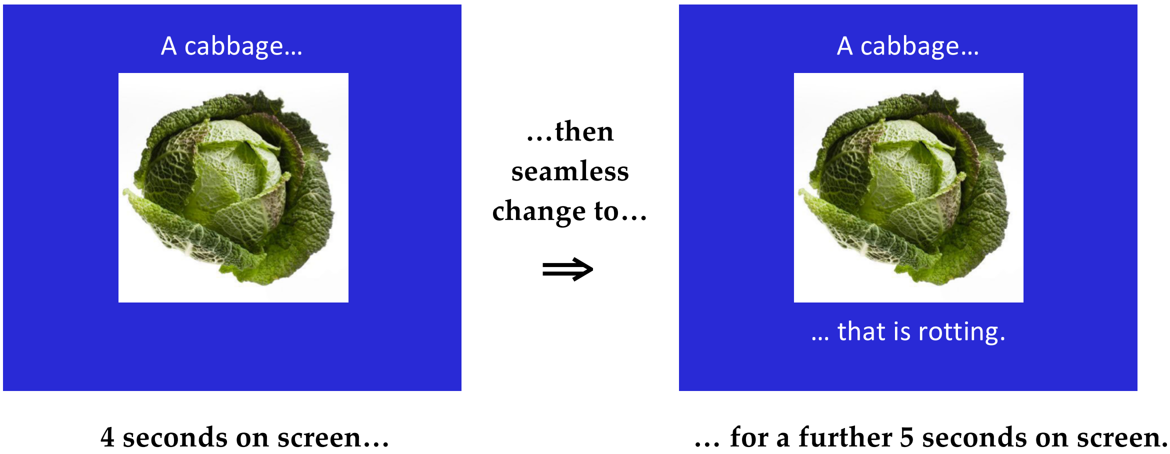
[34] The Mandarin language selected for use in the China study was the closest equivalent available to the English used in these instruction passages.
[35] For participants allocated to the oral presentation of stimuli, "ear defenders" was replaced with "headphones".

white background. Each stimulus was presented on screen for a total of 9 seconds: 4 seconds to display the noun component of the subject-predicate structure alone, then, for a further 5 seconds, the rest of the statement would be added beneath the central image. The next stimulus in the sequence would then appear. Figure 5 illustrates the screen layout and stimuli time constraints for the written presentation condition:

Figure 5. An example of the written presentation of the minimal condition.



The oral presentation of stimuli was comparable to the written presentation of stimuli. The oral presentation of a stimulus in subject-predicate statement form was accompanied by an image representative of the stimulus on the screen identical in size and form to the written stimuli presentation, but here no written statement was presented. Timing of the presentation of the statement components and overall length of presentation for each stimulus was identical to that of the written presentation, 4 seconds for the noun alone, with an additional 5 seconds for the remainder of the subject-predicate statement. Figure **6** shows one such example of the accompanying image and presentation for a stimulus.

Figure 6. An example of the visible screen accompanied by the oral presentation of the minimal condition.

After the presentation sequence of all 32 items had finished, indicated by the point at which the screen displayed “END”, the laptop in front of the participant was replaced with a Connect Four game board in the UK experiment, or with 五子棋 (pronounced *“WuZiQi”)*, the “five-piece connect” closest equivalent in China, which was used for the distractor task to follow. In both UK and China, each participant spent the next three minutes completing a distractor task playing with the research assistant. After these three minutes were over, the game board was removed, at which point each participant was given a clipboard with a pen and a blank white sheet of A4 paper, and told: “Could you now please write down any of the sentences you can remember from the screen. You have 4 minutes to write down as many as possible”. The participants were advised to return the following week for a “slightly different task”, and asked not to divulge the contents of the test with people waiting to be tested. Participants, however, were not encouraged or discouraged to talk about the contents of the test when away from the location, so as not to interfere with normal processes of cultural transmission that participants might engage in spontaneously such as narrative consolidation (i.e. telling others about the most memorable aspects of their experience). Participants returned after a week, at the same appointment time as the previous week, for the second period of testing. Participants were led into the same testing location as the previous week, again given a clipboard with pen and blank paper, and asked by the testing assistant to write down in 4 minutes as many of the items as they remembered from the previous week.

5.1.4 Measures and coding

Two dependent variables were assessed: free memory recall after a three-minute distractor test (immediate recall) and a second, delayed free recall after a period of one week (delayed recall).

The coding method was comparable for Experiments #1 and #2. Two assistants coded participants' responses independently. Both assistants completed a point-scoring sheet for the written responses of each participant and followed with a check for concurrence between the assistants' scores. The assistants discussed any disputes in scoring, drawing from coding guidance materials provided, until they reached an agreement. One completed scoring sheet was retained, the other discarded. The central concern with regard to the cultural transmission of concepts and key elements facilitating this transmission was how well the participant's private representation of the recalled stimulus adhered to the intended meaning of its author. Scoring was therefore concerned with the participant's recall of a representation that shared its meaning with the original stimulus.

Participants were scored on their recall of both the subject noun and the predicate adjective. No other component of the sentence structure or grammatical structure was coded. One point was scored for recall of both the subject noun and the predicate adjective in any grammatical structure that contained the basic concept and modifying property. This permitted a single point to be scored for the recall of several varying grammatical forms, for example: "A doctor that is invisible" or "invisible doctor" would both be scored as one point. The recall of a particular stimulus was scored only once per participant—even if he or she recalled it twice or more times. In addition, as the recall of a representation that shared its meaning with the original stimulus was the most important element of this study, rather than coding specific to the recall of identical wording for the noun, adjective, and conjoining components of the stimulus itself, one point was also scored if one of or both the noun and adjective recalled shared a grammatical root with that of the stimulus, or were synonymous in meaning, a plural conjugation, or poorly spelled but recognisable. For example, "a doctor that can't be seen" or "doctors are imvisable" would be acceptable and scored as one point. Recall of either the noun or adjective alone, in any grammatical form, scored no points. Greater detail on the specifics of coding methodology provided to the two assistants[36] can be viewed in Appendix 6.

5.1.5 Participants

Participants were recruited in accordance with quotas for age-banded groups in both the UK and China to ensure a representative age demographic was attained. In both locations participants were assigned to either a written presentation or an oral presentation of stimuli. In total, 365 people participated in this experiment with a mean age of 32.81 (SD = 17.22) years. Ages ranged from 13 to 86 years. One hundred and eighty-six of the participants were female (51.0%), and 179 were male (49.0%). Three hundred and thirty-five participants spoke the presented language as a natural language. All participants were informed they were to take part in a "memory task".

5.1.5.1 Participants in UK study

One hundred and eighty-four participants[37] were recruited from the general UK population. Ages ranged from 13 to 84 years, with a mean age of 32.13 (*SD* = 16.29) years. Participants were

[36] The coding assistant who led the procedure was blind to the hypothesis. However, the nature of the within-subjects design and procedure was sufficiently transparent to allow another scorer with knowledge of the test design to assist the first coding assistant. The level of transparency of recall data to be coded was such that no disagreement between the coders was recorded—inter-coder reliability approximated 100%.

[37] Ninety-seven participants were assigned to the written presentation of stimuli. Ages ranged from 13 to 84 years, with a mean age of 32.86 (*SD* = 16.39) years. Forty-nine of the participants were female, and 48 were male, 84 of whom spoke English as a natural language. Eighty-seven participants were assigned to the oral presentation of stimuli. Ages ranged from 13 to 78 years, with a mean age of 31.33 (*SD* = 16.23) years. Forty-six of the participants were female, and 41 were male, 76 of whom spoke English as a natural language.

indiscriminately approached at several sites in Oxfordshire and the West Midlands. Oxford locations included Oxford University Sport Centre, G & D's Café on the Cowley Road, and Joe's Bar and Grill in Summertown. Participants were also recruited using the same method at Shirley Golf Club in Solihull in the West Midlands. The snowballing method of recruitment was also used and instigated with participants who had already taken part in the study. Appointments were made for participants recruited by this method at the preceding locations. All recruited individuals were assigned an appointment time for a "memory task" in the first testing period and a second "somewhat different task" scheduled for a time exactly one week later. Ninety-five of the participants were female (51.6%), and 89 were male (48.4%). Research assistants also recruited participants in accordance with age-group quotas to ensure that a representative age demographic sample was attained. Table 7 contains descriptive and frequency statistics specific to age-group category for the UK study. All participants considered themselves to be fluent in English, and 160 of them spoke English as their first language. Participants were compensated £10 for their participation after completing the delayed period of testing.

Table 7. *Descriptive and frequency statistics for participants by age group in UK study*

Age group		Age				Sex		Language	
	N	Min	Max	*M*	*SD*	Male	Female	Foreign	Natural
≥13<20 years	46	13	19	16.76	1.81	22	24	5	41
≥20<28 years	50	20	27	22.92	2.43	17	33	7	43
≥28<50 years	51	28	49	35.1	6.17	28	23	12	39
≥50 years	37	50	84	59.62	8.62	22	15	0	37

5.1.5.2 Participants in China study

One hundred and eighty-one participants[38] were recruited from the general population of Beijing. Ages ranged from 13 to 86 years, with a mean age of 33.49 (*SD* = 18.15) years.

[38] Ninety-five participants were assigned to the written presentation of stimuli. Ages ranged from 13 to 78 years, with a mean age of 32.48 (*SD* = 16.94) years. Thirty-eight of the participants were female, and 57

Participants were indiscriminately approached in an eating complex at Beihang University, which included a supermarket, several canteens, and a restaurant, and within parks of the Beihang[39] university area, and at several business companies in the Wudakou district of Beijing. The snowballing method of recruitment was also used and instigated with participants who had already taken part in the study. Appointments were made for participants recruited by this method at the preceding locations. All recruited individuals were assigned an appointment time for a "memory task" in the first testing period and a second "somewhat different task" scheduled for a time exactly one-week later. Table 8 contains descriptive and frequency statistics for participants in the constituent age-group categories demanded by the age-demographic quota. Ninety-one of the participants were female (50.3%), and 90 were male (49.7%). All participants considered themselves to be fluent in Chinese; 175 of them spoke Chinese as their first language. Participants were compensated 50 RMB after completing the delayed period of testing.

Table 8. *Descriptive and frequency statistics relative to participant age-group category*[40]

Age group	Age					Sex		Ethnicity	
	N	Min	Max	*M*	*SD*	Male	Female	Other	Han
≥13<20 years	43	13	19	15.84	2.13	19	24	1	42
≥20<28 years	49	20	27	22.59	1.71	26	23	4	45
≥28<50 years	48	28	49	36.23	6.9	23	25	0	48
≥50 years	41	50	86	61.8	10.31	22	19	1	40

were male, 93 of whom spoke Chinese as a natural language. Eighty-six participants were assigned to the oral presentation of stimuli. Ages ranged from 13 to 86 years, with a mean age of 34.59 (*SD* = 19.43) years. Thirty-three of the participants were male and 53 were female, 82 of whom spoke Chinese as a natural language.

[39] The nature of university campus can differ dramatically in contrast to those typical to Europe and the US. These "university areas" tend to be much larger in scale, a large proportion of which are constituted by unaffiliated members of the general public, as well as students, academics, and service staff.

[40] A number of participants failed to complete the study due to language, comprehension problems, or experimenter error. These failed participants would have aligned with the following age groups: 1 in the ≥20<28 years age group; 9 in the ≥28<50 years age group; and 9 in the ≥50 years age group. These figures are not reported in the descriptive statistics of the sample.

5.1.6 Results

A hierarchical linear model (HLM) was used to investigate the relationship between counterintuitiveness and familiarity, the relationship between template-level violation and schema-level effects, the interaction of counterintuitiveness and age with regard to recall rates, and especially to test the prediction of Boyer's central hypothesis that there exists a mnemonic advantage for counterintuitive concepts over intuitive concepts. Specifically, the models investigated the main effects of and the interactions among counterintuitiveness (intuitiveness versus counterintuitiveness), familiarity (unfamiliar versus familiar), and delay (immediate versus one-week delay), and their influence on recall rates of stimuli. In all three cases, counterintuitiveness, familiarity, and delay were entered into the HLM as level 1 fixed factors. Country of experiment location, presentation mode, age, and schema-level effects of positive emotion, negative emotion, imagery, humour, and inferential potential were entered as level 2 fixed factors. Participant identity (a means of identifying "subjects") was entered as a level 2 random factor.

The development of the model was divided into what were potentially two or more building stages. First, there was a preliminary-model stage where only level 1 fixed factors and the level 2 fixed factor of country of experiment site were considered to permit evaluation of this pivotal factor, integral for determining an appropriate direction for cross-cultural comparisons of the following stages. If a significant cross-cultural difference in recall was to be detected, this would be followed by a second preliminary stage which considered a split HLM for the UK and China, and investigation of another pivotal factor, that of presentation mode, along with the level 1 fixed factors alone, this time to determine the need for further splits in the data set into more appropriate samples in accordance with written or oral presentation conditions. Last, a final model (or, *final models* if previous splits in the data set were deemed necessary by this procedure) that accommodated all factors, at all levels, and their interactions, would be developed. Table 9 displays the results of the first preliminary model, which was necessary for investigating the impact of country of experiment site on recall and appropriate direction:

Table 9. *HLM parameter estimates for preliminary minimal condition model indexing contributions of fixed factors on recall*

Parameter	*b*	*SE b*	*df*	*t*	*p*
Intercept	1.64	.2	386.54	8.23	< .001
Familiarity	- .56	.04	2419.46	-14.57	< .001
Counterintuitiveness	.17	.04	2419.46	4.32	< .001
Delay	.66	.04	2469.62	17.03	< .001
Country of location	- .24	.09	360.21	-2.63	.009
Presentation mode	0	.09	359.88	.013	.990

This preliminary model conflated both the UK and China samples. All effects are reported as significant at $p < .05$. In the immediate period of testing, participants recalled on average 21.9% of stimuli (7.02 of a possible 32 stimuli), and after a one-week delay, participants recalled on average 13.7% of stimuli (4.38 of a possible 32 stimuli). Parameter estimates revealed that counterintuitiveness significantly predicted the recall rate of stimuli, $F(1, 2419.46) = 18.64$, $p < .001$. Further investigation showed that this finding was actually a complete reversal of the general trend of previous findings in MCI theory, as intuitive stimuli (fINT and uINT) were significantly better recalled on average across the sample than stimuli with ontological violations at the template level (fMCI and uMCI). For the immediate period of recall, participants recalled on average 23.4% of intuitive stimuli ($M = 3.74$ out of 16, $SD = 2.14$), and 20.6% of counterintuitive stimuli ($M = 3.29$ out of 16, $SD = 2.31$). In the delayed recall period, participants recalled on average 14.3% of intuitive stimuli ($M = 2.28$ out of 16, $SD = 1.85$) and 13.1% of counterintuitive stimuli ($M = 2.1$ out of 16, $SD = 2.05$). Familiarity was also found to significantly predict recall rate as culturally familiar stimuli (fMCI and FINT) were found to be better recalled than unfamiliar stimuli (uMCI and uINT), $F(1, 2419.46) = 212.23$, $p < .001$. Importantly, this preliminary stage model showed that the country of the experiment site significantly predicted the recall of stimuli, $F(1, 360.21) = 6.91$, $p = .009$, and therefore, as a consequence, the following results represent a split in the UK and China samples, analysed separately for comparison. Table 10 represents a preliminary split model comparing the UK and China samples, with the primary aim at this stage of investigating pivotal factor of the impact of presentation mode, as participants were assigned to written or oral conditions in both countries. This stage also provided the opportunity to view the impact of the main effects alone on recall, prior to potentially being superseded as a result of significant interactions present in the final model.

Table 10. *HLM parameter estimates for preliminary split model of minimal condition for UK and China samples indexing contributions of fixed factors on recall*

Parameter	*b*	*SE b*	*df*	*t*	*p*
		UK			
Intercept	1.27	.11	290.48	12.06	< .001
Familiarity	- .43	.06	1205.79	-7.82	< .001
Counterintuitiveness	.11	.06	1205.79	2.05	.040
Delay	.92	.06	1239.26	16.39	< .001
Presentation mode	- .08	.13	181.79	- .60	.549
		China			
Intercept	1.30	.1	267.14	12.71	< .001
Familiarity	- .68	.05	1210.69	-13.21	< .001
Counterintuitiveness	.22	.05	1210.69	4.20	< .001
Delay	.40	.05	1227.05	7.75	< .001
Presentation mode	.07	.13	177.13	.59	.559

The next step in the development of the model required another preliminary split model of the UK and China samples. In the immediate period of recall, participants in the UK recalled on average 24.9% of stimuli (7.97 of a possible 32 stimuli), whereas in China, participants recalled on average 18.9% of stimuli (6.06 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 13.4% of stimuli (4.3 of a possible 32 stimuli), while in China, participants recalled on average 13.9% of stimuli (4.45 of a possible 32 stimuli). Parameter estimates revealed that the presentation mode for the experiment site did not significantly predict the recall of stimuli in either the UK or China ($p > .05$), and was consequently omitted from the developing model.[41] At this initial split stage, counterintuitiveness was found to

[41] As a consequence, the sample data analysed below considers the participants assigned to either the written or oral condition of stimuli presentation together as one sample.

significantly predict the recall rate of stimuli in both the UK and China, $F(1, 1205.79) = 4.21$, $p = 0.04$, and $F(1, 1210.69) = 17.63$, $p < .001$, respectively, as again contrary to previous MCI studies, at both locations, intuitive variety stimuli (fINT and uINT) were revealed to be significantly better recalled on average across the sample than stimuli with ontological violations at the template level (fMCI and uMCI). For the immediate period of recall, participants in the UK recalled on average 25.9% of intuitive stimuli ($M = 4.15$ out of 16, $SD = 2.21$), and 23.9% of counterintuitive stimuli ($M = 3.82$ out of 16, $SD = 2.52$), but in China, participants recalled on average 20.8% of intuitive stimuli ($M = 3.32$ out of 16, $SD = 2.07$) and 17.1% of counterintuitive stimuli ($M = 2.74$ out of 16, $SD = 2.1$). In the delayed recall period, UK participants recalled on average 13.8% of intuitive stimuli ($M = 2.2$ out of 16, $SD = 1.63$) and 13.1% of counterintuitive stimuli ($M = 2.1$ out of 16, $SD = 2.07$), whereas in China, participants recalled on average 14.8% of intuitive stimuli ($M = 2.36$ out of 16, $SD = 2.06$) and 13.1% of counterintuitive stimuli ($M = 2.09$ out of 16, $SD = 2.03$). These descriptive statistics appear in Figure 7. Familiarity was also found to significantly predict recall rate, as further investigation revealed culturally familiar stimuli to be significantly better recalled than unfamiliar stimuli, for participants in both the UK and China, $F(1, 1205.79) = 61.17$, $p < .001$, and, $F(1, 1210.69) = 174.5$, $p < .001$, respectively.

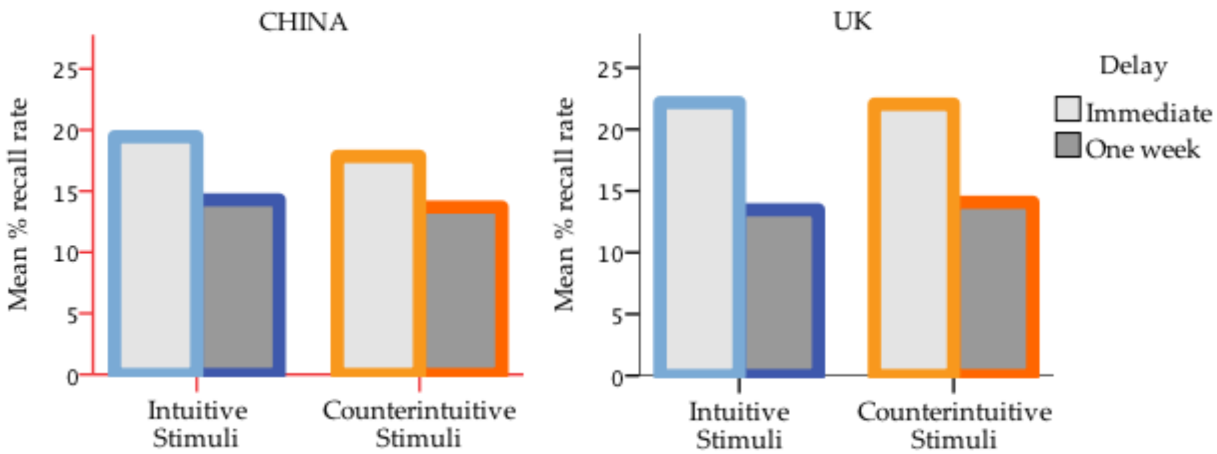


Figure 7. Bars representing mean percentage of intuitive stimuli and counterintuitive stimuli recalled in the immediate and one-week delayed periods of the minimal condition, Experiment #1.

So as to build the final HLM for both the UK and China, progressing from the preliminary model stage, a full factorial model of fixed effects was created, incorporating all remaining factors and covariates. These factorial models (for UK and China samples) were initially very large and contained many non-significant interactions. The model was methodically processed so that it contained only significant interactions and essential main effects bearing upon the hypotheses. Non-significant factors, covariates, and their interactions were excluded one at a time, highest p-value first, from the model until a finalised model containing only the significant predictors of recall rate and essential elements remained. Table 11 displays the final model of fixed effects:

Table 11. *HLM parameter estimates for final split model of minimal condition for UK and China samples indexing contributions of fixed factors on recall*

Parameter	*b*	*SE b*	*df*	*t*	*p*
UK					
Intercept	2.28	.16	307.26	14.38	< .001
Familiarity	- .56	.08	1201.74	-7.21	< .001
Counterintuitiveness	- .38	.13	1201.74	-2.84	.005
Delay	.92	.06	1241.06	16.46	< .001
Age	- .03	0	268.91	-7.69	< .001
Counterintuitiveness x familiarity	.26	.11	1201.74	2.33	.020
Counterintuitiveness x age	.01	0	1201.74	3.36	.001
China					
Intercept	2.16	.16	330.42	13.58	< .001
Familiarity	- .70	.12	1207.20	-5.95	< .001
Counterintuitiveness	.22	.12	1207.20	1.87	.062
Delay	.40	.05	1226.24	7.78	< .001
Age	- .03	0	339.53	-7.56	< .001
Counterintuitiveness x familiarity	- .40	.1	1207.20	-3.90	< .001
Counterintuitiveness x age	.01	0	1207.20	2.06	.040

The parameter estimates of the finalised HLM showed that the counterintuitive status of stimuli, contrary to the initial findings of the preliminary split model, did not significantly predict the number of stimuli recalled by participants in China ($p > .05$), but was significant for UK participants, $F(1, 1201.74) = 4.28$, $p = .039$. However, these findings should both be considered superseded by a significant interaction of counterintuitiveness x age in predicting recall, for both UK and China, $F(1, 1201.74) = 11.29$, $p = .001$, and, $F(1, 1207.2) = 4.24$, $p = .04$, respectively. This was apparent as younger persons in both samples recalled a higher proportion of counterintuitive stimuli over intuitive stimuli counterparts, a trend not present in the older participants in the sample. The period of delay in which the stimuli were recalled was found to be a significant predictor of recall for both UK and China studies, $F(1, 1241.06) = 271.03$, $p < .001$, and $F(1, 1226.24) = 60.53$, $p < .001$, respectively, as stimuli were as expected better recalled in the immediate period of testing. However, no significant interaction of counterintuitiveness x delay in predicting recall was found, in either the UK or China sample (both, $p > .05$). Consistent with the preliminary model, the main effect of familiarity associated with stimuli significantly predicted recall in both UK and China, $F(1, 1201.74) = 61.85$, $p < .001$, and, $F(1, 1207.2) = 71.84$, $p < .001$, respectively. This finding was superseded in both the UK and China by the discovery of an interaction of familiarity and counterintuitiveness $F(1, 1201.74) = 5.4$, $p = .02$, and $F(1, 1207.2) = 15.21$, $p < .001$, respectively, revealed by further investigation to result from a greater proportion of fMCI stimuli recalled over other stimuli categories, in both locations. A further interaction of familiarity and age for the China sample alone was also found, $F(1, 1207.2) = 5.68$, $p = .017$, revealed upon subsequent investigation to be due to an increased sensitivity to familiar stimuli and a larger ratio of their being recalled compared to unfamiliar stimuli amongst older participants in the sample. None of five surveyed schema-level effect factors of positive emotion, negative emotion, imagery, humour, and inferential potential was found to significantly predict the recall rates for stimuli in this the minimal condition, nor was any found to interact with counterintuitiveness (all, $p > .05$).

Analysis of residuals showed that the model appears to be accurate for the sample. Although a number of outliers were identified, no case exhibited a Cook's distance of more than

1.[42] The model appears to be generalizable to the population. On visual inspection, the residuals did not appear homoscedastic, expressed a generally linear relationship between independent and dependent variables, and appeared to be normally distributed to a satisfactory degree.[43] The results also showed that there was significant random (between participants) variance (0.68, SE = 0.06, Wald Z = 11.92, p = < .001), thereby justifying the decision to use a hierarchical model to control for correlated errors.

5.1.7 Experiment #1: Summary

The discovery of results demonstrating a complete reversal of the predictions of the typical formulation of the MCI hypothesis that has dominated previous studies in this area, as seen in the significant mnemonic advantage of intuitive stimuli over counterintuitive stimuli in both the UK and China studies, is certainly provocative. In comparison with previous MCI studies, the findings of this experiment (in terms of the main counterintuitive effect) have only been replicated in adults over the age of 25 years in Gregory and Barrett (2009). This incongruous finding has relevance to hypothesised age-related predictions of the counterintuitive effect (below). However, in an expansion of this typical formulation of the MCI hypothesis, support was found for the *familiar MCI hypothesis* in the finding of a significant interaction of familiarity and counterintuitiveness, in both UK and China samples. Contrasts revealed that findings were consistent with the notion that counterintuitive representations that for long periods have been widely communicated within a cultural group (and extensively culturally distributed) and part of the furniture of people's mental lives do maintain this position because of a superior mnemonic advantage, and therefore have a transmission advantage amongst cultural agents. This mnemonic advantage over novel counterintuitive ideas has been explained to be due to a

[42] Given the advice of Stevens (2002), no data points were excluded as none exhibited excessive influence upon the outcome (all had a Cook's distance of < 1).
[43] Upon visual inspection, the distribution was deemed to have a very slight negative skew and very slight positive tail. The Kolmogorov-Smirnov test for normality was considered to be inappropriate due to the large sample size.

synthesis of mnemonic advantage of ontological violation at the template level along with the added schema-level effect of being highly activated familiar concepts (see Sections 1.5.1 and 1.5.2). This provides an initial package of support to reject the assumptions of Bloch (2005) and Upal (2010) that such counterintuitive representations have lost their cognitive saliency and have become essentially as intuitive representations in their memorability.

Findings were revealed in support of the MCI age-effect hypothesis. Analysis revealed a significant interaction of age and counterintuitiveness in predicting recall, present in both the UK and China. Contrasts revealed younger persons were able to recall a significantly larger ratio of counterintuitive stimuli than intuitive stimuli. This trend was reversed for older persons in the samples, who remembered significantly more intuitive concepts than counterintuitive ones. Chapter 11 will discuss the implications of these age-related findings and will speculate as to the various roles different age groups might play in the epidemiology of cultural representations. Given the wider and more representative age demographics of both these cross-cultural samples compared to previous studies in this area, these findings here should be sufficient to motivate further investigation into the impact of age on the memorability of counterintuitive representations. Unfortunately, this study considered only a linear relationship between age and the recall of counterintuitive stimuli, as there was judged to be insufficient motivation for this study to test for a curvilinear relationship between age and the recall of counterintuitive concepts. Further studies might be developed to investigate this. Contrary to the findings of previous MCI studies (e.g. Gregory and Barrett 2009; Norenzayan et al. 2006) the time period in which participants recalled the stimuli (immediately, or after the one-week delay) was found to have no impact on the recall of counterintuitive stimuli, in both the UK and China, as the interaction of delay and counterintuitiveness was found not to significantly predict recall. It is possible the finding of this significant age-effect in the recall of MCI ideas could be related to the absence of a significant finding for the interaction of delay and counterintuitiveness, as these samples included younger persons not represented in the samples of previous MCI studies. The degradation of working memory with age could determine different memorability dynamics, at different ages. This effect shall be reviewed in the final discussion in Chapter 11, in light of evidence from the analyses to follow.

Apart from the discovery of the significant mnemonic effect of familiarity on the recall of stimuli, no other schema-level effect (positive emotion, negative emotion, imagery, humour, or inferential potential) significantly predicted recall, or interacted with the template-level violation of counterintuitiveness to significantly predict recall. Therefore, no evidence was available from the minimal condition of stimuli presentation to support the *schema-level effect hypothesis*. Although significant cross-cultural differences were revealed in the overall trends in the recall of stimuli, support for the universality of the counterintuitive effect can still be tentatively drawn from the significant interaction of counterintuitiveness and age that was replicated at both cross-cultural sites. One suggestion for these differences in the overall dynamics of recall between locations could be the small number of differences between the UK and China stimuli sets. Consistent with previous research on the comparative recall of written and oral materials, these findings fully support the *transmission mode equality hypothesis*. In a between-subjects comparison of written presented stimuli and oral presented stimuli, no significant differences in the recall of stimuli were revealed between these presentation modes for either the UK or the China sample.

In summary, findings here suggest that substantial revisions need to be made to our current understanding of the counterintuitive effect so as to facilitate continued empirical interest in the area and the opportunity to develop better studies to explore this intriguing mnemonic effect. The following chapter reports the results of a further free-recall experiment testing the main hypotheses in a mixed-media mode of presentation of stimuli, with additional descriptive material denoting an elaborated stimuli condition. Chapter 11, the last chapter, will further discuss the relevance and combined implications of all these findings from both the minimal and the elaborated conditions of stimuli presentation (Experiments #1 and #2, respectively).

5.2 *Experiment #2: Recall of elaborated condition stimuli*

This chapter reports the analysis results of the second of two free-recall experiments. In contrast to the minimal condition of the first experiment, this experiment presented stimuli in a mixed-media format and with an elaborated descriptive structure for the stimuli. The stimuli set and methodology were otherwise identical to that in Experiment #1 (Section 5.1). Experiment #2 was specifically designed to facilitate the inclusion of the free-recall of stimuli by children, as well as those of adults. In this respect, the age range of participants in Experiment #2's sample was widened even further than that of Experiment #1 to include children 3 to 12 years of age (composing around 40% of the total sample size). Experiment #2 aimed to test anew the same main hypotheses as the first experiment with regard to the typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies and extensions of Boyer's original description of the counterintuitive effect, which all centre on the predicted mnemonic advantages of counterintuitive ideas (see Chapter 2 for a full listing of hypotheses). In Experiment #1, which revealed for both the UK and the China samples a significant memorability advantage for intuitive stimuli over counterintuitive stimuli (thus revealing no support for the typical formulation of the MCI hypothesis), the interaction of counterintuitiveness and age was found to be significant as younger participants recalled a significantly larger ratio of counterintuitive stimuli to intuitive stimuli (indicating support for the MCI age-effect hypothesis). Experiment #1 also found support for the familiar MCI hypothesis, in that an interaction of counterintuitiveness and familiarity was revealed, resulting from the memorability advantage of familiar counterintuitive representations over unfamiliar counterparts. Although no support for the schema-level effect hypothesis was reported in

Experiment #1, it was again here hypothesised that mnemonic advantages for stimuli exemplifying any of the five schema-level effects (positive emotion, negative emotion, imagery, humour, and inferential potential) would be revealed. The purported universality of the counterintuitive effect again predicts that no cross-cultural differences would be observed for the MCI effect, a prediction supported by the results of the first main recall experiment, Experiment #1.

5.2.1 Method

The stimuli in this experiment were the same as in Experiment #1, although here for the oral presentation only (there was simultaneous written presentation) additional semantic material was added to what otherwise remained a uniform grammatical structure. Two modes of media were used and presented simultaneously to participants: an *elaborated condition* of stimuli was presented orally to participants, while at the same time the *minimal condition* of stimuli was visible to participants in a written presentation. The intent of this design was to permit children to participate in the sample, for the additional descriptive structure surrounding the stimulus and the mixed media presentation helped children to comprehend the stimuli. Methodology and protocol were largely comparable to the presentation of the minimal condition of stimuli in Experiment #1 as detailed in the first half of this chapter, in Section 5.1. Thirty-two stimuli corresponding to the familiarity x counterintuitiveness categories of *familiar counterintuitive* (fMCI), *unfamiliar counterintuitive* (uMCI), *familiar intuitive* (fINT), and *unfamiliar intuitive* (uINT) were presented sequentially to individual participants in both the UK and China. The elaborated condition of stimuli was drawn from the subject-predicate statement structure of the minimal condition:

> **Minimal condition formula (as used in Experiment #1):**
> *A [X] that is [Y]*
> *e.g. "a frog that is jumping" or "a mouse that is talking"*

Where X = noun and Y = adjective

To form the elaborated condition of stimuli, a rewording of the semantic content of the original subject-predicate statement was added to an expanded grammatical structure of the original subject-predicate statement. This distended form of elaborated stimulus was grammatically uniform across all stimuli and obeyed the following structure:

Elaborated condition formula:

There is a [DESCRIPTIVE of X, #1] [DESCRIPTIVE of X, #2] [ONTOLOGICAL CATEGORY SYNONYM of X] that is [SYNONYMOUS PHRASE of Y]. [He/She/It] is a [X] that is [Y].

e.g. 'There is a small furry animal that is chatting away. It is a mouse that is talking'

This elaboration was performed for both UK and China stimuli sets. Efforts were made to eliminate potentially confounding factors and random error in constructing the elaborated condition of stimuli. As well as uniformity of grammatical structure and timing being maintained for all stimuli, no word was used twice throughout the whole stimuli set for "DESCRIPTIVE #1", "DESCRIPTIVE #2" or "ONTOLOGICAL CATEGORY SYNONYM" so as to minimise any conceptual priming effect.

The formulation of the elaborated condition aimed to produce stimuli that bestowed a like private representation for all participants. The additional semantic content possessing narrative-kind elements that folktales and other stories might provide helped to ensure that the reference to the object the stimulus designates was consistent. With the addition of the thorough pretesting methodology, confidence existed that the public representation (stimulus) bestowed in all participants a similar private representation (the intended meaning of the stimulus must be shared by all participants to be an appropriate stimulus). This additional descriptive structure surrounding the stimulus and the mixed media presentation acted also to aid child participants in the sample (ages 3 to 12 years) in comprehending stimuli. Appendix 3 details the full UK stimuli set in the elaborated condition, and Appendix 4 details the elaborated condition of the stimuli in the China-based experiment. Coding of participant recall data and experimental design was identical to Experiment #1 (see Sections 5.1 and 5.3, respectively).

5.2.2 *Materials and procedure*

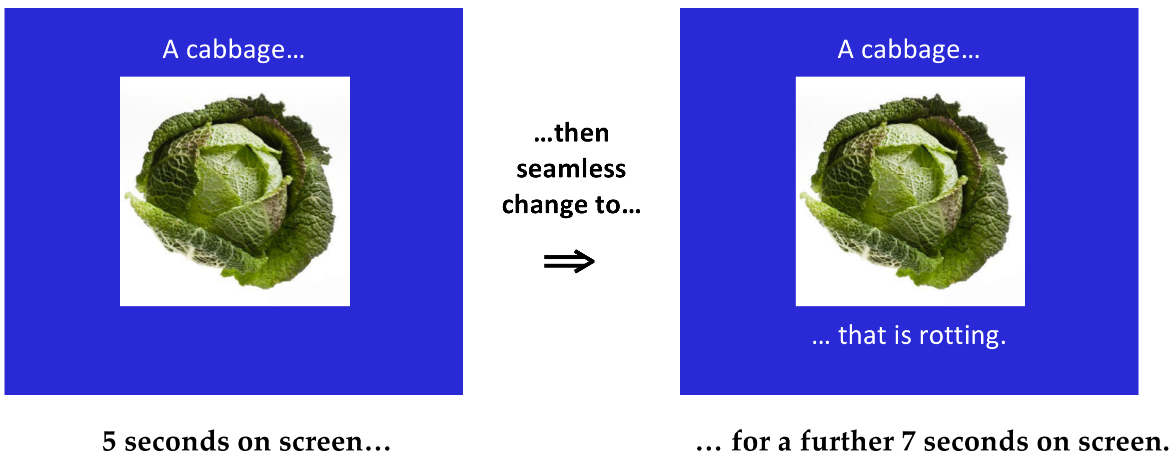
Materials and procedures were identical for the UK and China studies, within language constraints, and comparable to those of the minimal condition of stimuli presentation (Chapter 5) with minor necessary modifications to facilitate the use of mixed media of stimuli presentation in this elaborated condition. Participants were tested individually. Testing was conducted in a quiet corner of the same sports centre, park, place of work, café, or restaurant in which the participant had often been recruited. Participants were assigned either to a written presentation of stimuli or oral presentation of stimuli. Ear defenders were given to participants who experienced the written presentation, to ensure that ambient stimuli were minimised, and also to reflect the use of headphones in the oral presentation. Research assistants who were blind to the hypothesis were provided with a strict procedure to follow (see Appendix 5 for details). Procedures and the setup of the testing areas were thoroughly rehearsed several times prior to actual testing. After anonymously recording their personal details (age, sex, ethnicity, and natural language), participants were led to the corner of the site (restaurant, sports hall, place of work, etc.), were asked to take a seat approximately 1 metre from a 19-inch laptop screen, and were each given a pair of ear defenders. The participant was then told[44]: "You're about to take part in a memory task. The following video clip will contain a series of short sentences. Each sentence will remain on the screen for 9 seconds. You will see a total of 32 sentences. Please take care to consider each sentence carefully. Please now put on your

[44] The Mandarin language selected for use in the China study was the closest equivalent available to the English used in these instruction passages.

headphones." A slideshow of the randomly generated sequence of 32 stimuli was then presented in accordance with the format that follows.

For the UK study, stimuli were displayed in Calibri 48-point type, in white on a contrasting blue background, along with a central image representing a typical state in which the noun component of the statement would be entertained. All images were comparable in size, and all were presented on a white background. Each stimulus was presented on screen for a total of 12 seconds. For the first 5 seconds, the noun component of the subject-predicate structure was displayed alone, which was simultaneously accompanied by an oral presentation of the first sentence of the elaborated condition of the stimulus for a matching period of time. In the remaining 7 seconds, the rest of the statement was added beneath the central image to complete the subject-predicate statement (identical in grammatical form to the minimal condition), and again accompanied by the second sentence of the elaborated condition of the stimulus for the same amount of time which clearly reiterates the subject-predicate statement presented orally. After this time, the next stimulus in the sequence would then appear, a process that would continue until the last of the 32 stimuli. Figure 8 illustrates the screen layout and stimuli time constraints for this mixed media of presentation:

Figure 8. Example of the presentation of a stimulus, which would also be accompanied by oral presentation of the elaborated condition of the stimuli



After the sequence of item presentation had finished, indicated by the point at which the screen displayed “END”, the laptop before the participant was replaced with a Connect Four game board, or with 五子棋 (pronounced *“WuZiQi”)*, the “five piece connect” closest equivalent in China. The participant would then spend the next three minutes completing a distractor task on the game board, playing with the research assistant. After these three minutes were over, the game board was removed, at which point the participants were each given a clipboard with a pen and a blank white sheet of A4 paper, and told: “Could you now please write down any of the sentences you can remember from the screen. You have four minutes to write down as many as possible.” The participants were advised to return the following week for a “slightly different task,” and asked not to divulge the contents of the test to people waiting for testing. Participants, however, were not encouraged or discouraged to talk about the contents of the test when away from the testing location, so as not to interfere with normal processes of cultural transmission that participants might engage in spontaneously, such as narrative consolidation (i.e. telling others about the most memorable aspects of their experience). Participants returned after one week, at the same appointment time as the previous week, for the second period of testing. Participants were led into the same testing location as the previous week, again given a clipboard with pen and blank paper, and asked by the testing assistant to write down in four minutes as many of the items as they could remember from the previous week.

5.2.3 Participants

A total of 399 participants from both the UK and China were recruited to complete the elaborated condition of stimuli presentation. Ages ranged from 3.17 years to 82 years of age, with a mean age of 20.82 (*SD* = 17.36). One hundred and ninety-three participants were male (48.4%) and 206 female (51.6%). Three hundred and seventy-seven participants spoke the presented language as a natural language. Participants were recruited according to quotas for predetermined age groups to ensure that a representative age demographic was attained. Table 12 contains descriptive and frequency statistics for participants in these constituent age-groups:

Table 12. *Descriptive and frequency statistics according to age group for participants of the elaborated condition of stimuli.*

Age group		*Age*				*Sex*		*Language*	
	N	*Min*	*Max*	*M*	*SD*	*Male*	*Female*	*Foreign*	*Natural*
≥3<5 years	45	3.17	4.92	3.95	0.4	25	20	0	45
≥5<8 years	65	5	7.92	6.71	0.94	29	36	0	65
≥8<13 years	65	8	11	9.58	0.84	36	29	0	65
≥13<20 years	61	13	19	15.18	1.66	30	31	5	56
≥20<28 years	55	20	27	23.44	1.97	31	24	7	48
≥28<50 years	61	28	49	34.85	6.36	24	15	10	51
≥50 years	47	50	82	58.09	8.72	18	29	0	47
Totals	399	3.17	82	20.82	17.36	193	206	22	377

One hundred and ninety-eight participants were recruited from the general population of the UK. Ages ranged from 3 to 82 years, with a mean age of 22.24 (*SD* = 18.77) years. Participants were indiscriminately approached at several sites in Oxfordshire and the West Midlands. Oxford locations included Oxford University Sport Centre, G & D's Café on the Cowley Road, Joe's Bar and Grill in Summertown, and Shirley Golf Club in Solihull, West Midlands. Child participants were recruited from kindergartens and schools in Oxfordshire and West Midlands, and through parents associated with Shirley Golf Club in the West Midlands. The snowballing method of recruitment was also used and instigated with participants who had already taken part in the study. Appointments were made for participants recruited by this method at the preceding locations. All recruited individuals were assigned an appointment time for a "memory task" in the first testing period and a second "somewhat different task" scheduled for a time exactly one week later. One hundred participants were male (50.5%), and 98 were female (49.5%). All participants considered themselves fluent in English, and 179 spoke English as a natural language. Adult participants were compensated £10 for their participation after completing the delayed period of testing. Children (under 12 years) were given a small compensatory gift of their choice after both immediate and delayed recall (e.g. a rubber and puzzle, respectively).

Two hundred and one participants[45] were recruited from the general population of Beijing. Ages ranged from 13 to 69 years, with a mean age of 19.43 (SD = 15.77) years. Participants were indiscriminately approached in a large supermarket/canteen/restaurant complex at Beihang University, within parks of the Beihang[46] University area, and at several businesses in the Wudakou area of Beijing. Children were recruited at several schools in the Beihang University complex and the wider Beijing area. The snowballing method of recruitment was also used, instigated with participants who had already taken part in the study. Using this method, appointments were made for recruited participants at the preceding locations. All recruited individuals were assigned an appointment time for a "memory task" in the first testing period and for a "somewhat different task" in the second testing period, scheduled for a time exactly one week later. Ninety-three of the participants were male (46.3%), and 108 were female (53.7%). All participants considered themselves to be fluent in Chinese; 198 spoke Chinese as a natural language. Participants were compensated 50 RMB after completing the delayed test. Child participants were compensated with gifts similar to those given the children in the UK study.

5.2.4 Results

A hierarchical linear model (HLM) was used to investigate the relationship between counterintuitiveness and familiarity, the relationship between template-level violation and schema-level effects, the interaction of counterintuitiveness and age in regard to recall rates, and especially to test Boyer's central hypothesis prediction of a mnemonic advantage of

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[45] This figure does not include 16 participants who failed to complete the test either due to poor literacy or experimenter error.

[46] The nature of the university campus in Beijing differs dramatically from those typical to Europe and the US. These "university areas" tend to be much larger in scale, a large proportion of which are constituted by unaffiliated members of the general public as well as students, academics, and service staff.

counterintuitive concepts over intuitive concepts. Specifically, the models investigated the main effects and interactions of counterintuitiveness (intuitiveness versus counterintuitiveness), familiarity (unfamiliar versus familiar), and delay (immediate versus one-week delay) and how they influence recall rates for stimuli. In all three cases, counterintuitiveness, familiarity, and delay were entered into the HLM as level 1 fixed factors. Country of experiment location, age, and schema-level effects of positive emotion, negative emotion, imagery, humour, and inferential potential were entered as level 2 fixed factors. Participant identity (a means of identifying "subjects") was entered as a level 2 random factor.

The development of the model was divided into two building stages: first, a preliminary-model stage where only level 1 fixed factors and the cross-cultural level 2 fixed factor were considered to permit evaluation of pivotal factors at this point integral to determining an appropriate direction for the second stage, a final model (or "models" if significant cross-cultural differences were detected) which accommodated all factors, at all levels, and their interactions; second, following the preliminary model stage, a full factorial model of fixed effects was to be created incorporating all remaining factors and covariates. Table 13 displays the results of the preliminary model of this first stage:

Table 13. *HLM parameter estimates for preliminary elaborated condition model indexing contributions of fixed factors on recall*

Parameter	*b*	*SE b*	*df*	*t*	*p*
Intercept	1.28	.07	597.36	18.19	< .001
Familiarity	- .34	.03	2652.89	-9.86	< .001
Counterintuitiveness	- .08	.03	2652.89	-2.40	.017
Delay	.42	.03	2700.38	12.07	< .001
Country of location	.05	.09	392.95	.58	.564

Both the UK and China samples were considered together in this preliminary model. All effects are reported as significant at $p < .05$. In the immediate period of recall participants in the UK recalled on average 19.5% of stimuli (6.24 of a possible 32 stimuli), whereas in China, participants recalled on average 18.4% of stimuli (5.88 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 14% of stimuli (4.49 of a possible 32 stimuli), whereas in China, participants also recalled approximately 14% of stimuli on average (4.5 of a possible 32 stimuli). Unlike the findings of the experiment for the minimal condition of stimuli presentation in Chapter 5, parameter estimates showed that country of location for the experiment site did not significantly predict the recall of stimuli (p > .05), and was consequently omitted from the developing model.[47] At this initial stage, counterintuitiveness was found to significantly predict the recall rate of stimuli, F(1, 2652.89) = 5.57, p = .017, as stimuli with ontological violations and at the template level (fMCI and uMCI) were significantly better recalled on average across the sample than intuitive variety stimuli (fINT and uINT). For the immediate period of recall, participants in the UK recalled on average 18.6% of intuitive stimuli (M = 2.98 out of 16, SD = 2.98) and 20.4% of counterintuitive stimuli (M = 3.26 out of 16, SD = 2.31), but in China, participants recalled on average 18.3% of intuitive stimuli (M = 2.92 out of 16, SD = 2.11) and 18.5% of counterintuitive stimuli (M = 2.96 out of 16, SD = 2.43). In the delayed recall period, UK participants recalled on average 13.2% of intuitive stimuli (M = 2.11 out of 16, SD = 1.75) and 14.9% of counterintuitive stimuli (M = 2.38 out of 16, SD = 1.87), whereas in China, participants recalled on average 13.8% of intuitive stimuli (M = 2.21 out of 16, SD = 2.17) and 14.3% of counterintuitive stimuli (M = 2.29 out of 16, SD = 2.21). These descriptive statistics are displayed in Figure 9. Familiarity was also found to significantly predict recall rate as culturally familiar stimuli (fMCI and fINT) were found to be better recalled than unfamiliar stimuli (uMCI and uINT), F(1, 2652.89) = 97.21, p < .001.

[47] As a consequence, the sample data analysed below considers the participants of the UK and China experimental sites together as one sample.

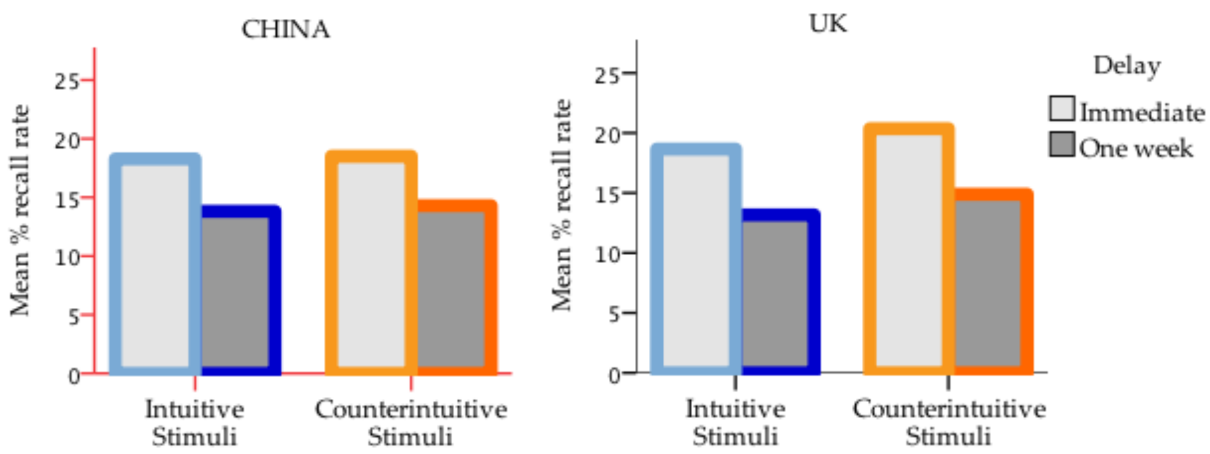

Figure 9. Bars representing mean percentage of intuitive stimuli and counterintuitive stimuli recalled in the immediate and one-week delayed periods of the elaborated condition, Experiment #2.

Following from the preliminary model stage, the second and final stage produced a full factorial model of fixed effects incorporating all remaining factors and covariates. This factorial model was initially very large and contained many non-significant interactions. The model was carefully processed so that it would be reduced to only significant interactions and essential main effects bearing upon the hypotheses. Non-significant factors, covariates, and their interactions were excluded one at a time, highest *p*-value first, from the model until a finalised model containing only the significant predictors of recall rate and essential elements remained. Table 14 displays the final model of fixed effects.

Table 14. *HLM parameter estimates for final elaborated condition model indexing contributions of fixed factors and covariates on recall.*

Parameter	*b*	*SE b*	*df*	*t*	*p*
Intercept	-0.06	1.18	2981.21	-.054	.957
Familiarity	1.17	0.56	2702.53	2.105	.035
Counterintuitiveness	- .64	.60	3038.92	-1.063	.288
Delay	.42	.03	2693.12	12.256	< .001
Familiarity x counterintuitiveness	- .75	.32	2717.44	-2.324	.020
Counterintuitiveness x age	.02	0	791.19	4.962	< .001
Familiarity x counterintuitiveness x age	- .01	0	2647.91	-3.680	< .001
Negative emotion	.62	.24	2757.50	2.583	.010
Humour	1.00	.42	2430.98	2.372	.018
Interest	.63	.19	3016.87	3.376	.001

In this finalised model, parameter estimates showed that how counterintuitive the stimuli were did not significantly predict how many stimuli participants recalled, $F(1, 3022.85) = 3.24$, $p = .072$, for this finding was superseded by a significant interaction of counterintuitiveness x age in predicting recall, $F(1, 2647.62) = 56.19$, $p < .001$. Younger persons in the sample recalled a higher proportion of counterintuitive stimuli over intuitive stimuli, a trend not present in the older participants of the sample. Interestingly, the age of a participant did not significantly predict recall of stimuli ($p > .05$). The period of delay in which the stimuli were recalled was found to be a significant predictor of recall, $F(1, 2693.12) = 150.21$, $p < .001$, as unsurprisingly stimuli were better recalled in the immediate period of testing. However, contrary to the findings of previous MCI studies, a significant mnemonic advantage of counterintuitive stimuli was not found to be isolated in the delayed period of testing (e.g. Gregory and Barrett 2009; Johnson, Kelly, and Bishop 2010; Norenzayan et al. 2006), as indicated here by the non-significant interaction of counterintuitiveness and delay (p > .05). Again diverging from the preliminary model, the main effect of familiarity associated with stimuli did not significantly predict recall ($p > .05$), as this finding was superseded by the discovery of an interaction of familiarity x counterintuitiveness $F(1, 2717.44) = 5.4$, $p = .02$, revealed by further investigation to result from a greater proportion of fMCI stimuli recalled over other stimuli categories. However, an added finding of an interaction of familiarity x counterintuitiveness x age $F(1, 2648.61) = 7.32$, $p = .007$, revealed that this recall advantage of fMCI stimuli was age-dependent, as fMCI stimuli were not preferred over uMCI stimuli among younger persons in the sample. In addition, three out of five surveyed schema-level factors were found to significantly predict the recall rates of stimuli in the elaborated condition. These were: negative emotion $F(1, 2757.50) = 6.67$, $p = .01$; humour, $F(1, 2430.983) = 5.627$, $p = .018$; and interest (proxy for "inferential potential"), $F(1, 3016.87) = 11.4$, $p = .001$. The schema-level factors of positive emotion and imagery did not significantly predict the recall rate of stimuli (both, $p > .05$).

Analysis of residuals showed that the model appears accurate for the sample. Although a number of outliers were identified, no case exhibited a Cook's distance of more than 1.[48] The model appears to be generalizable to the population. On visual inspection, the residuals did not appear homoscedastic, expressed a generally linear relationship between independent and dependent variables, and appeared to be normally distributed to a satisfactory degree.[49] The results also showed that there was significant random (between-participants) variance (0.68, *SE* = 0.06, Wald Z = 11.92, p = < .001), thereby justifying the decision to use a hierarchical model to control for correlated errors.

5.2.5 Experiment #2: Summary

Prior to being superseded by the interaction between counterintuitiveness and age in the finalised model, support for the MCI hypothesis can be drawn from findings of the preliminary HLM of fixed effects, which revealed counterintuitiveness as a significant predictor of recall rate of stimuli, and from which contrasts revealed a mnemonic advantage of counterintuitive representations over intuitive representations, across the sample. This finding diverges greatly from that of Experiment #1, which located a reversal of the counterintuitive effect for recall of its stimuli (intuitive stimuli were overall better recalled than counterintuitive stimuli). To understand how this harsh difference came to be, it is necessary to point out that in contrast to the sample of the minimal condition of stimuli presentation of Experiment #1, the increased age range and larger proportion of children and adolescents in the elaborated condition sample of Experiment #2 could have contributed to the discovery of an overall counterintuitive effect (children and adolescents recalled significantly more counterintuitive stimuli than intuitive stimuli, as illustrated by the support found for the MCI age-effect hypothesis in Experiments #1

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[48] Given the advice of Stevens (2002), no data points were excluded, as none exhibited excessive influence upon the outcome (all had a Cook's distance of < 1).

[49] Upon visual inspection, the distribution was deemed to have a very slight negative skew and very slight positive tail. The Kolmogorov-Smirnov test for normality was considered inappropriate due to the large sample size.

and #2; see below). It is also possible that the elaboration of the stimuli by way of the addition of descriptive material for the elaborated condition (Experiment #2), and the differences in presentation timing for each stimulus (9 seconds in Experiment #1; 12 seconds in Experiment #2), might also have contributed to the better encoding of counterintuitive concepts (as opposed to the failed encoding of miscomprehension, or private representation of an analogous intuitive variety due to poor encoding), for counterintuitive representations intrinsically place a higher cognitive load demand on the participant than intuitive concepts (see Section 1.5.4 for further background details). Similar to the findings of Experiment #1, the time period in which participants recalled the stimuli (immediate, or after a one-week delay) was again found not to affect the recall of counterintuitive stimuli, in both the UK and China. As considered in the summary of Experiment #1, the reason for this could be the inclusion of children in these samples.

Consistent with Experiment #1, support was again found for the *familiar MCI hypothesis* due an interaction of familiarity and counterintuitiveness, as familiar counterintuitive stimuli were again recalled better than unfamiliar counterintuitive stimuli. This repeated finding reinforces grounds to reject the assumptions of Bloch (2005) and Upal (2010), who suggest that counterintuitive representations that have become epidemiologically commonplace, familiar, and entwined in the accepted beliefs of a cultural group have lost their saliency, their mnemonic advantage, and their counterintuitive status, becoming essentially an intuitive representation. These findings are consistent with the reasoning of the familiar MCI hypothesis that counterintuitive representations that have been widely communicated and enjoy epidemiological success for a cultural group still receive mnemonic advantage from the ontological violation at the template level, with the added additional mnemonic advantage of being highly activated and familiar concepts at the schema level (see Sections 1.5.1 and 1.5.2, for further background details).

As replicated in the findings of Experiment #1, the discovery of an interaction of counterintuitiveness and age provides support for the MCI age-effect hypothesis. Contrasts revealed that younger persons in the sample again better remembered counterintuitive representations than intuitive representations, an effect that again opposes the findings among older participants in the sample (older adults recalled intuitive stimuli better than counterintuitive stimuli). Chapter 11 will examine the substantial implications of these age-related findings and further develop this discussion. The proposition of a curvilinear relationship between counterintuitiveness and age will also be considered. The lack of significant cross-cultural difference in the recall of stimuli and for the interaction of the counterintuitive effect and age provide support for the universality of the counterintuitive effect. Given some of the reported, and often supposed, differences between the "analytic" cognition of Westerners and the "holistic" thinking of East Asia, these findings might also provide a notable addition to this cross-cultural mind debate.

The significant impact on recall of stimuli exemplifying the schema-level characteristics of negative emotion, humour, and inferential potential suggests that it is important to consider schema-level effects as mnemonic factors for subsequent models of the counterintuitive effect. Chapter 11 will discuss the further implications of these schema-level mnemonic findings and propose directions for new research. Study #2, which follows next in Chapter 6, explores potential biases for counterintuitive concepts in the authorship of representations, which is an area yet to be explored by MCI theory. The chapter also provides experimental evidence that reveals the impact of age on the production of counterintuitive representations.

6 Study #2: Template-level preferences in the generation of schema-level ideas

Boyer's original theory of the cultural transmission of counterintuitive concepts asserts that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence grab our attention and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). But where do counterintuitive cultural representations originate? Who in cultural groups might be responsible for their production, or most capable of their authorship? Would the same persons account for the introduction of new counterintuitive ideas to cultural distributions? Does the purpose or schema-level mode in which counterintuitive representations are authored affect their memorability? In addition, do counterintuitive ideas authored by the person himself or herself have the same mnemonic advantages for that person as a counterintuitive representation that someone else has created? These questions surrounding how counterintuitive representations are generated are fresh and unanswered by the cognitive science of religion. Studies in this area until now have unilaterally focused on the recall of prepared counterintuitive ideas; no studies have attempted to answer questions surrounding the real-world genesis of these salient cultural representations.

This experimental study was the first to address an outstanding concern of research on the transmission of counterintuitive concepts, as cultural transmission is constrained not only by recall, but also by the emergence of representations. Mithen (1998) has theorised that the actual generation of such religious representations is rare, as it is a process that requires special artefacts such as face masks, costumes, and other materials such as idols to actualise (hence, the prominent role of art in the material culture of many religions). Barrett and Nyhof (2001) also noted that subjects had greater difficulty in forming mental images of counterintuitive stimuli than they did for stimuli consistent with domain-specific intuitive assumptions. While counterintuitive representations appear to be well remembered, there is no evidence to show how difficult it is to originate them, and who in populations is responsible for producing them. Given the preliminary findings on the impact of age on the memorability of counterintuitive concepts, might younger persons with more imaginative minds, rather than older persons, be responsible for generating counterintuitive representations and be most capable of producing them? "Children's worlds" have been reported to contain more works of the imagination than those of adults (Harris, 2000). As well as better remembering and recalling minimally counterintuitive concepts than older persons (Gregory and Barrett 2009; Barrett and Hornbeck, forthcoming), do younger persons given the appropriate conditions produce their own MCI ideas in greater quantities than do older persons? Given the task of combining an adjective plus a noun to form statements to represent each of five categories of schema-level properties, blind to the definition and potential for generating both minimally counterintuitive (MCI) and concepts consistent with our domain-specific intuitive assumptions (INT), what will be the result? The MCI production age-effect hypothesis predicts that a significant interaction of counterintuitiveness and age will be revealed, as younger persons will freely produce more MCI concepts than do older persons of the sample. (See Hypothesis #5, Chapter 2. Not to be confused with Hypothesis #3, the "MCI age-effect hypothesis".)

In addition, this experiment also provided the opportunity to explore the memorability biases of differing concept varieties over others with regard to the self-authorship of stimuli. The typical formulation of Boyer's (2000, 2001) theory of the transmission advantages of counterintuitive ideas common to MCI studies and extensions of the original formulation of the theory (2000, 2001) were again put to the test as the stimuli self-authored by participants were coded as intuitive and counterintuitive representations using Barrett's (2008) coding and quantifying scheme. Are minimally counterintuitive (MCI) concepts more memorable and more likely to be transmitted than intuitive (INT) concepts without any violation of ontological category? The MCI hypothesis predicts that MCI stimuli will be significantly better recalled than their INT stimuli counterparts. The impact of age on the memorability of self-generated intuitive and counterintuitive representations was also investigated. With regard to the free-recall and memorability of these self-generated MCI and INT representations, the MCI age-effect hypothesis predicts that there will be a significant interaction between age and recall of MCI stimuli, as younger persons will recall proportionally greater numbers of MCI versus INT stimuli than older persons in the sample (see Chapter 2 for a full detailed listing of the hypothesis). In addition, as these self-authored stimuli were generated as exemplifying membership in five categories of schema-level effect, it also permitted that counterintuitive- versus intuitive-representation generation preferences and memorability biases could be explored within and between these different reflective modes. These five schema-level categories were:

- negative emotion (NEG)
- positive emotion (POS)
- imagery (IMA)
- humour (HUM)
- interest[50] (IP)

These schema-level categories were identified in the empirical literature for having empirical support for promoting mnemonic advantage (see Section 1.5.3 for further details). The experiment to be described was quite unique in its design, and required participants to create stimuli of their own making, according to the rigid instructions provided, consistent with specified criteria of the five schema-level categories. However, the semantic components of these self-authored stimuli were not completely random. The participants were instructed to construct statements (as combinations of an adjective plus a noun) drawing a single adjective and a single noun from a bank of pre-specified nouns and adjectives (the selection processes are explained in Section 6.1). This permitted the resulting stimuli to be personally tailored to the experiences and private expressions relating to each of the five schema-level categories for the participants that created them. This design for the participant authorship of stimuli was intended to cater to the highly subjective nature of humorous representations (as universally appreciated humorous stimuli are perhaps impossible to come by; what is funny to one person

[50] "Interest" is here used as a proxy for inferential potential (IP).

is often mundane to the next person) and otherwise personal experiences relating to emotional valence of certain representations and also the level of mental imagery incurred. Following this initial self-authorship of stimuli task these personalised stimuli were recalled by the same participants that created them, first after a 3-minute delay, and again after a one-week delay.

6.1 Method

The first step of the experiment required participants in both China and the UK to generate a total of 20 stimuli unique to each participant. These participant-authored stimuli were formed by combining selections from a bank of adjectives and a bank of nouns, conjoined by the participant in the form of a statement (an adjective plus a noun). Given adequate written instructions specifying criteria for category membership, the participant selected and recorded statements they believed best exemplified and conformed to the five schema-level categories (four stimuli for each) of: negative emotion (NEG), positive emotion (POS), imagery (IMA), humour (HUM), and interest (IP), drawing from their personal experiences, inferences and emotional valence. Following completion of this task, these same 20 items were recalled by the same participant who generated them after a 3-minute distractor task and after a one-week period of delay. Efforts were made to avoid potentially confounding factors:

(1) Presentation time-length of the stimuli categories was uniform so that participants could not spend more time encoding the items of some categories over others.

(2) The order of questions presented to each participant was randomised. This protected against any mnemonic bias incurred from having a strict repeated order.

(3) Syntax of test items had a rigid grammatical structure so as not to induce bias incurred by differential levels of cognitive effort for processing of test items.

(4) Basic level concepts (e.g. circle, cat, girl) were used for the noun component of stimuli items within a balanced design (Rosch et al. 1976).

(5) Efforts were made to reduce the potential for analogical reasoning and creation of metaphor in entertaining of an item to a minimum, as this could promote an additional mnemonic advantage beyond that of the schema-level effect category (see below).

(6) Assistants blind to the hypotheses assisted with conducting the study to reduce any researcher bias.

The UK study was conducted first. The materials from the UK study were translated into Chinese with the aid of three conferring research assistants who were observant to the same potentially confounding factors.

6.2 *Generation of stimuli components*

One bank of 50 adjectives and one bank of 40 nouns were preselected in both the UK and China for use in the experiment. The participant selected one from each bank to form statements consistent with the answer criteria provided. Table 15 displays the 50 adjectives of the "adjective bank" for the UK study and the categories considered in its generation. (A direct translation was used for the China study.)

Table 15. *Categories considered in the generation of adjectives and subsequent adjective bank.*

Bank category	*Adjective bank*	*Schema-level effect*[51]
Positive emotional status	loyal, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, healthy.	*POS*
Negative emotional status	devious, dying, screaming, murderous, angry, thoughtless, ugly, untalented, scary, horrible.	*NEG*
Visual descriptive, low-spatial	spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough.	*IMA*
Visual descriptive, spatial	high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long.	*HUM*[52]
Action; movement	creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping	*IP*

[51] The schema-level effect category considered to have the closest conceptual relationship to the "bank category". This should not be taken to be too representative, especially when considering the HUM and IP categories, because the aim was to create a balance bank of adjectives to promote a great number of combinatorial opportunities, in an unbiased manner.

[52] Due to the highly subjective nature of humour and the facility for potentially any concept to be utilised in a humorous complex concept, a group of adjectives conforming to the bank category of 'visual descriptive, spatial' was selected with no immediate concept link to humour with aim of producing a balanced design.

For both the UK and China it was important to have a bank of adjectives in which the adjectives were unlikely to fit into more than one of the five schema-level categories, but which also provided the most combinatorial possibility.[53] With this in mind the "bank category" was conceived (see Table 16), and adjective components with conceptual relationships with each of the five schema-level effects established. This balanced array of adjectives ensured there would be an equal spread of combinatorial opportunity when participants selected representative statements for each schema-level effect. To briefly outline the selection process for these adjective components, the positive emotion category was considered the most likely to have adjectives exemplary of a positive emotional state that was general to the participants making the selections, or perhaps adjectives associated with good moral intent. In the same fashion, other adjectives appropriate for conjunction with a noun were selected for the remaining schema-level categories (see Table 15 for a complete listing). The imagery category was considered most likely to warrant use of an adjective exemplary of visual descriptive qualities in conjunction with a noun. An exception to this pattern was the humour category, because of the highly subjective nature of humour and the likelihood that any concept could be made humorous. Instead, a group of adjectives conforming to the bank category of "visual descriptive, spatial" was selected, with no immediate concept link to humour, chosen solely so as to produce a balanced design. Suitable adjective items were chosen arbitrarily from the dictionary so as to prevent the process from biasing the choices or representations of the participant. The potential of this bias was considered adequately reduced as long as the conceptual range and number of adjectives were sufficient to allow participants to make their own choices from a broad and widely representative array.

The following efforts were made to reduce confounding factors: (1) adjectives were rejected if they could double as nouns (e.g. "good", "straight", or "square"), and (2) adjectives

[53] The grammar of these participant self-authored statements is identical in English and Mandarin, formed by the pairing of an adjective plus a noun, in that order.

were rejected if they lent themselves easily to polysemy or use in metaphor (e.g. "black" or "shallow").

Table 16. *The complete noun bank as selected by ontological category membership*

Ontological category	*Noun bank*
PERSONS	son, daughter, mother, father, man, woman, boy, girl, baby, child
ANIMATES	dog, cat, frog, spider, bear, lion, goat, snake, shark, whale
SOLID OBJECTS	mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing
LIVING OBJECTS	tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo

Table 16 displays the 40 nouns used in the "noun bank" of the UK experiment (a direct translation was used for the China-based experiment). In accordance with ontological category membership, the 40 nouns, 10 from each ontological category, were initially chosen arbitrarily, intended to be widely representative of membership in the specified ontological category and to be basic concepts very likely to be easily used by the participants.

In both the UK- and China-based experiments, a question sheet (from here on called the Question Sheet; see Appendix 7 for further contextual details from the UK Question Sheet) was presented to participants, according to which they were to select and combine an adjective with a noun. A full list of these questions appears in Table 17. The questions were conceived to clearly and concisely express the criteria and requirements for statement selection for membership in that particular schema-level category and to be comprehensible to all ages 12 years and above. The time constraint for the selection of the adjective plus noun pairings was quite generous (4 minutes to combine and select four items). These questions were of approximately identical length and grammatical structure, though it was considered that the uniform length and syntax of the questions would have no potential impact on results.

Table 17. Q*uestions in accordance with schema-level category from which adjective-noun statements were constructed*

Schema-level Category	*Question*
Positive Emotion	Which combinations (one adjective + one noun, in that order) fill you with positive emotion/good feelings? It could be that your chosen combination is representative of the subject of a pleasant past memory, such as an event of personal significance. It could be an entity you simply have a strong liking for, or one that is stimulating in itself in a particularly pleasant manner when you think of it. Importantly, whatever your choice, it should fill you with a feeling of strong positive emotion.
Negative Emotion	Which combinations (one adjective + one noun, in that order) would you associate with negative emotion in yourself? It could be that your chosen combination stimulates a negative emotional feeling in you because it is representative of an unpleasant subject of past memories, or other event of personal significance to you. Or, it could relate to an entity for which you have a strong dislike, find particularly repulsive, or associate with feelings of anger, etc.
Imagery	Which combinations (one adjective + one noun, in that order) would you consider to be especially easy to picture in your mind, without the need to actually view the object itself? Your choice should not necessarily represent any entity of any special emotional significance to you, but could represent some entity from your past/memory that makes visualization particularly easy for you.
Humour	Which combinations (one adjective + one noun, in that order) would you consider to be especially humorous to you? Your choice could be one of special significance to you that draws from past experience memories, or it could be one that seems particularly amusing to you when in combination.
Interest	Which combinations (one adjective + one noun, in that order) would you consider especially thought-provoking, or an especially interesting combination that leads into several more thoughts and theories? Your choice should not necessarily represent an entity of any special emotional significance to you, or only be capable of bringing strong imagery to mind, but perhaps a combination you feel interesting of its own accord.

To ensure that the adjective and noun items had been correctly determined, a pilot study was conducted with 10 members of the Oxford public at the village of Elsfield, Oxfordshire.

(The same study was conducted later with 9 members of the public in Beijing; see below.) They were asked to create four items for each schema-level category as per the tasks and time conditions explained on the Question Sheet (see Appendix 7 for more details). A noun or adjective item was to be discarded and replaced from the respective bank if it: (1) was used by any of the pretest participants in a syntactically inappropriate manner (e.g. a reversal of the requested adjective-noun order, or use of an adjective as a noun), or (2) an adjective that was used in an adjective-noun statement that expressed a clearly metaphorical meaning—deviating from its intended meaning in the experimental design. The results of this pilot test showed that only one adjective required discarding from the proceedings: "shallow" was used in metaphorical conjunction on two occasions (e.g. "shallow mother") and was therefore replaced before pilot testing was completed. This single correction to the adjective bank was the only change made to the UK adjective-noun banks.

Following completion of Study #2 in the UK, an identical pilot test was conducted with 9 participants from several locations in Beijing, using materials directly translated from English to Mandarin. Conforming to the same criteria for discarding potentially confounding elements, it was found no adjectives or nouns needed to be replaced. Therefore, the final separate noun and adjective banks were directly comparable to those in the UK study. Also, grammatical similarities between English and Mandarin with respect to adjective-noun order permitted this aspect to be identical for both experiment sites.

6.3 Materials and procedure

The experiment had a within-subjects design. A Question Sheet was distributed to participants at both the UK and China experiment sites. The Question Sheet comprised five sheets, each disclosing criteria for the selection of items to exemplify the five schema-level categories (positive emotion, negative emotion, imagery, humour, and interest. The ordering of these individual sheets was randomised for participants. Items were determined by the each participant's pairing of one adjective plus one noun. In accordance with these instructions, for each selection category the participants themselves created four test-items to make a full stimuli set of 20 items.

In the UK, participants were tested in groups of 5 to 15 people; in China, there were 24 to 26 participants per group. Testing was conducted in situ at the Oxford University Centre for Sport, Iffley Road (UK) and at a canteen at Beihang University during a break from table service (China). At both locations ambient stimuli remained minimal. The research assistants were provided with a strict procedure to follow. Procedure and the setup of the testing area were thoroughly rehearsed several times prior to actual testing. The participants were instructed to take a seat at tables with appropriate dividing spaces in between. They were then handed a pen and Answer Sheet 1a (see Appendix 8 for UK example) face-up at the personal information and basic task instructions page, and asked not to turn over the page. At this point, they were also given a Question Sheet (see UK example in Appendix 7) face down, which they were requested not to turn over, as well. They were then asked to fill in their personal details in the spaces provided and to carefully read through the instructions on the front page of Answer Sheet 1a. After a short period (approximately 1 minute), when all participants had done this, they were then requested to turn over the first page of the Answer Sheet and to turn over the Question Sheet to its first page, and advised: "You have 4 minutes to complete this page of the Question Sheet. Please record your answers on your Answer Sheet. Please ensure you provide all four answers and consider your answers carefully." When 30 seconds remained, the participants were advised: "30 seconds left." After the 4 minutes ended, the participants were asked, "Please turn to the next page of your Question Sheet." This process continued until the 5 sheets of the Question Sheet were at completion, at which time they were advised, "Now, please turn to the next page of your Answer Sheet and complete the tasks provided. You have 3 minutes to complete the three tasks." The three tasks, which were mathematical, served as a distractor task.

During this 3-minute period the research assistant carefully approached each table and placed Answer Sheet 1b (see UK example in Appendix 9) facedown within easy reach of each participant. When the 3 minutes had elapsed, the participants were told, "Time is up. Please place both your Answer Sheet and Question Sheet face-down and place them on the side of the table." They were then instructed, "Please turn over the sheet that we have just given you and fill in your personal details." They were then instructed to: "Please write down as many of the adjective-noun combinations that you created as you can remember. You have 3 minutes in which to do so." When this period ended, the participants were thanked for their time and asked to return in 7 days' time, at the same time of day, for a "somewhat different task".

At the same location returning after a one week delay, the participants were again instructed to take a seat, at which point they were given a pen and a face-down copy of Answer Sheet 2a (identical to Answer Sheet 1b, Appendix 9). When all participants had their materials in front of them, they were then instructed to turn over the Answer Sheet and fill in their personal details. After a short period of delay (approximately 30 seconds) they were then instructed, "Please write down as many of the adjective/noun combinations that you created last week as you can remember. You have 3 minutes in which to do so". When the 3 minutes ended, the participants were told, "Stop writing".[54]

6.4 Measures and coding

The items recorded by participants in the generation task above were then examined to identify whether the participants had unknowingly authored MCI concepts. To correctly identify the authorship of an MCI idea, as well as to record the corresponding schema-level effect category in accordance with the criteria for which it had been generated (was it a transfer or breach violation? of what expectation set?), two coders in both the UK and China studies were trained in the procedures for Barrett's (2008) quantifying and coding scheme. These coders had no

[54] At this point the Answer Sheets were collected and instruction commenced for the completion of Pretest #2, the details of which are covered in Chapter 0.

previous experience with or knowledge of MCI theory. They independently processed all the adjective-noun combinations provided by the participants to detect any breach or transfer types of violation of expectation set. Items were coded as either intuitive (INT), minimally counterintuitive (MCI), or impossible to ascertain (X) due to the bizarre nature of the generated item or the excessive ambiguity in its reference due to polysemy, metaphorical use, or the ease with which it lent itself to metaphor. All X items were discarded from further proceedings. For each participant the two coders compared their answers. If the coders did not agree on the appropriate category for a generated item, they discussed it in a prescribed manner until they concurred. This method required the coders to together brainstorm as many possible meanings and language uses of the generated adjective-noun pair in question as they could immediately think of, then judge which of them was most likely to be the intended meaning of the participant. If the likelihood of the most likely meaning, or language use, of the item was thought to be 90 percent or more of all possible representations, it was marked as either "MCI" or "INT", and if the probability was considered to be less it was excluded as "X". For example, consider the modified noun "shrinking chair", which could have a number of different meanings and language usages, such as a chair that is slowly grinding away on the floor to reduce its size, or being eaten by woodworm. In addition, it could be an item in a fairy tale involved in an event in which furniture becomes smaller. The coders had to determine the probability of the most likely representation in the mind of the participant. If the coders could not reach agreement, the item was excluded. In addition to identifying whether the modified noun belonged in the intuitive or counterintuitive category, the coders also independently determined whether the modified nouns they had identified as MCI ideas were either breach or transfer types of violations of the expectation set. Again, discussion was required to resolve any disagreement. The data was coded in identical fashion for both the UK- and China-based experiments data using the quantifying and coding scheme of Barrett (2008).

A research assistant coded the participant-created stimuli with regard to the schema-level effect categories for which they were constructed. The coding required was considered sufficiently transparent for one research assistant to complete the task. Participants were scored on the basis of their recall of both the adjective and noun. Minor spelling mistakes were accepted, and items were also permitted if the adjective recalled shared the identical grammatical root but deviated in conjugation (e.g. "attacker" instead of "attacking"). Scores were tallied on both the Answer Sheet on which the items were created (Answer Sheet 1a; Appendix 8) and the Answer Sheet upon which the items were recalled (Answer Sheet 1b or Answer Sheet 2a; Appendix 8 or Appendix 9, respectively), in the particular recall period. By this method the scores could be reconciled and any potential errors prevented. Any item correctly recalled was scored one point and marked indicating the schema-level effect category that it exemplified. When all the participant's items had been coded, all correctly recalled items were tallied according to schema-level effect category.

6.5 Participants

A total of 90 participants were from both the UK and China were used in this study. Ages ranged from 10 to 58 years of age, with a mean age of 25.82 (SD = 10.95). Sixty-six participants were male (73.3%) and 24 female (26.7%). Seventy-three participants spoke the presented language as a natural language.

In the UK experiment, 40 participants were recruited from the general public and from sporting societies in Oxfordshire and Buckinghamshire. Researchers indiscriminately approached persons at the Iffley Road Sports Centre in Oxford and the High Wycombe Judo Centre and within the working public from the village of Elsfield in Oxfordshire. The age of participants ranged from 16 to 52 years old, with a mean age of 30.32 (SD = 9.99). Twenty-six participants were male (65%) and 14 female (35%). All participants considered themselves to be fluent in English. Twenty-six members of the sample spoke English as a natural language. Participants were compensated £10 for their participation in a "cognitive task".

The 50 participants of the China-based experiment were recruited from the general public surrounding Beihang University in Beijing. Researchers approached persons employed at and within the local catering services, shops, and supermarkets, as well as other students and non-academics in the complex, to instigate a snowballing method of recruitment. A sample was gathered comprising students and academics, skilled workers and unskilled workers in a variety of industries, and unemployed persons. The age of participants ranged from 10 to 58 years, with a mean age of 22.22 years (*SD* = 10.42). Forty participants were male (80%) and 10 female (20%). All participants considered themselves to be fluent in Chinese. Forty-seven members of the sample identified themselves as being of Han ethnicity. Participants were compensated 50 Yuan for their participation in a "cognitive task" (or its Chinese language equivalent).

6.6 Results

The nature of the experiment permitted two dimensions to be analysed: the number of counterintuitive stimuli generated by participants, and the recall of these stimuli authored by the same participants. It also facilitated investigation of the relationship between the template-violation of counterintuitiveness and the five schema-level effects (positive emotion, negative emotion, imagery, humour, and inferential potential) with respect to both the authorship of representations and the recall of representations which the participant personally authored.

6.6.1 Analysis of the production of representations generated by participants

An analysis of covariance (ANCOVA) considering the number of counterintuitive test items authored by participants, with country of experiment site as a between-subjects factor and age as a covariate, was used to investigate the relationship between the creation of counterintuitive representations and age. Although age was found to significantly predict the number of counterintuitive test items created by participants in the initial GLM model, $F(1, 86) = 14.12$, $p < .001$, *partial* $\eta^2 = .141$, it was revealed that the country in which the experiment was conducted also affected the number of counterintuitive test items authored, $F(1, 86) = 28.23$, $p < .001$, *partial* $\eta^2 = .247$, both large effect sizes,[55] respectively. Consequently, further analysis was split with respect to the country of experiment location (UK or China). This split analysis for the UK and China data was conducted by an ANCOVA with considerations comparable with those of the first analysis above, but without country of experiment site as a between-subjects factor. The covariate of age significantly affected the number of counterintuitive test items authored by participants in both the UK and China, $F(1, 38) = 7.66$, $p = .009$, *partial* $\eta^2 = .168$, and, $F(1, 47) = 7.13$, $p = .01$, *partial* $\eta^2 = .132$, respectively. This constituted a large effect size for the UK group and a medium effect size for the China group, and in both groups was due to younger participants generating a greater number of counterintuitive representations than older participants in the sample.

A second GLM in the form of a one-way repeated-measures ANOVA was used to investigate biases of counterintuitive ideas authorship within schema-level effect categories. This was facilitated in accordance with given instruction during the experiment, for which the participants, unknowingly, were generating intuitive or counterintuitive stimuli as their answers. The five levels of the main effect represented the five schema-level effects (positive emotion, negative emotion, imagery, humour, and inferential potential), with country of experiment site as a between-subjects factor. Figure 10 shows the comparative sums of counterintuitive representations authored by the participants.

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[55] Cohen (1988, 1992) offers a conversion (see Cohen 1988: 283) for partial *eta* squared effect sizes (*partial* η^2) where 0.0099 constitutes a small effect, 0.0588 a medium effect, and 0.1379 a large effect.

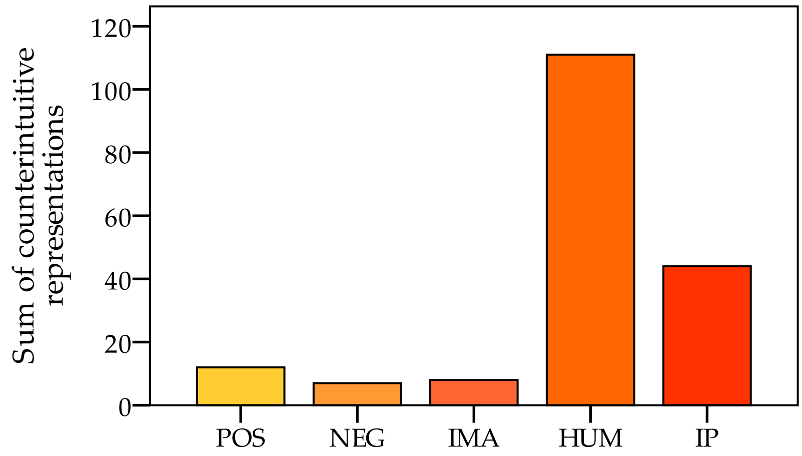

Figure 10. Sum of counterintuitive representations generated by participants according to schema-level effect category. Positive emotion = POS; negative emotion = NEG; imagery = IMA; humour = HUM; inferential potential = IP.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of schema-level category, $\chi^2(9) = 121.41$, $p < .001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .6$ for the main effect of schema-level category). All effects are reported as significant at $p < .05$. Analysis revealed significant differences between the number of counterintuitive test items created by participants according to the differing schema-level effect categories, $F(2.38, 162.12) =$, $p < .001$, *partial* $\eta^2 = .436$. No significant effect was found for the interaction of country of experiment site and schema-level category ($p > .05$). Post-hoc tests based on estimated marginal means (Bonferroni corrected) revealed that the three schema-level categories with the lowest mean number of participant-generated counterintuitive representations, positive emotion ($M = .17$, $SD = .42$), negative emotion ($M = .1$, $SD = .39$), and imagery ($M = .11$, $SD = .36$) were not significantly different ($p > .05$). However, the humour schema-level category ($M = 1.54$, $SD = 1.18$), with the highest mean number of counterintuitive representations authored by participants, had significantly more counterintuitive representations generated in accordance with its criteria than any of the other 4 schema-level effect categories (all, $p < .001$). The schema-level category with the second-highest mean number of counterintuitive representations authored by participants was inferential potential (*M* = .67, *SD* = 1), significantly more than generated for the remaining schema-level categories, positive emotion, negative emotion, and imagery (all, $p < .001$).

With regard to both of the above GLMs, analysis of residuals showed that the model appears to be accurate for the sample. Although a number of outliers were identified, no case exhibited a Cook's distance of more than 1.[56] The model appears to be generalizable to the population. On visual inspection, the residuals did not appear homoscedastic, expressed a generally linear relationship between independent and dependent variables, and appeared to be normally distributed to a satisfactory degree.[57]

6.6.2 *Analysis for recall of representations generated by the same participant*

With regard to the analysis of free-recall for test items that participants authored themselves, given the instructions of the Question Sheet (Appendix 7) in the first part of the experiment, two dependant variables were assessed: free memory recall after a 3-minute distractor task, and a second free recall period after a one-week delay. Percentage scores were calculated to represent the proportion of intuitive or counterintuitive stimuli recalled for each participant, as totals varied among participants. Initially, a three-way repeated-measures GLM considering the main effects of schema-level, counterintuitiveness, and delay was attempted. However, this model failed due to insufficient residual degrees of freedom: counterintuitive stimuli were rarely generated by participants for the schema-level effects categories of positive emotion, negative emotion, and imagery (see Section 1.5.3), in accordance with the selection criteria. As a consequence, the disparity in the number of missing scores between the within-subjects variables was too great for a successful model. As a model including the effect of schema-level

56 Given the advice of Stevens (2002), no data points were excluded, as none exhibited excessive influence upon the outcome (all had a Cook's distance of < 1).
57 Upon visual inspection, the distribution was deemed to have a very slight negative skew and very slight positive tail. The Kolmogorov-Smirnov test for normality was considered to be inappropriate due to the large sample size.

on recall was not considered essential to proceedings, the two-way GLM above for counterintuitiveness and delay is reported. However, and second, the findings of a two-way GLM for the main effects of schema-level category and delay on recall are also reported here. Analysis of residuals showed that the model appears to be accurate for the sample. Although a number of outliers were identified, no case exhibited a Cook's distance of more than 1. The model appears to be generalizable to the population. On visual inspection, the residuals did not appear homoscedastic, expressed a generally linear relationship between independent and dependent variables, and appeared to be normally distributed.

The data was analysed using a two-way mixed ANOVA considering counterintuitiveness (2 levels representing recall rates of intuitive and counterintuitive stimuli) and delay (2 levels representing immediate and one-week-delayed recall periods), with country of experiment site as a between-subjects factor, and age as a covariate. Initial analysis revealed a significant cross-cultural difference between the UK and China samples, as country of experiment site was found to significantly affect the recall of stimuli, $F(1, 55) = 4.74$, $p = 0.034$, *partial* $\eta^2 = 0.079$. Consequently, a split analysis considering the UK sample and China sample independently was conducted. A similar repeated-measures GLM with age as a covariate revealed there to be no significant recall advantage for counterintuitive stimuli over intuitive stimuli for either the China or UK group (both, $p > .05$). Perhaps more surprising given the results from the experiments and analyses in Chapters 5, 6 and 7 was that no significant interaction between age and counterintuitiveness was found for either the China or UK group (both, $p > .05$). Nor was there any significant interaction between counterintuitiveness and delay in either group (both, $p > .05$). Table 18 displays the full factorial analysis of the GLM.

Table 18. *Analysis of variance for the recall of participant-authored test items.*

Source	*df*	*F*	*partial* η^2	*p*
UK				
Counterintuitiveness	1	.15	.006	.702
Counterintuitiveness within-group error	26	(587.19)		
Age	1	1.61	.058	.215
Counterintuitiveness x Age	1	.24	.009	.627
Delay	1	8.76	.252	.006
Delay within-group error	26	(218.07)		
Counterintuitiveness x Delay	1	.03	.001	.862
Counterintuitiveness x Delay within-group error	26	(148.32)		
CHINA				
Counterintuitiveness	1	6.59	.023	.424
Counterintuitiveness within-group error	28	(1480.97)		
Age	1	1.11	.038	.302
Counterintuitiveness x Age	1	.39	.014	.537
Delay	1	2.37	.078	.135
Delay within-group error	28	(394.37)		
Counterintuitiveness x Delay	1	.38	.013	.543
Counterintuitiveness x Delay within-group error	28	(252.83)		

Note. Values enclosed in parentheses represent mean square errors.*p < 0.05. **p < 0.01.

A second, two-way mixed ANOVA considering the main effect of schema-level category (5 levels representing positive emotion, negative emotion, imagery, humour, and inferential potential) and delay (2 levels representing immediate and one-week delayed recall periods) on stimuli recall, with country of experiment site as a between-subjects factor, was also used to analyse the data. Initial analysis revealed that the country of experiment site did not significantly affect the recall of participant-generated stimuli for the UK and China samples ($p <$ .05). Mauchly's test indicated that sphericity could be assumed for the main effect of schema-level category, $\chi^2(9) = 11.55$, $p = .24$, and for the interaction of schema-level category and delay, $\chi^2(9) = 8.52$, $p = .48$. All effects are reported as significant at $p < .05$. The schema-level effect category according to which a stimuli was authored was found to significantly affect recall, $F(4, 332) = 4.76$, $p = .001$, *partial* $\eta^2 = .054$. Post-hoc tests based on estimated marginal means

(Bonferroni corrected) revealed that there were significant recall advantages for stimuli selected as exemplifying positive emotion (M = 1.83, SD = 1.11) and imagery (M = 1.84, SD = 1.11), with the highest mean recall values, over stimuli selected for the schema-level category of humour (M = 1.37, SD = 1.11) having the lowest mean recall value, p = .003 and p = .001, respectively. No other significant differences in recall totals were revealed for the remaining schema-level effect categories in the post-hoc pairwise comparisons (all, p > .05). No significant interaction of delay and schema-level effect or of age and schema-level effect was revealed (both, p > 0.05).

6.7 Summary

The analysis of counterintuitive and intuitive representations authored by subjects provides a fresh area to explore to develop an understanding of the epidemiology of cultural representations. Studies until now have investigated the mnemonic biases for counterintuitive ideas already established as cultural ideas, or for novel ideas given to participants, but none so far has attempted to explain the origin of cultural representations of this variety. This experiment provided just that: insight towards explaining how such counterintuitive representations enter cultural distributions in the first place, which members of societies are most likely to produce them, and the mnemonic dynamics of representations that were self-authored. Analysis of the production of representations by participants revealed support for the *MCI production age-effect hypothesis* as a significant interaction of counterintuitiveness and age was found (see Hypothesis #5, Chapter 2; not to be confused with Hypothesis #3, the "MCI age-effect hypothesis"). Younger persons given the opportunity to combine adjective plus noun to represent their ideas and feelings freely produced more MCI concepts in this task than did older persons in the sample. Given children's often odd-seeming conceptual productions (e.g. through attributing mental states and intentional acts to dolls/toys) and the strange varieties of ideas they appear to preferably attend to (e.g. actions of imaginary friends, folktales involving talking animals), the finding that younger persons in the population spectrum produce significantly more counterintuitive representations than older adults may not seem so farfetched. Section 11.1 in the last chapter will discuss the implications of this disproportionate generation of MCI representations in younger persons compared to older persons.

The results of the free-recall experiment that followed this initial generation task provided no supplementary support for the MCI hypothesis. Analysis revealed that self-generated MCI representations were not significantly better recalled than self-generated INT stimuli. Given the mixed findings and lack of support for the MCI hypothesis in Study #1 (in addition to Study #3 and Additional Analysis #3), it is now perhaps not surprising to have revealed no mnemonic advantage for MCI concepts over INT concepts for the whole sample. What is surprising, given the support found for the MCI age-effect hypothesis in both experiments of Study #1 (in addition to Study #3 and Additional Analysis #3), is that no interaction between age and counterintuitiveness was discovered. Although younger persons produced significantly more MCI representations than INT representations, these younger persons in the sample did not recall proportionally more MCI stimuli than INT stimuli as has been seen in the other recall experiments of this dissertation (see Studies #1 and #3, Chapters 5 and 7 respectively). Therefore, no support could be provided to the MCI age-effect hypothesis. What could account for this failure of Study #2 to support the MCI age-effect hypothesis as well as to replicate the findings of Experiments #1 and #2 (Study #1), which themselves did support the MCI hypothesis? It could be due to the smaller sample size of the experiment (N = 90, compared with N = 365 and N = 399 of Experiments #1 and #2, respectively, of Study #1), or perhaps due to the shortage of adolescents in the sample (the UK sample included only 4 participants under the age of 19 years, and the China sample only 11). It could also be that the ratio of MCI to INT ideas produced by participants in this task was too large. Norenzayan et al. (2006) have hypothesised that narrative body encompassing a collective of intuitive and counterintuitive representations is subject to the constraints of cognitive optimality based on the number of counterintuitive elements it comprises: cognitive optimality at the narrative level (return to Section 2 for greater detail). In analysing the texts of the Brothers Grimm folktales, they found that the most culturally successful or most widely known tales were those with between one and two counterintuitive agents or objects contained within the story. If the tale had too many or too few counterintuitive elements, it was generally not so widely known. A similar significant result was found for the free recall of lists of statements containing different counts of both intuitive and counterintuitive representations: lists with counts of counterintuitive ideas of around one to two were better remembered than lists with too few or too many counterintuitive components. However, many more MCI studies have found that cognitive optimality applies to the level of the concept, not to lists or to the entire narrative (e.g. Banerjee, Haque, and Spelke 2013; Barrett and Nyhof 2001; Boyer and Ramble 2001; Johnson, Kelly, and Bishop 2010). Another evocative explanation might arise from the membership of a significant majority of the participant-generated counterintuitive stimuli in the humour schema-level effect category. In the recall aspect of the experiment, stimuli that adhered to the schema-level effect of humour had the lowest mean-recall rates of all 5 schema-level categories and were significantly more poorly recalled than stimuli in either the positive emotion or imagery schema-level effect category. Interestingly, both the schema-level categories of positive emotion and imagery contained significantly fewer authored MCI stimuli than the category of humour did. These findings contrasted starkly with the findings for the elaborated condition free-recall experiment of Experiment #2 in Study #1, where for the presented stimuli (not the self-generated ones), the HLM revealed a mnemonic advantage for stimuli exemplifying the schema-level effect of humour, but also for the effects of negative emotion and inferential potential (both, not significant in this experiment). These findings could open the door to a new and interesting hypothesis about the cultural environment that counterintuitive concepts require to possess a mnemonic advantage. These environmental conditions could differ for self-authored MCI representations and for MCI representations entertained via externally transmitted means. Further implications of the findings of this Study #2 in conjunction with the findings in the other experimental chapters will be discussed in the concluding Chapter 11.

7 Study #3: The transmission advantage of supernatural agents

This chapter reports the results of a second experimental study using the measure of free recall conducted at locations in both the UK and China to investigate mnemonic biases in the transmission of ideas. (Study #2 used a generation task.) Study #3 was designed so as to test the main hypotheses centred on Boyer's theory of the mnemonic and transmission advantages of counterintuitive religious-type concepts, but also investigated the memorability advantages of concepts adherent to the PERSONS ontological category and the transmission advantages of ideas familiar to the cultural groups and considered the interactions of these factors. The MCI hypothesis **refers to the** typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies, which asserts that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence demand attention and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). The MCI hypothesis predicts that minimally counterintuitive (MCI) stimuli that violate a template-level intuitive assumption will be significantly better recalled than intuitive stimuli (INT) counterparts that are consistent with domain-specific intuitive assumptions.

Guthrie (1993), Boyer (2001) and Barrett (2000; 2004a) have hypothesised that a psychological mechanism hypersensitive to agency detection would be adaptive, since having a strong perceptual bias to interpret ambiguous events as caused by an agent makes it far less likely that our ancestors would have been killed by predators. It would have been far less costly for our ancestors to detect too many agents in their environments than too few (also H. C. Barrett 2005). Adopted by the cognitive science of religion community, the interaction of the counterintuitive effect and the *hypersensitive agency detection device* (HADD), due to its oversensitivity to the unseen presence of agents, helps to explain the universal proliferation of god and deity concepts. Supernatural agents are reported to be a recurrent universal of world religions (Brown 1991), and the primary defining factor of religion (Atran 2002; Barrett 2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and Honkela 2003). This important theoretical proposition has not previously been experimentally investigated. Hence, the supernatural agency hypothesis predicts a significant interaction of counterintuitiveness and ontological category, as MCI concepts that fall under the PERSONS ontological category will be better recalled than MCI concepts and intuitive concepts (INT) consistent with domain-specific intuitive assumptions of other ontological category kinds. The design of this free-recall experiment also facilitated the anticipated outputs of the HADD be tested. The HADD hypothesis predicts that animate stimuli will be significantly better recalled than inanimate stimuli. In an additional analysis, a group containing stimuli falling under the PERSONS and ANIMATES ontological categories ("animates") was expected to have a significantly better mean recall rate than a second group containing stimuli falling under the SOLID OBJECTS and LIVING THINGS ontological categories ("inanimates").

As an expansion of the typical formulation of the MCI hypothesis that has dictated previous MCI free-recall studies, drawing from Boyer's (2000, 2001) original description of the mnemonic advantages of counterintuitive ideas, this study also investigated the interaction of the counterintuitive template-level effect with schema-level mnemonics, as per Boyer's original assertion of the epidemiological advantages of "familiar" counterintuitive ideas (2001: 58-105). In this regard, the *familiar MCI hypothesis* predicts that familiar-counterintuitive stimuli will be significantly better recalled than novel, unfamiliar-counterintuitive stimuli. The impact of age on the recall of counterintuitive representations was investigated, facilitated by means of samples representative of the age demographics of the populations studied. As predicted by the MCI age-effect hypothesis younger persons were expected to recall significantly more counterintuitive representations than the older adult counterparts. In addition, the cross-cultural experiment sites of the UK and China facilitated the testing of the claimed universality of the counterintuitive effect. Chapter 2 contains a full, detailed listing of the hypotheses guiding this analysis.

Participants for Study #3 were assigned either to a written presentation of stimuli or to an oral presentation of stimuli in the minimal condition (a simple subject-predicate statement), or to a mixed-media format of stimuli presentation with added descriptive formulation (added descriptive narrative). Chapter 8, which follows the current chapter, reports the findings of an additional analysis that ran prior to the analyses in the current chapter and investigated potential differences in the recall of counterintuitive representations between these minimal and elaborated narrative conditions of grammatical formulation of stimuli. In Chapter 8, Additional Analysis #1 investigated whether concepts embedded in narrative more likely to be remembered and communicated than concepts presented with minimal contextual information, when they possess equal levels of semantic coherence and strictness of reference. It was motivated by the claim of Gonce et al. (2006) and Upal et al. (2007, 2010) that simple grammatical structures lacking the context provided by a narrative are insufficient to successfully communicate MCI concepts by providing the memorability advantages for them over intuitive concepts that Boyer (2000, 2001) has hypothesized (see Section 1.5.7 for further background details). As a result, analysis and discussion of differences in recall rates of stimuli among participants assigned to the minimal condition (written or oral presentation of stimuli) and elaborated condition (mixed-media presentation of stimuli) are not present in this current chapter, but will be reported in Chapter 8.

7.1 Method

The stimuli of this experiment were the same as those used for Experiments #1 and #2 of Study #1. The methodology for Study #3 should be considered an amalgamation of the protocol for Experiments #1 and #2 of Study #1. Hence, the experimental design, materials and procedures, measures and coding for this study were identical to those detailed in Chapter 5, and are not here described.

In brief overview, a single free-recall experiment conducted in both the UK and China, participants were either presented with a *minimal condition* of stimuli presentation, or an *elaborated condition* of stimuli presentation.[58] Thirty-two stimuli adherent to the familiarity x counterintuitiveness categories of *familiar minimally counterintuitive* (fMCI), *unfamiliar minimally counterintuitive* (uMCI), *familiar intuitive* (fINT), and *unfamiliar intuitive* (uINT) were presented sequentially to individual participants in a free-recall experiment by either written or oral presentation, to participants in both the UK and China. The complete stimuli sets for both the UK and China studies appear in Section 3.5 of Chapter 3. First, with respect to the minimal condition of stimuli presentation, all stimuli obeyed the grammatical structure of subject-predicate statements:

Minimal condition formula for stimuli in the UK study:

A [X] that is [Y]

e.g. "a frog that is jumping" or "a doctor that is invisible"

Where X = noun and Y = adjective

Minimal condition formula for stimuli in the China study:

Grammatical formula for statements containing an adjective:

一 (yī) + *[measure word] + [noun(subject)]* 它 (tā) + 是 (shì) + *[adjective (predicate)]* + 的 (de)

Or,

Grammatical formula for statements containing a verb:

一 (yī) + *[measure word] + [noun(subject)]* 它 (tā) + 在 (zài) + *[verb (predicate)]* + 了 (le)

To form the elaborated condition of stimuli, a descriptive rewording of the original subject-predicate statement of the minimum condition was added to form an expanded grammatical structure with consistent semantic content. The additional semantic material that

[58] A comparison of results from the recall of stimuli from the minimal and elaborated conditions facilitated testing of the *item-centric hypothesis*, which predicts that additional contextual material will not make counterintuitive ideas more memorable or more easily transmitted (see Chapter 2 for a summary of the hypothesis and Additional Analysis #1 in Chapter 8 for full detailed results).

was added to form the elaborated condition retained a uniform grammatical structure across all stimuli. This distended form of elaborated stimulus obeyed the following structure for UK participants:

Elaborated condition formula:

There is a [DESCRIPTIVE of X, #1] [DESCRIPTIVE of X, #2] [ONTOLOGICAL CATEGORY SYNONYM of X] that is [SYNONYMOUS PHRASE of Y]. [He/She/It] is a [X] that is [Y].

e.g. "There is a small furry animal that is chatting away. It is a mouse that is talking"

In contrast with the minimal condition, the elaborated condition in both the UK and China was a simultaneous multimedia presentation containing both written and verbal grammatical components. The *elaborated condition* of stimuli was presented orally to participants wearing headphones, while simultaneously a subject-predicate statement of the stimuli (identical to the minimal condition) was presented to participants in written format on the laptop screen in front of them. Appendix 3 details the full UK stimuli set in the elaborated condition. Appendix 4 details the elaborated condition of the stimuli in the China-based experiment.

7.2 Participants

Participants were recruited in accordance with quotas for age-banded groups in both the UK and China to ensure that a representative demographic of age was acquired. In both of these locations participants were assigned to either a minimal format of the presentation of stimuli or an elaborated format of the presentation of stimuli. In total, 764 people participated in this experiment, with a mean age of 26.55 (SD = 18.29) years. Ages ranged from 3 years and 2 months to 86 years of age. Three hundred and ninety-two of the participants were female (51.3%), and 372 were male (48.7%). Seven hundred and twelve participants spoke the presented language as a natural language. All participants were informed they were to take part in a "memory task".

7.2.1 Participants in UK experiment

Three hundred and eighty two participants[59] were recruited from the general UK population. Ages ranged from 3 years and 2 months to 84 years, with a mean age of 27.01 (*SD* = 18.28) years. Participants were indiscriminately approached at several sites in Oxfordshire and the West Midlands. Oxford locations included: Oxford University Sport Centre, G and D's Café on the Cowley Road, and Joe's Bar and Grill in Summertown. Participants were also recruited using the same method at Shirley Golf Club in Solihull in the West Midlands. The snowballing method of recruitment was also used and instigated with participants who had already taken part in the study. Appointments were made for participants recruited by this method at the preceding locations. All recruited individuals are assigned an appointment time for a first testing period, with the second recall task being scheduled for a time exactly one week later. One hundred and ninety three of the participants were female (50.5%) and 189 were male (49.5%). Research assistants also recruited participants in accordance with age-group quotas to ensure a representative age-demographic sample was attained. All participants considered themselves fluent in English, and 339 persons spoke English as their first language.[60]

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[59] One hundred and eighty-four participants were assigned to the minimal format of the presentation of stimuli (97 to the written presentation mode; 87 to the verbal presentation mode). Ages ranged from 13 to 84 years, with a mean age of 32.14 (*SD* = 16.29) years. Ninety-five of the participants were female, and 89 were male; 160 spoke English as a natural language. A preliminary two-way mixed ANOVA for counterintuitiveness and delay, and the between-subject factor of presentation mode (oral or written), was used to analyse the recall rates of verbal versus written stimuli in the test of the mode-equality hypothesis. For the UK sample, the mode in which the stimuli were presented, oral or written, was found not to affect the recall rates of stimuli, and also no interaction of counterintuitiveness x presentation mode was found (both, $p > .05$). The factor was therefore excluded from the main GLM model.

One hundred and ninety-eight participants were assigned to the elaborated format of the presentation of stimuli. Ages ranged from 3 years and 2 months to 82 years, with a mean age of 22.24 (*SD* = 18.78) years. Ninety-eight of the participants were female, and 100 were male; 179 spoke English as a natural language.

[60] Preliminary analyses indicated that the between-subjects factors of natural language and sex did not affect participant recall rates in the UK experiment (both, $p > .05$).

Participants were compensated £10 for their participation after completing the delayed period of testing. Table 19 contains descriptive and frequency statistics for participants in the constituent age groups for the UK experiment.

Table 19. *Descriptive and frequency statistics for participants by age-group in UK sample*

Age group		Age				Sex		Language	
	N	Min	Max	*M*	*SD*	Male	Female	Foreign	Natural
≥3<5 years	24	3.17	4.92	3.96	.52	11	13	0	24
≥5<8 years	28	5	7.92	7.15	.8	13	15	0	28
≥8<13 years	31	8.08	11	9.47	.76	17	14	0	31
≥13<20 years	77	13	19	16.17	1.84	39	38	9	68
≥20<28 years	77	20	27	23.29	2.34	31	46	13	64
≥28<50 years	81	28	49	35.35	6.5	43	38	21	60
≥50 years	64	50	84	59.8	9.19	35	29	0	64
Totals	382	3.17	84	27.01	18.28	193	189	43	339

7.2.2 Participants in China experiment

Three hundred and eighty-two participants[61] were recruited from the general population of Beijing. Ages ranged from 3 years and 7 months to 86 years, with a mean age of 26.09 (SD = 18.3) years. Participants were indiscriminately approached in an eating complex at Beihang University that included a supermarket, several canteens and a restaurant, and within parks of the Beihang[62] university area, and at several businesses in the Wudakou district of Beijing. The

[61] One hundred and eighty-one participants were assigned to the minimal format of the presentation of stimuli (95 to the written presentation mode; 86 to the verbal presentation mode). Ages ranged from 13 to 86 years, with a mean age of 33.49 (SD = 18.14) years. Ninety-one of the participants were female, and 90 were male, 175 who spoke Chinese as a natural language. A preliminary two-way mixed ANOVA for counterintuitiveness and delay and the between-subjects factor of presentation mode (oral or written) was used to analyse the recall rates of verbal versus written stimuli in the test of the mode-equality hypothesis. For the China sample, the mode in which the stimuli were presented, oral or written, was found not to affect the recall rates of stimuli, nor was any interaction of counterintuitiveness x presentation mode found (both, $p > .05$). The factor was therefore excluded from the main GLM model.

Two hundred and one participants were assigned to the elaborated format of the presentation of stimuli. Ages ranged from 3 years and seven months to 69 years, with a mean age of 19.42 (SD = 15.77) years. Ninety-three of the participants were male, and 108 were female, 198 who spoke Chinese as a natural language.

[62] The nature of a Chinese university campus can differ dramatically from those typical in Europe and the US. These "university areas" tend to be much larger in scale, a large proportion of which are constituted by unaffiliated members of the general public, as well as students, academics and service staff.

snowballing method of recruitment was also used and instigated with participants who had already taken part in the study. Appointments were made for participants recruited by this method at the preceding locations. All recruited individuals were assigned an appointment time for a first testing period, with the second recall task being scheduled for a time exactly one week later. Table 20 contains descriptive and frequency statistics for participants in the constituent age-group categories demanded by the age-demographic quota. One hundred and ninety-nine of the participants were female (52.1%), and 189 were male (47.9%). All participants considered themselves to be fluent in Chinese, 373 of who spoke Chinese as their first language.[63] Participants were compensated 50 RMB after completing the delayed period of testing for their participation in a "cognitive task".

Table 20. *Descriptive and frequency statistics relative to participant age-group category for the China sample*[64]

Age group		Age				Sex		Ethnicity	
	N	Min	Max	*M*	*SD*	Male	Female	Other	Han
≥3<5 years	21	3.58	4.25	3.93	.23	14	7	0	21
≥5<8 years	37	5.17	7.83	6.37	.91	16	21	0	37
≥8<13 years	34	8	11	9.69	.91	19	15	0	34
≥13<20 years	73	13	19	15.52	2.03	32	41	2	71
≥20<28 years	77	20	27	22.71	1.74	43	34	5	72
≥28<50 years	79	28	49	35.34	6.44	32	47	1	78
≥50 years	61	50	86	59.72	9.5	27	34	1	60
Totals	382	3.58	86	26.09	18.32	183	199	9	373

7.3 Results

Given the lack of significant differences revealed in the results of Additional Analysis #1, detailed in the next chapter (see Section 8.3 for greater details of the analysis), it was considered justifiable not to split the data set according to presentation mode (i.e. minimal or elaborated

[63] Preliminary analyses indicated that the between-subjects factors of natural language and sex did not affect participant recall rates in the China experiment (both, $p > .05$).

[64] A number of participants failed to complete the study due to language, comprehension problems, or experimenter error. These failed participants would have aligned with the following age groups: 1 x ≥20<28 years; 9 x ≥28<50 years; and 9 x ≥50 years. These figures are not reported in the descriptive statistics of the sample.

conditions of stimuli presentations). Although there was an overall significant difference in the number of stimuli recalled for the between-subjects effect of presentation mode, $F(2, 524) = 5.172$, $p = .006$, *partial* $\eta^2 = .019$,[65] as would be expected due to the differences in length of stimuli presentation (12 seconds for the elaborated condition compared with 7 seconds for the minimal condition of stimuli), no significant differences were revealed for the interaction of the main factors of ontological category, counterintuitiveness, and familiarity that would affect the hypotheses, and the presentation mode in which the stimuli were presented to participants (all, $p > 0.05$).

A similar initial four-way ANOVA (counterintuitiveness, familiarity, ontological category, and delay) that considered the entire data set revealed no significant effect on the recall of stimuli for the country in which the participants had been tested, $F(1, 685) = 2.482$, $p = .116$. No significant differences were revealed for the interaction of country of participant testing location and the main factors affecting the hypotheses of counterintuitiveness, $F(1, 685) = 2.377$, $p = .124$, and familiarity, $F(1, 685) = .121$, $p = .729$. However, given the facility for a cross-cultural comparison in greater detail and the intriguing significant difference discovered in the interaction of country of location and ontological category, $F(2.926, 2004.211) = 10.201$, $p < .001$, *partial* $\eta^2 = .015$, Huynh-Feldt corrected as sphericity not assumed,[66] with a small effect size, it was considered of interest to split the data file for this between-subjects factor.

The analysis that resulted from these preliminary analyses was then a four-way mixed ANOVA considering counterintuitiveness, familiarity, ontological category, and delay, and with age as a covariate. Similar analyses were run for both the UK and China samples to facilitate a comparison of results. All effects are reported as significant at $p < .05$. In the immediate period of recall, participants in the UK recalled on average 22.2% of target items

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[65] Cohen (1988, 1992) offers a conversion (see Cohen 1988:. 283) for partial *eta* squared effect sizes (*partial* η^2) where 0.0099 constitutes a small effect, 0.0588 a medium effect, and 0.1379 a large effect.

[66] Girden (1992) suggests that when estimates for Mauchly's test for sphericity are greater than 0.75 then the Huynh-Feldt correction should be used, but when sphericity estimates are less than 0.75, or nothing is known about sphericity, the Greenhouse-Geisser correction should be used instead.

(7.08 of a possible 32 stimuli), whereas in China, participants recalled on average 18.75% of target items (5.96 of a possible 32 stimuli). In the one-week delayed period of recall, UK participants recalled on average 13.8% of target items (4.4 of a possible 32 stimuli), while in China, participants recalled on average 14% of target items (4.48 of a possible 32 stimuli). Analyses were performed to determine whether recall effects might have been driven by differences in the participants' demographics or theoretically unimportant features of the experimental design. A significant effect of the age of the participant on recall rates of stimuli was found in both the UK, $F(1, 336) = 11.26$, $p = .001$, *partial* $\eta^2 = .032$, and China, $F(1, 347) = 9.06$, $p = .003$, *partial* $\eta^2 = .025$. The period of delay in which the stimuli were recalled was found to have a significant effect on the recall rate for stimuli, as target items were better recalled in the immediate period of recall than in the second period of recall after a one-week delay, in both the UK, $F(1, 336) = 67.39$, $p < .001$, *partial* $\eta^2 = .167$, and in China, $F(1, 347) = 36.03$, $p < .001$, *partial* $\eta^2 = .094$. The effects on recall of the sex of the participant, and whether participants spoke the language used in the experiment as a natural language, were both found to be not significant, as would be expected (both $p > 0.05$).

Table 21. *Analysis of variance for the recall of stimuli.*

Source	*df*	*F*	*partial* η^2	*p*
UK				
Counterintuitiveness	1	38.77**	.103	< .001
Counterintuitiveness x Age	1	47.02**	.123	< .001
Counterintuitiveness within-group error	336	(929.4)		
Counterintuitiveness x Ontological Category	3	3.51*	.01	.015
CI x Ontological Category within-group error	1008	(1003.58)		
Ontological Category	2.83	23.65**	.066	< .001
Ontological Category x Age	2.83	.811	.002	.482
Ontological Category within-group error	952.22	(1163.74)		
Familiarity	1	28.74**	.079	< .001
Familiarity within-group error	336	(751.08)		
Counterintuitiveness x Familiarity	1	4.38*	.013	.037
CI x Familiarity within-group error	336	(881.59)		
Familiarity x Ontological Category	2.94	11.35**	.033	< .001

Familiarity x Ontological Cat. within-group error	988.65	(1009.89)		
		CHINA		
Counterintuitiveness	1	7.11**	.02	.008
Counterintuitiveness x Age	1	17.01**	.047	< .001
Counterintuitiveness within-group error	347	(883.21)		
Ontological Category	3	25.05**	.067	< .001
Ontological Category x Age	3	11.11**	.031	< .001
Ontological Category within-group error	1041	(930.02)		
Counterintuitiveness x Ontological Category	3	3.39*	.01	.018
CI x Ontological Category within-group error	1041	(885.07)		
Familiarity	1	19.44**	.053	< .001
Familiarity within-group error	347	(943.73)		
Counterintuitiveness x Familiarity	1	.008	< .001	.928
CI x Familiarity within-group error	347	(805.47)		
Familiarity x Ontological Category	3	8.67**	.024	< .001
Familiarity x Ontological Cat. within-group error	1040.04	(981.16)		

Note. Values enclosed in parentheses represent mean square errors. *$p < 0.05$. **$p < 0.01$.

Table 21 lists results from the mixed ANOVA for all factors affecting the hypotheses and other significant findings of interest. Analyses revealed a significant main effect of the counterintuitive status of stimuli (counterintuitive versus intuitive items) on recall rate, in both the UK and China, with medium and small effect sizes, respectively. Intriguingly, UK participants recalled a significantly larger number of counterintuitive stimuli than intuitive stimuli, whereas surprisingly in the China sample participants recalled significantly more intuitive stimuli (fINT and uINT) than counterintuitive stimuli (fMCI and uMCI). For the immediate period of recall, participants in the UK recalled on average 22% of intuitive stimuli (M = 3.52 out of 16, SD = 2.21), and 22.1% of counterintuitive stimuli (M = 3.53 out of 16, SD = 2.43), but in China, participants recalled on average 19.3% of intuitive stimuli (M = 3.09 out of 16, SD = 2.08) and 18% of counterintuitive stimuli (M = 2.89 out of 16, SD = 2.3). In the delayed recall period, UK participants recalled on average 13.1% of intuitive stimuli (M = 2.09 out of 16, SD = 2.11) and 14% of counterintuitive stimuli (M = 2.24 out of 16, SD = 1.96), whereas in China, participants recalled on average 14.2% intuitive stimuli (M = 2.27 out of 16, SD = 2.11) and 13.7%

of counterintuitive stimuli (M = 2.19 out of 16, SD = 2.13). There was no interaction of counterintuitiveness and delay revealed in the analyses, in either the UK, $F(1, 336) = .385$, $p = .536$, or China, $F(1, 336) = .107$, $p = .984$. The recall advantage of counterintuitive stimuli over intuitive stimuli (or intuitive stimuli over counterintuitive stimuli) was equally spread across both periods of recall—the effect was not specific to one period of recall. These findings in regard to recall rate are illustrated in Figure 14.

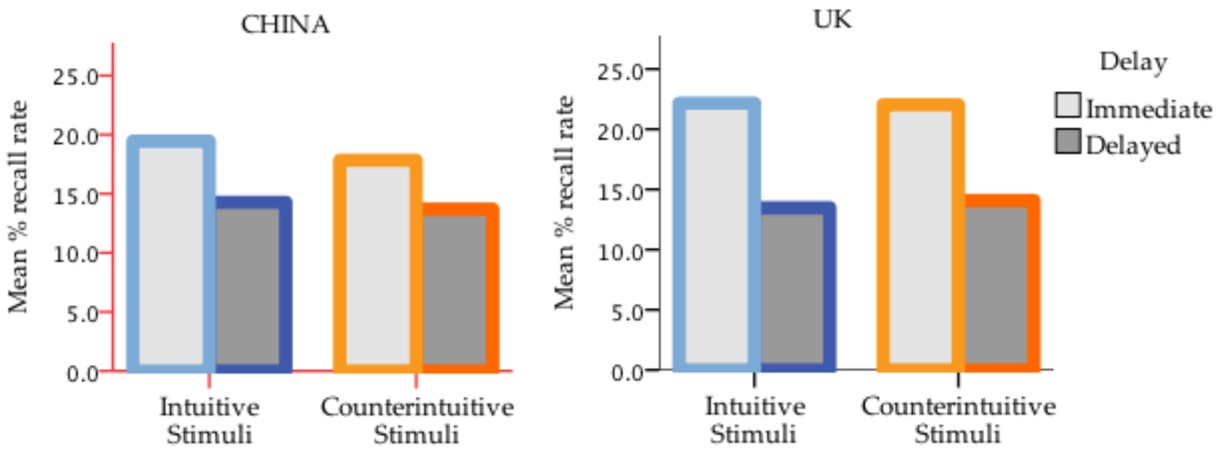

Figure 11. Bars representing mean percentage of recall in immediate and delayed recall periods for the UK and China for Study #3.

The ontological category to which the basic unmodified concept of the stimuli adhered (e.g. the basic concept MAN, from the modified concept INVISIBLE MAN) was also found to be a significant main effect on recall, shown as a medium effect size in both UK and China. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category for the UK sample, $\chi^2(5) = 34.04$, $p < .001$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .955 for the main effect of ontological category); sphericity was assumed for the China sample. Post-hoc tests revealed that stimuli adherent to PERSONS were significantly better recalled than all the other ontological categories of ANIMATES, SOLID OBJECTS, and LIVING THINGS, in both locations (all $p < .001$), Bonferroni corrected for multiple comparisons. There were no other significant differences revealed for the UK group (all, p > .05). However, in the analysis of the China sample, LIVING THINGS were also revealed to be significantly better recalled than stimuli belonging to ANIMATES (p = .002) and SOLID OBJECTS (p = .003), Bonferroni corrected. These findings are displayed in Figure 15.

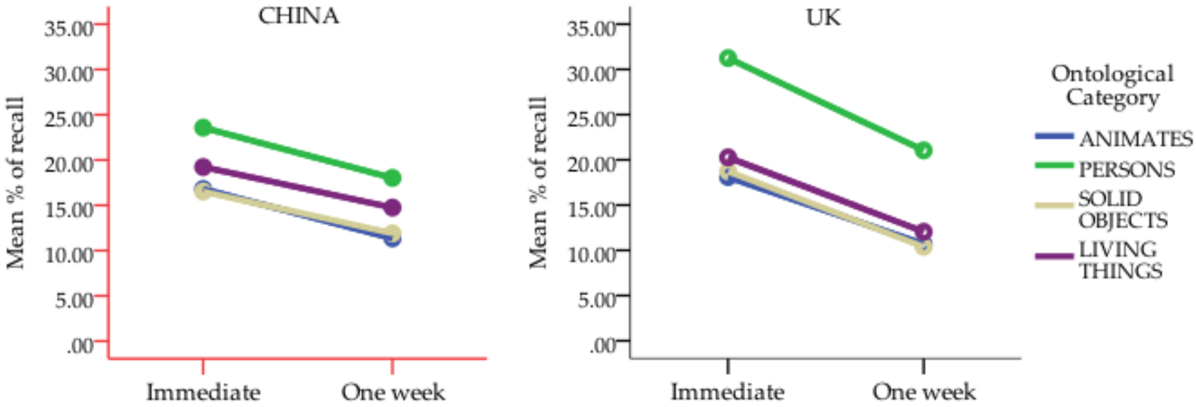

Figure 12. Mean percentage recall with respect to ontological category for immediate and delayed recall periods in UK and China.

An additional analysis conflated stimuli according to animate and inanimate features to test the predictions of the HADD hypothesis. Stimuli falling under ANIMATES and PERSONS ontological categories were conflated into "animates", and stimuli falling under SOLID OBJECTS and LIVING THINGS ontological categories were amalgamated into the "inanimates" group. The free-recall performance of stimuli in these groups was compared. A repeated-measures ANOVA considering animacy (animates versus inanimates) and delay revealed a significant main effect of animacy in both the UK, $F(1, 337) = 59.16$, $p < .001$, *partial* $\eta^2 = .149$, and China, $F(1, 349) = 3.99$, $p = .046$, *partial* $\eta^2 = .011$. These were large and small effect sizes, respectively. For the immediate period of recall, participants in the UK recalled on average 24.6% of animate stimuli (M = 3.93 out of 16, SD = 2.36) and 19.6% of inanimate stimuli (M = 3.13 out of 16, SD = 2.3), but in China, participants recalled on average 20.1% of animate stimuli (M = 3.16 out of 16, SD = 2.46) and 18.1% of inanimate stimuli (M = 2.84 out of 16, SD = 2.08). In the delayed recall period, UK participants recalled on average 15.8% of animate stimuli

($M = 2.53$ out of 16, $SD = 1.99$) and 11.4% of inanimate stimuli ($M = 1.82$ out of 16, $SD = 1.7$), whereas in China, participants recalled on average 14.2% animate stimuli ($M = 2.26$ out of 16, $SD = 2.2$) and 13.7% of inanimate stimuli ($M = 2.19$ out of 16, $SD = 2.11$). There was no interaction between the animacy category and delay revealed in the UK or China analyses (both, $p > .05$).

Analyses of the main GLM revealed a significant interaction of counterintuitiveness x ontological category. This presented a small effect for both UK and China samples. Consistent with the supernatural agency hypothesis, further investigation revealed that stimuli that were MCI concepts falling under the PERSONS ontological category were better recalled than other stimuli by ontological category combinations in both the UK and China. Mauchly's test indicated that the assumption of sphericity had been violated for the interaction of counterintuitiveness x ontological category for the China sample, $\chi^2(5) = 16.44$, $p = .006$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .954 for the main effect of ontological category). Sphericity was assumed for the UK sample. However, no indication for the mnemonic advantages of culturally familiar supernatural agents was found, as there was no significant interaction of counterintuitiveness x familiarity x ontological category, neither for the UK sample, $F(2.948, 1008) = .168$, $p = .915$, nor for the China sample, $F(2.949, 1041) = 1.297$, $p = .274$. Mauchly's test indicated that the assumption of sphericity had been violated for the interaction of familiarity x counterintuitiveness x ontological category for both the UK and China samples, $\chi^2(5) = 16.38$, $p = .006$, and $\chi^2(5) = 15.88$, $p = .007$, respectively. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .952$ and $\varepsilon = .955$, respectively, for the main effect of ontological category).

A significant main effect of familiarity on the recall rates of stimuli was found, with a medium effect size in both the UK and China samples. This was revealed to be due to significantly better recall rates of familiar stimuli (fINT and fMCI) over unfamiliar stimuli (uINT and uMCI) at both locations. Analyses also revealed a significant interaction of counterintuitiveness x familiarity in the UK, showing a small effect size. As revealed by contrasts, participants in the UK experiment recalled significantly more familiar-counterintuitive stimuli (fMCI) than other stimuli types. Although no significant interaction of counterintuitiveness x familiarity was revealed, upon analysis of data collected from the participants in China, with special regard to the familiar MCI hypothesis, post-hoc tests found familiar-counterintuitive stimuli were significantly better recalled than unfamiliar-counterintuitive stimuli in both the immediate recall period, $t(758) = 8.694$, $p < .001$, and the one-week delayed period of recall, $t(700) = 9.146$, $p < .001$, Bonferroni corrected for multiple comparisons ($\alpha < 0.25$). In the immediate period of recall for the UK experiment, participants in the UK recalled on average 24.3% of familiar-intuitive stimuli ($M = 1.94$ out of 8, $SD = 1.34$), 19.8% of unfamiliar-intuitive stimuli ($M = 1.58$ out of 8, $SD = 1.32$), 25.6% of familiar-counterintuitive stimuli ($M = 2.05$ out of 8, $SD = 1.52$), and an average of 18.5% of unfamiliar-counterintuitive stimuli ($M = 1.48$ out of 8, $SD = 1.33$). In the immediate period of recall in China, participants recalled an average of 22.9% of familiar-intuitive stimuli ($M = 1.83$ out of 8, $SD = 1.35$), 15.8% of unfamiliar-intuitive stimuli ($M = 1.26$ out of 8, $SD = 1.19$), 20.5% of familiar-counterintuitive stimuli ($M = 1.64$ out of 8, $SD = 1.41$), and 15.6% of unfamiliar-counterintuitive stimuli ($M = 1.25$ out of 8, $SD = 1.3$). For the delayed period of recall, participants recalled familiar-intuitive stimuli on average 15.6% in the UK ($M = 1.25$ out of 8, $SD = 1.08$) and 17.3% in China ($M = 1.38$ out of 8, $SD = 1.36$). Unfamiliar-intuitive stimuli were recalled 10.6% on average in the UK ($M = .85$ out of 8, $SD = .98$) and 11% in China ($M = .88$ out of 8, $SD = 1.13$). Familiar-counterintuitive stimuli were recalled on average 16.6% in the UK ($M = 1.33$ out of 8, $SD = 1.32$) and 16.1% in China ($M = 1.29$ out of 8, $SD = 1.34$). Finally, an average of 11.4% of unfamiliar-counterintuitive stimuli were recalled in the UK ($M = .91$ out of 8, $SD = .98$) and 11.3% in China ($M = .9$ out of 8, $SD = 1.12$).

Analyses revealed a significant interaction of counterintuitiveness x age, with a medium effect size in the UK and a small effect size in China. For both populations, contrasts revealed that younger participants including children better remembered and recalled a proportionally greater number of counterintuitive versus intuitive ideas than did adult participants at the older end of the age continuum. However, there was no significant interaction of counterintuitiveness x ontological category x age, neither for the UK sample, $F(3, 1008) = 1.04$, $p = .373$, sphericity assumed nor for the China sample, $F(2.939, 1041) = .592$, $p = .618$, Huynh-Feld corrected as sphericity not assumed.[67] Therefore, it might appear that age is not an important factor in the mnemonic advantages of supernatural agent concepts. No significant interaction of familiarity x age was found, in the UK, $F(1, 336) = .541$, $p = .462$, as well as in China, $F(1, 347) = 2.519$, $p = .113$, as younger persons in the spectrum appeared to be equally familiar with the stimuli as older persons in the spectrum, as the mnemonic bias for familiar items was equally effectual at both ends of the lifespan continuum. With respect to the interaction of ontological category x age, no significant interaction was found in the UK sample, Huynh-Feldt corrected,[68] but for the China sample a significant interaction was revealed with a small effect size, sphericity assumed. Whereas PERSONS concepts were consistently better recalled by participants throughout the age range of the UK sample, contrasts revealed that for the China sample PERSONS concepts were better recalled by younger persons, but interestingly older persons in the age spectrum more commonly recalled LIVING THINGS concepts. These findings for ontological category and interaction with age were also accompanied by the discovery of a significant interaction of familiarity x ontological category in both the UK and China samples, both showing small effect sizes. Mauchly's test indicated that the assumption of sphericity had been violated for the

[67] Mauchly's test revealed that the assumption of sphericity had been violated for the interaction of counterintuitiveness x ontological category for the China sample, $\chi^2(5) = 16.44$, $p = .006$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .954$ for the main effect of ontological category). Sphericity was assumed for the UK sample.

[68] Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category, $\chi^2(5) = 34.04$, $p < .001$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .903$ for the main effect of ontological category).

interaction of ontological category x familiarity for the UK sample, $\chi^2(5) = 15.54$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .955$ for the main effect of ontological category); sphericity was assumed for the China sample. Contrasts revealed that familiar-PERSONS stimuli were better recalled than other category varieties in the UK, and that both familiar LIVING THINGS and familiar PERSONS stimuli were better recalled in the China sample.

Analysis of residuals for this GLM showed that the model appears to be accurate for the sample. Although a number of outliers were identified, no case exhibited a Cook's distance of more than 1.[69] The model appears to be generalizable to the population. On visual inspection, the residuals did not appear homoscedastic, expressed a generally linear relationship between independent and dependent variables, and appeared to be normally distributed to a satisfactory degree.[70]

7.4 Summary

This analysis revealed contradictory and surprising findings in support of (in the case of the UK experiment) and also in rejection of (in the case of the China experiment) the typical formulation of the MCI hypothesis that has dominated previous experimental MCI studies. In the UK free-recall experiment, counterintuitive stimuli were significantly better recalled than intuitive stimuli, whereas in the China experiment, intuitive stimuli were significantly better recalled than counterintuitive stimuli. This was a complete reversal of the counterintuitive effect from one location to the other. Intriguingly, in comparison to Study #1, no significant interaction of counterintuitiveness and experiment site was revealed in the analysis of Experiment #1, and neither was there any notable difference with regard to the counterintuitive effect when

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69 Given the advice of Stevens (2002), no data points were excluded, as none exhibited excessive influence upon the outcome (all had a Cook's distance of < 1).

70 Upon visual inspection, the distribution was deemed to have a very slight negative skew and very slight positive tail. The Kolmogorov-Smirnov test for normality was considered inappropriate due to the large sample size.

viewing the findings from the UK and China samples of Experiment #2. However, it should be noted that differences between the findings of Experiment #1 and #2 with regard to the counterintuitive effect might contribute to explaining the cross-cultural differences found for Study #3. Whereas in Experiment #1 of Study #1 intuitive stimuli were overall better recalled than counterintuitive stimuli, in Experiment #2 the reverse was found as counterintuitive stimuli were significantly better recalled than intuitive stimuli. This difference in Study #1 was attributed to the inclusion of children under the age of 13 years in the sample of Experiment #2, who were not present in the sample of Experiment #1. At this point it can only be assumed that the larger sample size and increased statistic power for the analysis of Study #3 has revealed something that was previously undetectable. These findings alone beg to be investigated further and explored by additional analyses (see Chapter 9).

In contrast to previous studies in the MCI theory literature (e.g. Gregory and Barrett 2009; Norenzayan et al. 2006), the counterintuitive effect was not found to be present only in the delayed period of recall, but was evenly spread over both the immediate and one-week delayed testing periods. Proportionally larger recall rates of counterintuitive stimuli over intuitive stimuli, or vice versa, were not found when the testing periods were compared. This lack of significant interaction of counterintuitiveness x delay was consistent with the findings of both Experiments #1 and #2 of Study #1.

This study is the first of its kind to investigate the hypothesised transmission advantages for supernatural agents. It is also the first experimental study to find support for this central tenet of the cognitive science of religion. Support for the supernatural agency hypothesis was found in both the UK and China experiment sites, as counterintuitive mentalistic-agent concepts were overall better recalled than other concept combinatorial varieties. Both significant findings at these locations had equivalent small effect sizes. This equivalence between cross-cultural sites is consistent with the reporting of supernatural agents as recurrent universal of world religions (Brown 1991), and as the primary defining factor of religion (Atran 2002; Barrett

2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and Honkela 2003). Although not of concern to the supernatural agency hypothesis, there was no significant finding of the interaction of familiarity x counterintuitiveness x ontological category with regard to the recall of stimuli. To find that culturally familiar supernatural mentalistic agent concepts had a superior mnemonic—and therefore an inferred transmission advantage—would have had strong implications for the psychological foundations of all the major world religions. Interestingly, there was no interaction in the recall of stimuli for counterintuitive mentalistic-agent concepts and age, as might be foreseen given the reliable finding of the interaction of counterintuitiveness and age in Studies #1, #2, and #3. The mnemonic advantage for supernatural agent concepts appears to be constant for persons of all ages.

Support was also found for the HADD hypothesis, a component of the supernatural agency hypothesis. An additional analysis revealed that a group containing stimuli falling under the PERSONS and ANIMATES ontological categories ("animates") had a significantly better mean recall rate than a second group containing stimuli falling under the SOLID OBJECTS and LIVING THINGS ontological categories ("inanimates"). The theoretical postulation of HADD has previously had little experimental investigation (only Barrett and Johnson 2013; Nairne et al. 2013), and there was virtually no available experimental evidence for the role of HADD in acquiring and maintaining religious concepts. This study is the first of this kind to provide experimental evidence for HADD's role in the transmission of religious-type ideas. However, in isolation, HADD is not of particular relevance to the scientific exploration of religion. It is HADD's interaction with the counterintuitive effect that has explanatory power for religious phenomena. The main effect of ontological category, as built into the experimental design, permitted a deeper evaluation of the constituent ontological components of HADD. The operations of HADD may depend on factors more complicated than the fact of humans' strong perceptual bias to interpret ambiguous events as caused by "animates" rather than "inanimates". At both the UK and China experimental sites, stimuli adherent to the PERSONS ontological category (e.g. a man that is invisible, or a queen that is rich) were significantly better recalled than stimuli belonging to the other three ontological categories of ANIMATES, SOLID OBJECTS, and LIVING THINGS.

An even more intriguing finding was revealed in the analysis of the China recall data. Stimuli belonging to the LIVING THINGS ontological category (e.g. a pumpkin that is poisonous) were also better recalled than stimuli in either of the ANIMATES and SOLID OBJECTS ontological categories. This is a new and unique finding, absent in the analysis of the UK sample. Chapter 11 will speculate on the cognitive basis of this mnemonic bias as well as potential explanations for the cross-cultural difference. Another unique finding was a significant memorability advantage over other familiarity x ontological category varieties for stimuli that were both culturally familiar and adherent to the PERSONS ontological category in both the UK and China, and also for familiar LIVING THINGS concepts in the analysis of recall data from Chinese participants. A significant interaction of ontological category x age was also revealed, and it is perhaps now not surprising that this was only found for the China sample. Whereas PERSONS concepts were consistently better recalled by participants throughout the age range of the UK sample, contrasts revealed that for the China sample PERSONS concepts were better recalled by younger persons, but interestingly older persons in the age spectrum more commonly recalled LIVING THINGS concepts. However, it is possible that a linear model used here to analyse this data was not sufficiently sophisticated to detect the finer aspects of the interactions of ontological category with age. For instance, there might have been age effects present only in the much younger groups that the linear analysis was insensitive to. Given that different domains of intuitive knowledge come online at different times during early childhood, it might be predicted that differential mnemonic biases for certain ontological category kinds will be present amongst childhood age groups at different stages of development.

Although a significant interaction of counterintuitiveness x familiarity was found in the UK sample, because stimuli that were both counterintuitive and familiar to the cultural group (fMCI) were better recalled than stimuli of other categories, the same significant finding was not revealed for participants at the China experiment site. However, more specific to the familiar-MCI hypothesis, support was found at both experiment sites from post-hoc tests, as a significant recall advantage of fMCI stimuli over uMCI was present in both immediate and one-week delayed recall periods. For both the UK and China, these post-hoc findings provide satisfactory grounds to support the familiar-MCI hypothesis. There are therefore grounds to reject the assumption of Bloch (2005) and Upal (2010), who have both claimed that an MCI representation that becomes commonly communicated and culturally familiar to a cultural group does not have the same mnemonic advantages as a novel and unfamiliar counterintuitive representation due to a loss of saliency as a successful cultural representation.

It would be reasonable to presuppose that persons become more familiar with the most commonly represented conceptual furniture of their relative cultural environments with increasing age. However, the lack of significant findings in the interaction of familiarity x age at both UK and China sites provides a primary indication that this presumption could be wrong. One explanation for this lack of finding that doesn't totally overturn our common conceptions could be that children quickly become familiar early on with the same cultural representations that are abundant in our cultural environments that adults are also very familiar with. We might not be in touch with the regularity we entertain through sensual information, verbal and visual communication, and memory triggers the objects we are most familiar with on a day-to-day basis (such as muddy potatoes, wealthy monarchs, well-known cartoon characters, and supernatural deities). We might conclude that children quickly become familiar with the same common conceptual furniture that adults do quicker than we might suppose. Given the appropriate level of linguistic ability to enable confirmation, children spend pretty much the same amount of time in the cultural environments adults do—for general, nontechnical items, containing basic concepts, the conceptual vocabularies of adults and children might not be too dissimilar. Perhaps only a short time in our cultural environments is sufficient to attain the same familiarity level with the most common physical objects, persons, animates, and artefacts inhabiting it as there is for everyone else. This lack of familiarity x age finding might well also be attributed to the success of the thorough pretesting methodology that included children in its samples.

Strong support for the MCI age-effect hypothesis was given by the significant interaction of counterintuitiveness x age that was comparable in both the UK and China samples. Children and younger participants at the earlier end of the participant age-range better remembered and recalled a proportionally greater number of counterintuitive versus intuitive ideas than did adult participants at the older end of the age spectrum. No support for the universality of the counterintuitive effect was found here. The diametrically opposed findings for the UK and China with regard to the typical formulation of Boyer's MCI hypothesis, and yet the comparable findings in regard to the interaction of counterintuitiveness x age for both UK and China samples, is certainly grounds to justify further and deeper investigation. In accordance with this, a further analysis respective to the age groups in which participants were recruited (with the aim of representing comprehensive age demographics for both the UK and China populations) will facilitate comparisons between and within age groups, with the aim of discovering deeper dynamics with regard to age undetected by the current linear analysis that conflated all age groups. Additional Analysis #2 (Chapter 9) will also facilitate a more detailed analysis of the significant interaction of ontological category x age found for the China sample, in contrast with the UK group, where no such significant interaction was found.

8 Additional Analysis #1: Context-dependent versus item-centric transmission

Is context in the form of a story narrative necessary for counterintuitive ideas to be transmitted? Are concepts embedded in narrative more likely to be remembered and communicated than concepts presented with minimal contextual information, when they possess equal levels of semantic coherence and strictness of reference? Gonce et al. (2006) and Upal et al. (2007, 2010) have claimed that simple grammatical structures lacking the context provided by a narrative are insufficient to successfully communicate MCI concepts and provide the memorability advantages for them over intuitive concepts that Boyer (2000, 2001) has hypothesised (see Section 1.5.7 for details).

The pretest methodology described in Chapter 4 ensured that the identical stimuli used in both minimal (with a simple subject-predicate statement) and elaborated (with narrative context) presentation modes possessed equal levels of semantic coherence and strictness of reference. Therefore stimuli consistently delivered the same private representation to participants and did not differ in their private representation between presentation modes. Hence, the *item-centric hypothesis* predicts that additional contextual material will not aid the memorability and transmission of counterintuitive ideas. Therefore, the H_0 to be rejected is that differential rates in the recall of counterintuitive stimuli relative to intuitive stimuli will be observed for stimuli presented in the two different presentation modes.

8.1 Method

To facilitate investigation of the *item-centric hypothesis* (Hypothesis #7: see Section 2 for further details), but also to determine direction for any split analyses to be incurred for the analysis of Study #3 (see previous chapter), a data set that included adults and adolescents only (N = 589), omitting the three child age-groups (≥3<5 years, ≥5-8 years, and ≥8<13 years), was considered. The sample was otherwise identical to the adults and adolescents that composed the sample in Study #3. Children were excluded from this analysis because the study of the elaborated condition, which presented stimuli in mixed-media format whereby stimuli had additional descriptive contextual information, included children in its sample as well as adults and adolescents, whereas a portion of the sample presented with the minimal condition (a subject-predicate statement) of stimuli structure contained adults and adolescents alone. It was necessary to ensure the different presentation modes were presented to participants from equivalent age groups to facilitate the comparison, due to the hypothesised interaction of the recall of counterintuitive concepts and age (the MCI age-effect hypothesis). Stimuli were presented sequentially to individual participants of a free-recall experiment in either a written or oral presentation condition, to participants in both the UK and China. The complete stimuli sets for both the China and UK studies can be viewed in Section 3.5 of Chapter 3. First, with respect to the minimal condition of stimuli presentation, all stimuli obeyed the grammatical structure of subject-predicate statements:

Minimal condition formula for stimuli for UK participants:

A [X] that is [Y]

e.g. "a frog that is jumping" or "a doctor that is invisible"

Where X = noun and Y = adjective

Elaborated condition formula for stimuli for participants in China:

Grammatical formula for statements containing an adjective:

yī 一 + *[measure word] + [noun(subject)]* tā 它 + shì 是 + *[adjective (predicate)]* + de 的

Or,

Grammatical formula for statements containing a verb:

yī 一 + *[measure word] + [noun(subject)]* tā 它 + zài 在 + *[verb (predicate)]* + le 了

To form the elaborated condition of stimuli, a descriptive rewording of the original subject-predicate statement in the minimum condition was added to form an expanded grammatical structure with consistent semantic content. The additional semantic material added to form the elaborated condition retained a uniform grammatical structure across all stimuli. This distended form of elaborated stimulus obeyed the following structure for UK participants:

Elaborated condition grammatical formula [for UK participants]:

There is a [DESCRIPTIVE of X, #1] [DESCRIPTIVE of X, #2] [ONTOLOGICAL CATEGORY SYNONYM of X] that is [SYNONYMOUS PHRASE of Y]. [He/She/It] is a [X] that is [Y].
e.g. "There is a small furry animal that is chatting away. It is a mouse that is talking"

Unlike the minimal condition, the elaborated condition in both the UK and China was a simultaneous multimedia presentation containing both written and verbal grammatical components. The *elaborated condition* of stimuli was presented orally to participants wearing headphones, while simultaneously a subject-predicate statement of the stimuli (identical to the minimal condition) was presented to participants in written format onscreen in front of them. Appendix 3 details the full UK stimuli set in the elaborated condition, and Appendix 4 displays the elaborated condition of the stimuli in the China-based experiment. Methods (Section 7.1), materials and procedure (Section 7.2), and measures and coding (Section 7.3) were otherwise identical to those in Study #3 (Chapter 7).

8.2 Participants

Other than the omission of the three child age-groups (≥3<5 years, ≥5<8 years, and ≥8<13 years) the participants in Additional Analysis #1 were the same participants as those described in the UK and China samples described in Study #3 (see sections 7.4.1 and 7.4.2, respectively, for further details and recruitment methods). However, to facilitate the intended comparison here, the UK and China samples have been conflated. Table 22 displays descriptive and frequency statistics for the total sample and according to the age groups by which they were recruited in obedience with prescribed quotas.

Table 22. *Descriptive and frequency statistics according to participant age-group for subjects of the additional analysis of context-dependent versus item-centric transmission*

Age group		Age				Sex		Language	
	N	Min	Max	*M*	*SD*	Male	Female	Foreign	Natural
≥13<20 years	150	13	19	15.85	1.95	71	79	11	139
≥20<28 years	154	20	27	23	2.08	74	80	18	136
≥28<50 years	160	28	49	35.34	6.45	75	85	22	138
≥50 years	125	50	86	59.76	9.31	62	63	1	124
Totals	589	13	86	32.33	16.91	282	307	52	537

8.3 Results

A four-way mixed ANOVA considering counterintuitiveness, familiarity, ontological category, and delay, with the between-subjects factor of presentation mode, was used to analyse the data. Figure 16 represents the mean recall percentages of intuitive and counterintuitive stimuli for participants assigned to the minimal and elaborated conditions. For the immediate period of recall, participants assigned to the minimal condition recalled on average 23.4% of intuitive stimuli (M = 3.74 out of 16, SD = 2.18) and 20.5% of counterintuitive stimuli (M = 3.28 out of 16, SD = 2.37), but participants assigned to the elaborated condition recalled on average 24.1% of intuitive stimuli (M = 3.86 out of 16, SD = 2.01) and 20.3% of counterintuitive stimuli (M = 3.24 out of 16, SD = 2.3). In the delayed recall period, the minimal condition participants recalled on average 14.3% of intuitive stimuli (M = 2.28 out of 16, SD = 1.86) and 13.1% of counterintuitive stimuli (M = 2.1 out of 16, SD = 1.96), whereas elaborated condition participants recalled on average 17.3% intuitive stimuli (M = 2.76 out of 16, SD = 2.16) and 14.1% of counterintuitive stimuli (M = 2.26 out of 16, SD = 2.11). As might be expected, the results of the GLM showed an overall significant difference in the number of stimuli recalled for the between-subjects effect of presentation mode, $F(2, 524) = 5.172$, $p = .006$, *partial* $\eta^2 = .019$. This difference could reasonably be attributed to the differences in length of stimuli presentation (12 seconds for the elaborated condition compared with 7 seconds for the minimal condition of stimuli). However, there was no significant interaction of presentation mode with central factors impacting on the hypotheses, with regard to: counterintuitiveness, $F(2, 524) = 1.701$, $p = .184$; familiarity, $F(2, 524) = .92$, $p = .399$; or, ontological category, $F(2, 524) = .537$, $p = .464$.

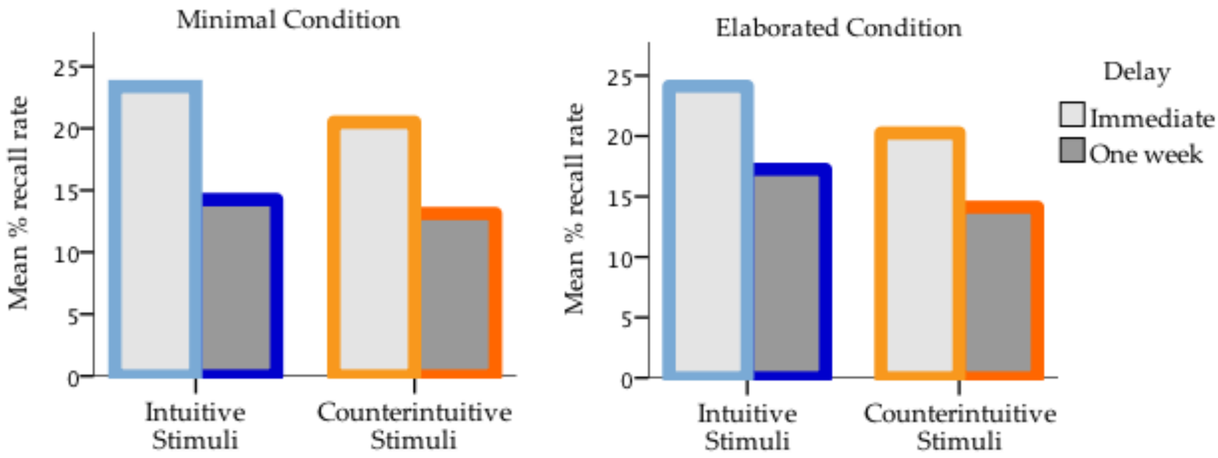


Figure 13. Bars representing mean percentage of counterintuitive stimuli recalled in immediate and delayed recall periods for participants assigned to the minimal and elaborated conditions.

8.4 Summary

These results provide robust support for the *item-centric hypothesis.* There is strong reasoning to reject the argument put forward by some authors (e.g. Gonce et al. 2006; Upal et al. 2007, 2010) that claims that simple grammatical structures, lacking the context provided by a narrative, are insufficient to successfully communicate counterintuitive concepts and provide memorability advantages for them over intuitive concepts. Counterintuitive stimuli, subjected to the proper pretest methodology to ensure their strict reference and consistent private representation, do not require the enshrouding context of a narrative to possess a mnemonic advantage over commonplace intuitive concepts.

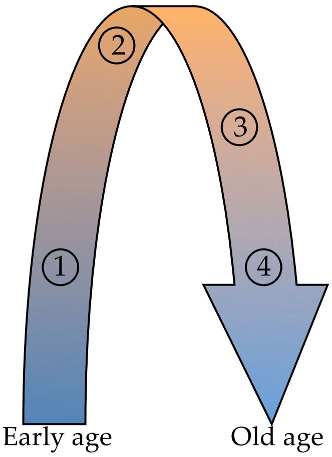
As a consequence of this lack of significant findings in regard to the interactions of presentation mode x familiarity, presentation mode x counterintuitiveness, and presentation mode x ontological category, the central analysis of Study #3 did not consider a split analysis for participants that completed the minimal (subject-predicate statement) and elaborated (added descriptive narrative) stimuli presentation conditions. The samples of participants presented with either the minimal and elaborated condition of stimuli grammatical structure could be justifiably conflated.

9 Additional Analysis #2: Analysis of recall by age group

Is a linear model too simplistic to properly account for the relationship between counterintuitive concept transmission and age? The models of the studies of this thesis considered only a linear relationship between age and the recall of counterintuitive representations, not a curvilinear relationship. During the design stage of the studies in this thesis, prior to the discovery of the enlightening findings of the previous chapters, curvilinear models were judged to be insufficiently well motivated for use here, and so were not initially considered. However, given the consistent finding of the significant interaction of counterintuitiveness x age in studies #1-3 and the conflicting results in support of the counterintuitive effect when samples of differing age-ranges were considered, the additional analysis in further investigation of these age effects is hereby justified. There are also strong reasons why forthcoming studies should consider a curvilinear relationship between age and the counterintuitive effect. Drawing from the dynamics of age-related findings reported in Studies #1-3, in addition to some further theoretical judgements (see below), Table 23 illustrates an effect curve that hypothesises what this curvilinear relationship between age and counterintuitiveness might look like:

Table 23. *Hypothesised curvilinear relationship for age and recall of minimally counterintuitive (MCI) versus intuitive (INT) ideas.*

MCI/INT	*Age group*[71]	*Age range*	*Prediction of hypothesis*
1	Pre-schoolers	≥3<5 years	No MCI advantage
	Young children	≥5<8 years	MCI advantage
2	Middle childhood	≥8<13 years	Strong MCI advantage
	Adolescents	≥13<20 years	Strong MCI advantage
3	Young adults	≥20<28 years	Weak to no MCI advantage
4	Middle adulthood	≥28<50 years	Weak INT advantage
	Older adults	≥50 years	INT advantage



1. Preschool children are predicted to show no mnemonic preference for the recall of MCI concepts over INT ideas. INT concepts could possess a mnemonic advantage.
2. The hypothesis predicts a strong mnemonic advantage for MCI concepts over INT ideas in middle childhood and adolescence.
3. Weak or no mnemonic advantage for MCI ideas in young adults.
4. No MCI mnemonic advantage later in lifespan, instead the preferential recall of INT ideas.

Orange colour on the age-line represents predicted mnemonic recall preference for counterintuitive ideas; blue colour represents predicted mnemonic advantage for intuitive ideas.

An inverted U-shaped effect distribution for the curvilinear relationship between lifespan maturation and the recall of counterintuitive representations versus intuitive representations is hypothesised. Starting at point #1, the absence of a transmission advantage for counterintuitive representations in preschool children would be because the undergirding intuitive ontologies are still developing at this age, and hence, many counterintuitive representations may not be any more distinctive than counter-schematic representations and other empirical oddities (that possess no mnemonic advantage over intuitive representations; see Barrett and Nyhof 2001). In subsequent development, at point #2 children would be particularly attentive to "exceptions to

[71] The boundaries of these age groups are drawn from developmental psychology and World Health Organisation (WHO) categorisations.

the rules" of intuitive ontologies, yielding the mnemonic dynamics for counterintuitive ideas that Boyer (2000, 2001) has hypothesised. As is consistent with the findings of Studies #1 and #3, this is a trend for the mnemonic advantage of counterintuitive ideas that continues through adolescence. The period of young adulthood, at point #3, is predicted to be a time of cognitive change and mixed expression of the counterintuitive effect, due to commencement of the deterioration of cognitive load capacities and processing speeds (e.g. Van Gerven et al. 2000, 2002; Chaytor and Schmitter-Edgecombe 2004; see Section 1.5.4 for further details), or otherwise explained by the diminishing of fluid intelligence and increasing reliance on crystallised abilities (Horn and Cattell 1967, Rabbitt 1993). Support for the hypothesised effect at this age can be drawn from the conflicting results of MCI studies that have largely relied on university students as participants (with the exception of Boyer and Ramble 2001; Gregory and Barrett 2009). As we move into middle to late adulthood at point #4, the progression of the diminishing fluid intelligence versus crystallized intelligence and other typical characteristics of aging such as the declining quality of episodic memory and cognitive load capabilities affect the memorability of counterintuitive representations and give intuitive representations their mnemonic advantage within these older groups (see Section 1.5.4 for further details on the relationship between memory and age).

Study #3 revealed a significant interaction of ontological category x age, but only for the China sample. Whereas PERSONS concepts were consistently better recalled by participants throughout the age range of the UK sample, contrasts revealed that for the China sample PERSONS concepts were better recalled by younger persons, but interestingly older persons in the age spectrum more commonly recalled LIVING THINGS concepts. However, it is possible that a linear model used to analyse this data in Study #3 was not sufficiently sophisticated to detect the finer aspects of the interactions between ontological category and age. For instance, there might have been age effects present only in the much younger groups to which the linear analysis was not sensitive. It might be predicted given that different domains of intuitive knowledge come online at different times during early childhood that differential mnemonic biases for certain ontological category kinds will be present amongst these ages. This additional analysis then facilitates a more detailed analysis of the interaction of ontological category and age, and provides means for comparison within and between the China and UK age groups. This additional analysis also permitted that the third main effect of familiarity and its relationship with the different age groups be investigated.

9.1 Overview

Methods, materials, measures and coding were identical to those in Study #3 (see Chapter 7). The participants and the methods of recruitment were also the same as in Study #3 (see Sections 7.4.1 and 7.4.2 for UK and China, respectively). Table 24 provides descriptive and frequency statistics for each age group composing the UK and China samples. In accordance with the age group under consideration, similar analyses were run for both the UK and China samples, facilitating a cross-cultural comparison of results.

Table 24. *Descriptive and frequency statistics for participants by age group for UK & China samples*

Age group		Age				Sex		Language	
	N	Min	Max	*M*	*SD*	Male	Female	Foreign	Natural
UK									
≥3<5 years	24	3.17	4.92	3.96	.52	11	13	0	24
≥5<8 years	28	5	7.92	7.15	.8	13	15	0	28
≥8<13 years	31	8.08	11	9.47	.76	17	14	0	31
≥13<20 years	77	13	19	16.17	1.84	39	38	9	68
≥20<28 years	77	20	27	23.29	2.34	31	46	13	64
≥28<50 years	81	28	49	35.35	6.5	43	38	21	60
≥50 years	64	50	84	59.8	9.19	35	29	0	64
CHINA									
≥3<5 years	21	3.58	4.25	3.93	.23	14	7	0	21
≥5<8 years	37	5.17	7.83	6.37	.91	16	21	0	37
≥8<13 years	34	8	11	9.69	.91	19	15	0	34
≥13<20 years	73	13	19	15.52	2.03	32	41	2	71
≥20<28 years	77	20	27	22.71	1.74	43	34	5	72
≥28<50 years	79	28	49	35.34	6.44	32	47	1	78
≥50 years	61	50	86	59.72	9.5	27	34	1	60

To statistically investigate whether this additional analysis with regard to age group was justified, an initial mixed ANOVA was run that considered counterintuitiveness, familiarity, ontological category, and delay with age group as a within-subjects factor. The data file was split by country of experiment site (UK and China) to facilitate the comparison. The analysis considered the full sample considered in Study #3, comprising the seven age groups.[72] Analyses revealed a significant interaction of counterintuitiveness x age group in both the UK, $F(6, 331) = 11.61$, $p < .001$, *partial* $\eta^2 = .174$ and China, $F(6, 342) = 5.619$, $p < .001$, *partial* $\eta^2 = .090$, large and medium effect sizes, respectively. No interaction of familiarity x age was found in either the UK or China samples (both, $p > .05$). A significant interaction of ontological category x age group in both the UK, $F(18, 993) = 3.105$, $p < .001$, *partial* $\eta^2 = .053$, and in China, $F(18, 1026) = 4.14$, $p < .001$, *partial* $\eta^2 = .068$, both medium effect sizes. Sphericity was assumed in both the UK and China. These findings therefore justified the additional analysis that was to focus on each of the seven age groups and the hypotheses affecting them.

9.2 Results

For all of the following results sections regarding each of the seven age groups composing the full sample, a four-way repeated-measures ANOVA considering counterintuitiveness, familiarity, ontological category, and delay was used to analyse the collected free-recall data. All effects are reported as significant at $p < .05$, if no Bonferroni correction for multiple comparisons is specified.

9.2.1 Preschool children (≥3<5 years)

In the immediate period of recall preschool children in the UK recalled on average 5.22% of target items (1.67 of a possible 32 stimuli), whereas in China, participants recalled on average

[72] Three hundred and eighty-two participants were recruited from the general UK population. Ages ranged from 3 years and 2 months to 84 years, with a mean age of 27.01 (*SD* = 18.28) years. Three hundred and eighty-two participants were recruited from the general population of Beijing. Ages ranged from 3 years and 7 months to 86 years, with a mean age of 26.09 (*SD* = 18.3) years.

3.44% of target items (1.1 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 3.84% of target items (1.23 of a possible 32 stimuli), whereas in China, participants recalled on average 2.72% of target items (.87 of a possible 32 stimuli). The period of delay in which the stimuli were recalled (immediate versus one-week delay) was found to have no significant effect on the recall rates, as stimuli were significantly better recalled in the immediate period of recall than in the second period of recall after a one-week delay, in both the UK, $F(1, 21) = 4.109$, $p = .056$, and China, $F(1, 15) = .65$, $p = .43$.

Table 25. *Analysis of variance for the recall of test items by preschool children (≥3<5 years).*

Source	*df*	*F*	*partial* η^2	*p*
UK				
Counterintuitiveness	1	.488	.023	.492
Counterintuitiveness within-group error	21	(261.77)		
Familiarity	1	6.906*	.247	.016
Familiarity within-group error	1	(100.79)		
Ontological Category	3	1.479	.066	.229
Ontological Category within-group error	63	(352.18)		
Source	*df*	*F*	*partial* η^2	*p*
CHINA				
Counterintuitiveness	1	.429	.028	.523
Counterintuitiveness within-group error	15	(182.29)		
Familiarity	1	.484	.031	.497
Familiarity within-group error	15	(161.46)		
Ontological Category	1.941	.781	.049	.464
Ontological Category within-group error	29.11	(489.79)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 25 lists results from the mixed ANOVA for factors affecting the hypotheses and other main effects. In this the youngest age group, analyses revealed no significant main effect of the counterintuitive status of stimuli (counterintuitive versus intuitive items) on recall rate of stimuli, in both the UK and China, as participants recalled equal numbers of intuitive (fINT and uINT) and counterintuitive stimuli (fMCI and uMCI). For the immediate period of recall, participants in the UK recalled on average 4.94% of intuitive stimuli ($M = .79$ out of 16, $SD = 1.02$) and 5.5% of counterintuitive stimuli ($M = .88$ out of 16, $SD = .99$), but in China, participants recalled on average 3.75% of intuitive stimuli (*M* = .6 out of 16, *SD* = .94) and 3.13% of counterintuitive stimuli (*M* = .5 out of 16, *SD* = .69). In the delayed recall period, UK participants recalled on average 3.25% of intuitive stimuli (*M* = .52 out of 16, *SD* = .68) and 4.44% of counterintuitive stimuli (*M* = .71 out of 16, *SD* = 1.06), whereas in China, participants recalled on average 3.5% intuitive stimuli (*M* = .56 out of 16, *SD* = .73) and 1.94% of counterintuitive stimuli (*M* = .31 out of 16, *SD* = .48). There was no interaction of counterintuitiveness and delay revealed in the analyses, in either the UK, $F(1, 21) = .241$, $p = .628$, or China, $F(1, 15) = 1.364$, $p = .261$, as there was no detectable difference in the recall rates of counterintuitive stimuli or intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 17.

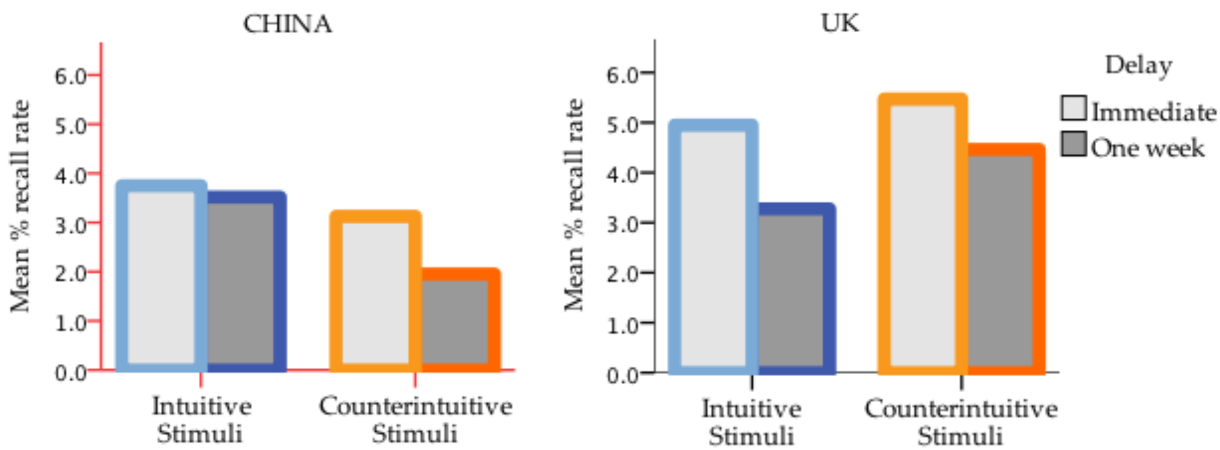


Figure 14. Bars representing mean percentage of recall in immediate and delayed recall periods for preschool children (≥3<5 years) in UK and China.

A significant main effect of familiarity on the recall rates of stimuli was found for UK participants only, with a large effect size. This was revealed by contrasts to be due to significantly better recall rates of familiar stimuli (fINT and fMCI) over unfamiliar stimuli (uINT and uMCI). The familiarity level of a stimulus was found not to affect the recall rates of stimuli in the China sample of preschool children. The ontological category to which the basic unmodified concept of the stimuli adhered (e.g. the basic concept MAN, from the modified concept INVISIBLE MAN or TALL MAN) was not found to significantly affect the recall rates of stimuli in either the UK or China (all, $p > .05$).[73] These results are shown in Figure 18.

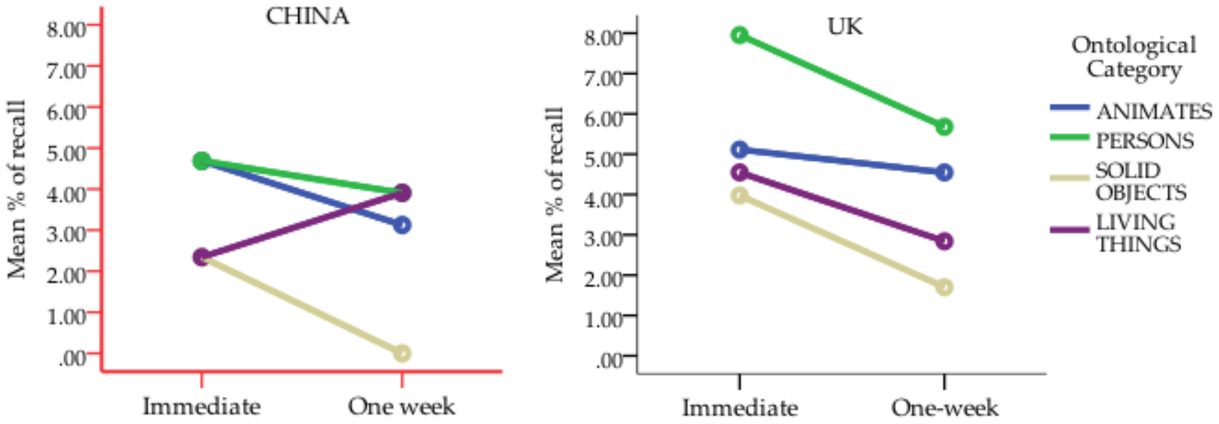


Figure 15. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for preschool children (≥3<5 years) in UK and China.

9.2.2 *Young children (≥5<8 years)*

For the age group containing young children aged 5 to 7 years, in the immediate recall period participants in the UK recalled on average 13.8% of target items (4.4 of a possible 32 stimuli), whereas in China, participants recalled on average 10.8% of target items (3.47 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 12.3% of target items (3.93 of a possible 32 stimuli), while in China, participants recalled on average 8.1% of target items (2.6 of a possible 32 stimuli). Delay was not found to have a significant effect on recall rates for young children of the UK sample, $F(1, 27) = 2.296$, $p = .142$. However, in the China sample, the period of delay in which the stimuli were recalled did affect the recall rate of stimuli, $F(1, 32) = 9{,}319$, $p = .005$, *partial* $\eta^2 = .226$, a large effect size, as target items were significantly better recalled in the immediate period of recall than during the second period of recall after a one-week delay.

[73] Sphericity was assumed for the UK sample. However, Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category for the China sample, $\chi^2(5) = 12{,}059$, $p = .034$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .415$ for the main effect of ontological category).

Table 26. *Analysis of variance for the recall of test items by young children (≥5<8 years).*

Source	*df*	*F*	partial η^2	*p*
UK				
Counterintuitiveness	1	7.551*	.219	.011
Counterintuitiveness within-group error	27	(816.28)		
Familiarity	1	2.893	.097	.1
Familiarity within-group error	27	(703.02)		
Ontological Category	3	4.299**	.137	.007
Ontological Category within-group error	81	(741.33)		
Source	*df*	*F*	partial η^2	*p*
CHINA				
Counterintuitiveness	1	.059	.002	.81
Counterintuitiveness within-group error	32	(363.1)		
Familiarity	1	.005	< .001	.945
Familiarity within-group error	32	(490.65)		
Ontological Category	3	4.049**	.112	.009
Ontological Category within-group error	96	(672.55)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 26 lists results from the mixed ANOVA for factors affecting the hypotheses and other main effects. For the young children age group, analyses revealed a significant main effect of the counterintuitive status of stimuli (counterintuitive versus intuitive items) on the recall rate of stimuli for the UK participants, showing a large effect size, as counterintuitive stimuli (fMCI and uMCI) were significantly better recalled than intuitive stimuli (fINT and uINT). However, in China, no significant difference was revealed between the recall rates of intuitive and counterintuitive stimuli. For the immediate period of recall, participants in the UK recalled on average 11.2% of intuitive stimuli (*M* = 1.79 out of 16, *SD* = 1.45), and 16.3% of counterintuitive stimuli (*M* = 2.61 out of 16, *SD* = 1.79), but in China, participants recalled on average 11.6% of intuitive stimuli (*M* = 1.86 out of 16, *SD* = 1.48) and 10.1% of counterintuitive stimuli (*M* = 1.61 out of 16, *SD* = 1.34). In the delayed recall period, UK participants recalled on average 10.1% of intuitive stimuli (*M* = 1.61 out of 16, *SD* = 1.03) and 14.5% of counterintuitive stimuli (*M* = 2.32 out of 16, *SD* = 1.52), whereas in China, participants recalled on average 8.3%

intuitive stimuli (M = 1.33 out of 16, SD = 1.58) and 7.9% of counterintuitive stimuli (M = 1.27 out of 16, SD = 1.4). The analyses revealed no interaction of counterintuitiveness and delay in either the UK, $F(1, 27) = .287$, $p = .597$, or China, $F(1, 32) = .127$, $p = .724$, as there was no detectable difference between the recall rates of counterintuitive stimuli and intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 19.

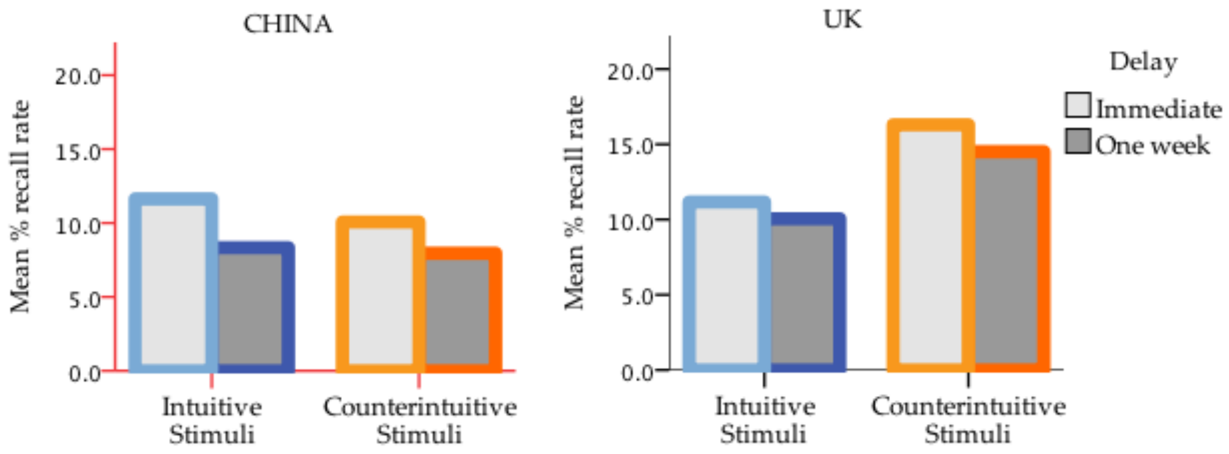


Figure 16. Bars representing mean percentage of recall in immediate and delayed recall periods for young children (≥5<8 years) in UK and China.

The familiarity level of a stimulus was found not to affect the recall rates of stimuli in either the UK or the China sample ($p > 0.05$). The ontological category to which the basic unmodified concept of the stimuli adhered (e.g. the basic concept MAN, from the modified concept INVISIBLE MAN or TALL MAN) was also found to be a significant main effect on recall, shown as a medium effect size in both UK and China. Sphericity was assumed for both samples ($p > .05$). Post-hoc tests revealed that stimuli adherent to PERSONS were better significantly recalled than SOLID OBJECTS ($p = .012$), and LIVING THINGS ($p = .019$), Bonferroni corrected for multiple comparisons. There were no other significant differences revealed for the UK group (all, $p > .05$). For the China young-children group, a significant difference between SOLID OBJECTS and the ontological categories of ANIMATES ($p = .019$), and LIVING THINGS (p = .019) was revealed, Bonferroni corrected, as stimuli adherent to this ontological category had a significantly lower recall rate at this age. There were no other significant differences between the ontological categories in China (all, p > .05). These findings are illustrated in Figure 20.

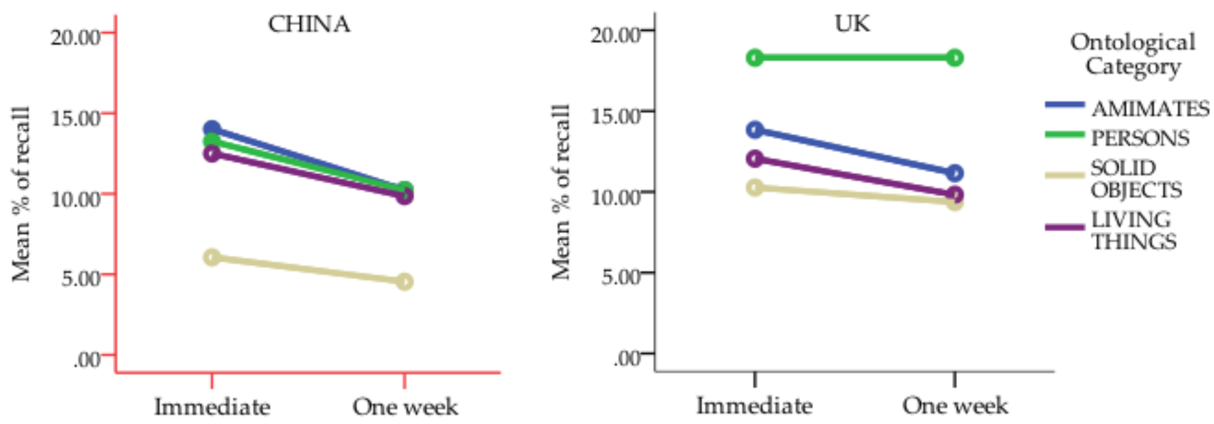


Figure 17. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for young children (≥5<8 years) in UK and China.

9.2.3 *Middle childhood (≥8<13 years)*

For the age group containing participants in middle childhood, 8 to 12 years of age, in the immediate recall period participants in the UK recalled on average 17.8% of target items (5.71 of a possible 32 stimuli), and coincidentally in China, participants also recalled an average of 17.8% target items (5.71 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 14.3% of target items (4.59 of a possible 32 stimuli), whereas in China, participants recalled on average 13.8% of target items (4.43 of a possible 32 stimuli). Delay was found to have a significant effect on recall rates of stimuli for participants in the UK sample, $F(1, 28) = 17.4$, $p < .001$, *partial* $\eta^2 = .383$, and also in China, $F(1, 31) = 9.478$, $p = .004$, *partial* $\eta^2 = .234$, both large effect sizes. Target items in both locations were significantly better recalled in the immediate period of recall than in the second period of recall after a one-week delay.

Table 27. *Analysis of variance for the recall of test-items by children in middle childhood (≥8<13 years).*

Source	*df*	*F*	*partial* η^2	*p*
		UK		
Counterintuitiveness	1	9.355**	.25	.005
Counterintuitiveness within-group error	28	(1179.57)		
Familiarity	1	7.763**	.213	.009
Familiarity within-group error	28	(1511.7)		
Ontological Category	3	4.012*	.125	.01
Ontological Category within-group error	84	(943.66)		
Source	*df*	*F*	*partial* η^2	*p*
		CHINA		
Counterintuitiveness	1	4.349*	.123	.045
Counterintuitiveness within-group error	31	(943.72)		
Familiarity	1	16.309**	.345	< .001
Familiarity within-group error	31	(632.48)		
Ontological Category	3	10.026**	.244	< .001
Ontological Category within-group error	74.62	(1674.82)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 27 lists results from the mixed ANOVA for factors affecting the hypotheses and other main effects. For the middle childhood age group, analyses revealed a significant main effect of the counterintuitive status of stimuli (counterintuitive versus intuitive items) on recall rate of stimuli, for both the UK and China participants, showing a large and medium effect size, respectively. In both locations, counterintuitive stimuli (fMCI and uMCI) were significantly better recalled than intuitive stimuli (fINT and uINT). For the immediate period of recall, participants in the UK recalled on average 15.1% of intuitive stimuli (M = 2.42 out of 16, SD = 1.34), and 20.6% of counterintuitive stimuli (M = 3.29 out of 16, SD = 1.44), but in China, participants recalled on average 15.6% of intuitive stimuli (M = 2.5 out of 16, SD = 1.52) and 20.1% of counterintuitive stimuli (M = 3.21 out of 16, SD = 2.04). In the delayed recall period, UK participants recalled on average 11% of intuitive stimuli (M = 1.76 out of 16, SD = 1.22) and 17.7% of counterintuitive stimuli (M = 2.83 out of 16, SD = 1.34), whereas in China, participants recalled on average 11.6% intuitive stimuli (M = 1.85 out of 16, SD = 1.48) and 16.1% of counterintuitive stimuli (M = 2.58 out of 16, SD = 1.89). There was no interaction of counterintuitiveness and delay revealed in the analyses, in either the UK, $F(1, 27) = .287$, $p = .597$, or China, $F(1, 32) = .127$, $p = .724$, as there was no detectable difference in the recall rates for counterintuitive stimuli or intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 21.

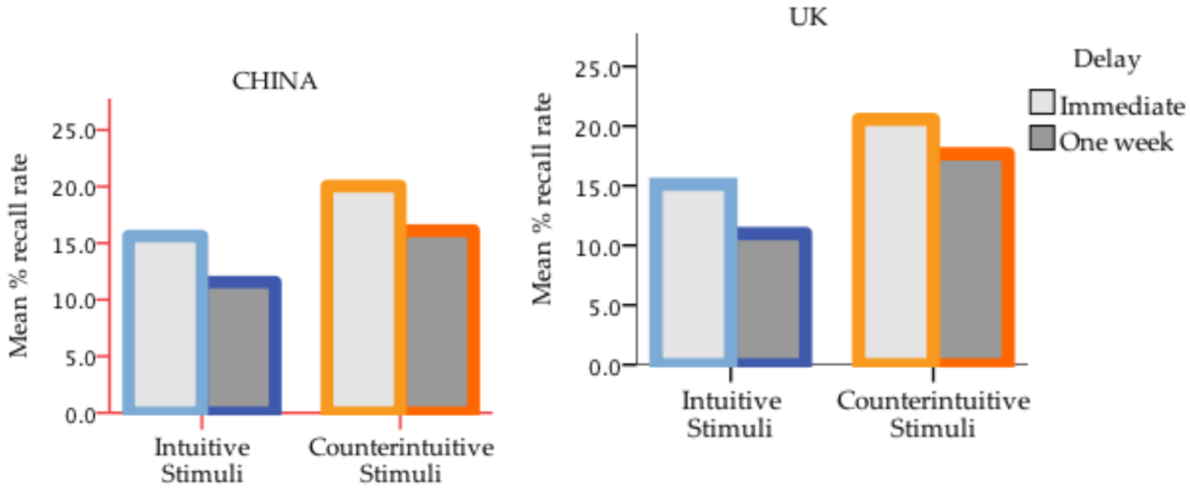


Figure 18. Bars representing mean percentage of recall in immediate and delayed recall periods for middle childhood (≥8<13 years) in UK and China.

A significant main effect of familiarity on the recall rates of stimuli was found for both UK and China participants for the middle childhood age group, both with large effect sizes. This was revealed by contrasts to be due to significantly better recall rates of familiar stimuli (fINT and fMCI) over unfamiliar stimuli (uINT and uMCI). The ontological category to which the basic unmodified concept of the stimuli adhered was also found to be a significant main effect on recall, shown as a medium effect size in the UK, and a large effect size in China. Sphericity was assumed for the UK sample. However, Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category for the China sample, $\chi^2(5) = 11.55$, $p = .042$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .678$ for the main effect of ontological category). Post-hoc tests revealed that for the UK group, stimuli adherent to PERSONS were significantly different to and better recalled than all other ontological category varieties of ANIMATES ($p =$

.002), SOLID OBJECTS (p = .001), and LIVING THINGS (p = .003), Bonferroni corrected for multiple comparisons. However, in the analysis of the China sample, no significant difference was revealed between the recall rates of stimuli adhering to the four ontological categories, all ($p > 0.05$), Bonferroni corrected. These findings are displayed in Figure 22.

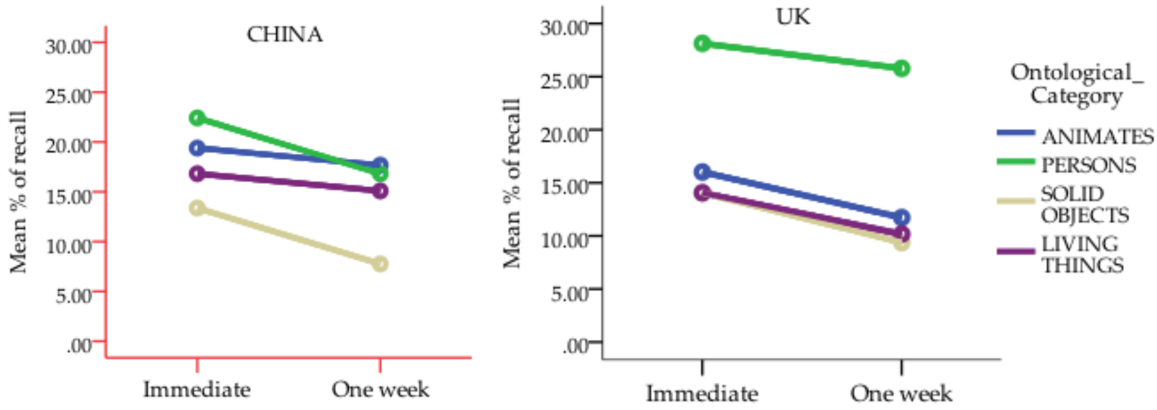


Figure 19. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for middle childhood (≥8<13 years) in UK and China.

9.2.4 *Adolescents (≥13<20) years*

In the immediate recall period, for the age group containing adolescents aged 13 to 19 years, participants in the UK recalled on average 30.1% of target items (9.64 of a possible 32 stimuli), whereas in China, participants recalled on average 24.5% of target items (7.83 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 20.3% of target items (6.48 of a possible 32 stimuli), while in China, participants recalled on average 20.7% of target items (6.63 of a possible 32 stimuli). Delay was found to have a significant effect on recall rates for adolescents in both the UK sample, $F(1, 66) = 66.72$, $p < .001$, *partial* $\eta^2 = .503$, and the China sample, $F(1, 68) = 14.22$, $p < .001$, *partial* $\eta^2 = .173$, both displaying large effect sizes. In both locations target items were significantly better recalled in the immediate period of recall than in the second period of recall after a one-week delay.

Table 28. *Analysis of variance for the recall of test items by adolescents (≥13<20 years).*

Source	*df*	*F*	*partial* η²	*p*
		UK		
Counterintuitiveness	1	15.371**	.189	< .001
Counterintuitiveness within-group error	66	(1423.85)		
Familiarity	1	13.322**	.168	.001
Familiarity within-group error	66	(857.86)		
Ontological Category	3	21.172**	.243	< .001
Ontological Category within-group error	184.44	(1641.04)		
Source	*df*	*F*	*partial* η²	*p*
		CHINA		
Counterintuitiveness	1	5.973*	.081	.017
Counterintuitiveness within-group error	68	(1153.29)		
Familiarity	1	20.462**	.231	< .001
Familiarity within-group error	68	(1416.57)		
Ontological Category	3	7.83**	.103	< .001
Ontological Category within-group error	204	(1251.42)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 28 shows the results from the mixed ANOVA analysis for factors affecting the hypotheses and other main effects. For the adolescents age-group, analyses revealed a significant main effect of the counterintuitive status of stimuli on recall rate of stimuli, for both the UK and China participants, displaying a large and medium effect size, respectively. In both locations counterintuitive stimuli were significantly better recalled than intuitive stimuli. For the immediate period of recall, participants in the UK recalled on average 28.4% of intuitive stimuli (M = 4.55 out of 16, SD = 2.18), and 31.8% of counterintuitive stimuli (M = 5.09 out of 16, SD = 2.41), but in China, participants recalled on average 23.3% of intuitive stimuli (M = 3.72 out of 16, SD = 1.68) and 25.7% of counterintuitive stimuli (M = 4.11 out of 16, SD = 1.34). In the delayed recall period, UK participants recalled on average 16.6% of intuitive stimuli (M = 2.65 out of 16, SD = 1.83) and 23.9% of counterintuitive stimuli (M = 3.83 out of 16, SD = 2.09), whereas in China, participants recalled on average 18.7% intuitive stimuli (M = 2.99 out of 16, SD = 1.93) and 22.8% of counterintuitive stimuli (M = 3.64 out of 16, SD = 2.03). The analyses revealed no interaction of counterintuitiveness and delay in either the UK, $F(1, 66) = 2.892$, $p = .094$, or China, $F(1, 68) = .718$, $p = .4$, as there was no detectable difference between the recall rates of counterintuitive stimuli and intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 23.

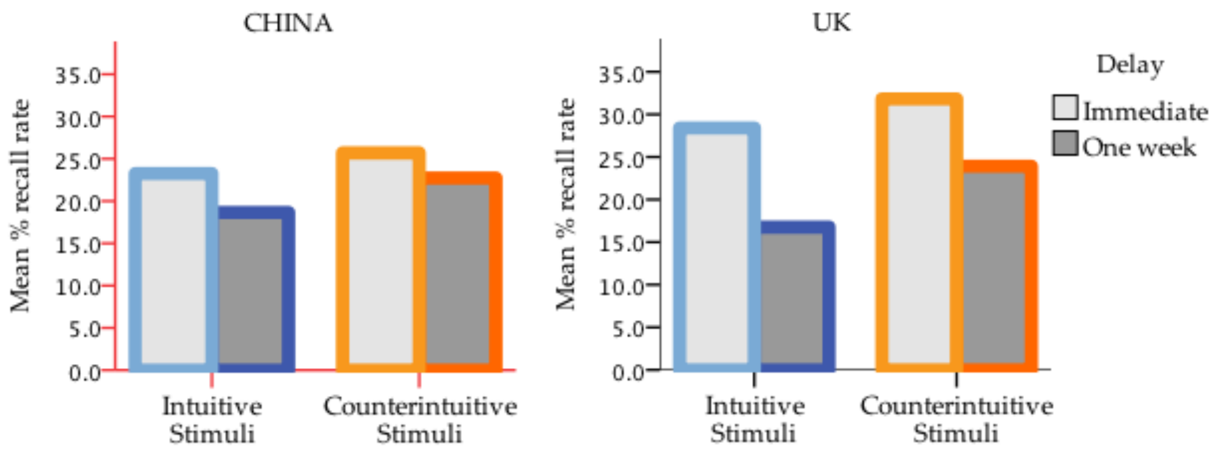


Figure 20. Bars representing mean percentage of recall in immediate and delayed recall periods for adolescents (≥13<20 years) in UK and China.

A significant main effect of familiarity on the recall rates of stimuli was found for both UK and China participants for the adolescents age-group, both with large effect sizes. This was revealed by contrasts to be due to significantly better recall rates of familiar stimuli (fINT and fMCI) over unfamiliar stimuli (uINT and uMCI). The ontological category to which the basic unmodified concept of the stimuli adhered was also found to be a significant main effect on recall, shown as a large effect size in the UK and a medium effect size in China. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category for the UK sample, $\chi^2(5) = 12.81$, $p = .025$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .820$ for the main effect of ontological category). Sphericity was assumed for the China sample. Post-hoc tests revealed that in both the UK and China, stimuli adherent to PERSONS were significantly better recalled than all other ontological category varieties of ANIMATES (UK, $p < .001$; China, $p = .001$), SOLID OBJECTS (UK, $p < .001$;

China, p = .001), and LIVING THINGS (UK, p < .001; China, p = .002), Bonferroni corrected for multiple comparisons. There were no other significant differences between the ontological categories in either the UK or China (all p > .05). These findings are displayed in Figure 24.

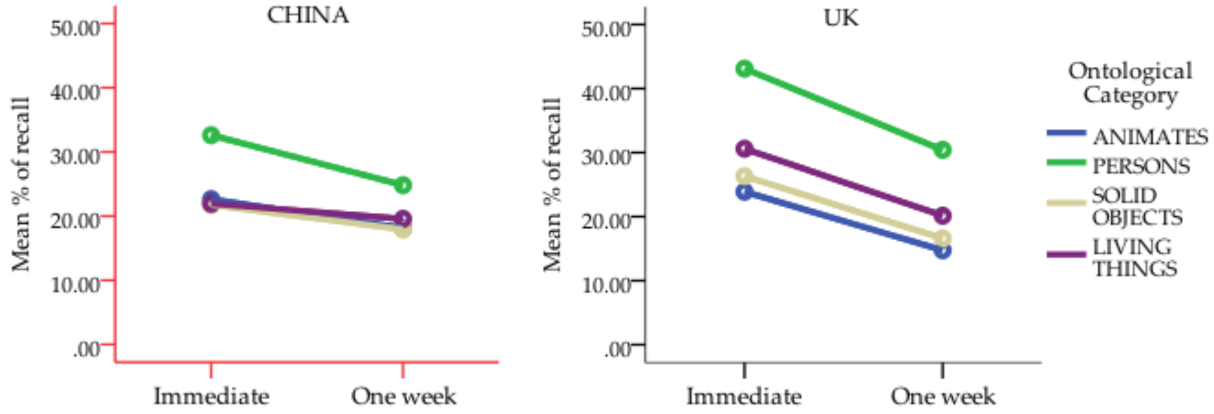


Figure 21. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for adolescents (≥13<20 years) in UK and China.

9.2.5 Young adults (≥20<28 years)

In the immediate recall period, participants in the age group containing young adults aged 20 to 27 years in the UK recalled on average 28.6% of target items (9.15 of a possible 32 stimuli), whereas in China, participants in the same age group recalled on average 25.6% of target items (8.19 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 16.5% of target items (5.29 of a possible 32 stimuli), while in China, participants recalled on average 17.3% of target items (5.52 of a possible 32 stimuli). Delay was found to have a significant effect on recall rates for adolescents in both the UK sample, $F(1, 61) = 86.28$, $p < .001$, *partial* $\eta^2 = .586$, and the China sample, $F(1, 72) = 54.59$, $p < .001$, *partial* $\eta^2 = .431$, both displaying large effect sizes. In both locations target items were significantly better recalled in the immediate period of recall than in the second period of recall after a one-week delay.

Table 29. *Analysis of variance for the recall of test items by young adults (≥20<28 years).*

Source	*df*	*F*	*partial* η^2	*p*
		UK		
Counterintuitiveness	1	.233	.004	.631
Counterintuitiveness within-group error	61	(912.24)		
Familiarity	1	29.27**	.324	< .001
Familiarity within-group error	61	(930.42)		
Ontological Category	3	18.581**	.233	< .001
Ontological Category within-group error	183	(1296.18)		
Source	*df*	*F*	*partial* η^2	*p*
		CHINA		
Counterintuitiveness	1	.286	.004	.594
Counterintuitiveness within-group error	72	(1079.69)		
Familiarity	1	26.508**	.269	< .001
Familiarity within-group error	72	(1236.41)		
Ontological Category	3	14.344**	.166	< .001
Ontological Category within-group error	216	(1023.34)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 29 displays results from the mixed ANOVA for factors affecting the hypotheses and other main effects. Analyses revealed no significant difference in the recall rates of counterintuitive versus intuitive stimuli, for both the UK and China participants in the young adult age group. For the immediate period of recall, participants in the UK recalled on average 29.1% of intuitive stimuli (M = 4.66 out of 16, SD = 2.13) and 28.1% of counterintuitive stimuli (M = 4.49 out of 16, SD = 2.5), but in China, participants recalled on average 26.6% of intuitive stimuli (M = 4.25 out of 16, SD = 2.08) and 24.6% of counterintuitive stimuli (M = 3.94 out of 16, SD = 2.14). In the delayed recall period, UK participants recalled on average 16.8% of intuitive stimuli (M = 2.69 out of 16, SD = 1.83) and 16.3% of counterintuitive stimuli (M = 2.6 out of 16, SD = 1.99), whereas in China, participants recalled on average 17.9% intuitive stimuli (M = 2.86 out of 16, SD = 2.23) and 12.7% of counterintuitive stimuli (M = 2.03 out of 16, SD = 2.09). The analyses revealed no interaction between counterintuitiveness and delay, in either the UK, F(1, 61) = .038, p = .847, or China, F(1, 72) = .003, p = .956, as there was no detectable difference in the recall rates for counterintuitive stimuli or intuitive stimuli across the two periods of recall. These findings with regard to recall rate are illustrated in Figure 25.

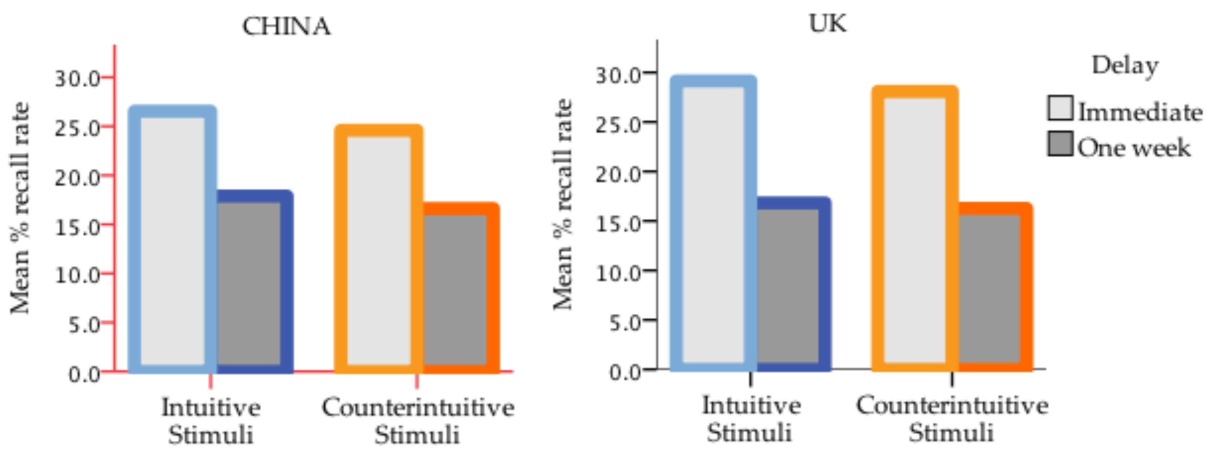


Figure 22. Bars representing mean percentage of recall in immediate and delayed recall periods for young adults (≥20<28 years) in UK and China.

For participants of the young adults age group, a significant main effect of familiarity on the recall rates of stimuli was found for both UK and China, both with large effect sizes. This was revealed by contrasts to be due to significantly better recall rates for familiar stimuli (fINT and fMCI) over unfamiliar stimuli (uINT and uMCI). The ontological category to which the basic unmodified concept of the stimuli adhered was also found to be a significant main effect on recall, shown as a large effect size in both the UK and China. Sphericity was assumed for both the UK and China samples. Post-hoc tests revealed that in both the UK and China, stimuli adherent to PERSONS were better significantly recalled than all other ontological category varieties of ANIMATES (both, $p < .001$), SOLID OBJECTS (both, $p < .001$), and LIVING THINGS (UK, $p < .001$; China $p = .006$), Bonferroni corrected for multiple comparisons. There were no other significant differences between the ontological categories in either the UK or China (all $p > .05$). These findings are illustrated in Figure 26.

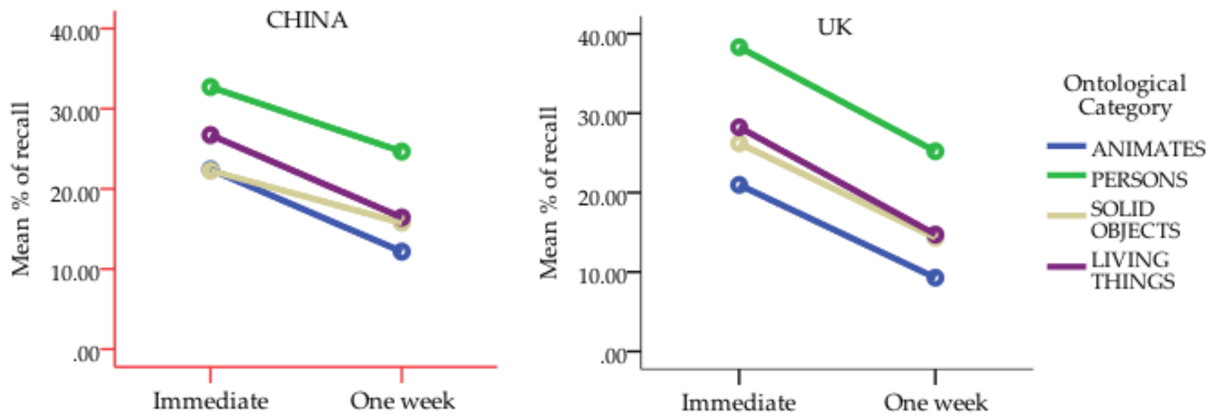


Figure 23. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for young adults (≥20<28 years) in UK and China.

9.2.6 *Middle adulthood (≥28<50 years)*

For the age group containing participants in middle adulthood, those aged 28 to 49 years, in the immediate recall period participants in the UK recalled on average 23.4% of target items (7.5 of a possible 32 stimuli), in China, participants recalled an average of 20% target items (6.4 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 13.5% of target items (4.31 of a possible 32 stimuli), whereas in China, participants recalled on average 14.6% of target items (4.68 of a possible 32 stimuli). Delay was found to have a significant effect on recall rates of stimuli for participants in the UK sample, $F(1, 71) = 103.08$, $p < .001$, *partial* $\eta^2 = .592$, and also in China, $F(1, 69) = 16.49$, $p = < .001$, *partial* $\eta^2 = .193$, both large effect sizes. Target items in both locations were significantly better recalled in the immediate period of recall than the second period of recall after a one-week delay.

Table 30. *Analysis of variance for the recall of test-items by middle adulthood (≥28<50 years).*

Source	*df*	*F*	*partial* η^2	*p*
UK				
Counterintuitiveness	1	4.497*	.06	.037
Counterintuitiveness within-group error	71	(677.8)		
Familiarity	1	40.75**	.365	< .001
Familiarity within-group error	71	(575.35)		
Ontological Category	3	29.84**	.296	< .001
Ontological Category within-group error	195.86	(1187.7)		

Source	df	F	*partial* η^2	p
		CHINA		
Counterintuitiveness	1	14.833**	.177	< .001
Counterintuitiveness within-group error	69	(782.8)		
Familiarity	1	27.287**	.283	< .001
Familiarity within-group error	69	(1236.41)		
Ontological Category	3	5.806**	.078	.001
Ontological Category within-group error	207	(800.68)		

Note. Values enclosed in parentheses represent mean square errors. $^*p < 0.05$. $^{**}p < 0.01$.

Table 30 displays a listing of results from the mixed ANOVA for factors impacting on the hypotheses and other main effects. For the middle adulthood age group, analyses revealed that counterintuitive stimuli had a significant main effect on the recall rate of stimuli over intuitive stimuli, for both the UK and China participants, showing a medium and large effect size, respectively. In contrast to the younger age groups, the participants in middle adulthood, in both locations, recalled intuitive stimuli significantly better than counterintuitive stimuli. For the immediate period of recall, participants in the UK recalled on average 24.8% of intuitive stimuli (M = 3.96 out of 16, SD = 2.09), and 22.1% of counterintuitive stimuli (M = 3.54 out of 16, SD = 2.17), but in China, participants recalled on average 22.6% of intuitive stimuli (M = 3.62 out of 16, SD = 2.24) and 17.4% of counterintuitive stimuli (M = 2.78 out of 16, SD = 2.38). In the delayed recall period, UK participants recalled on average 15% of intuitive stimuli (M = 2.4 out of 16, SD = 1.66) and 11.9% of counterintuitive stimuli (M = 1.91 out of 16, SD = 1.69), whereas in China, participants recalled on average 16.9% of intuitive stimuli (M = 2.71 out of 16, SD = 2.46) and 12.3% of counterintuitive stimuli (M = 1.97 out of 16, SD = 2.18). There was no interaction of counterintuitiveness and delay revealed in the analyses, in either the UK, $F(1, 71) = .084$, $p = .773$, or China, $F(1, 69) < .001$, $p = 1$, as there was no detectable difference in the recall rates of counterintuitive stimuli or intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 27.

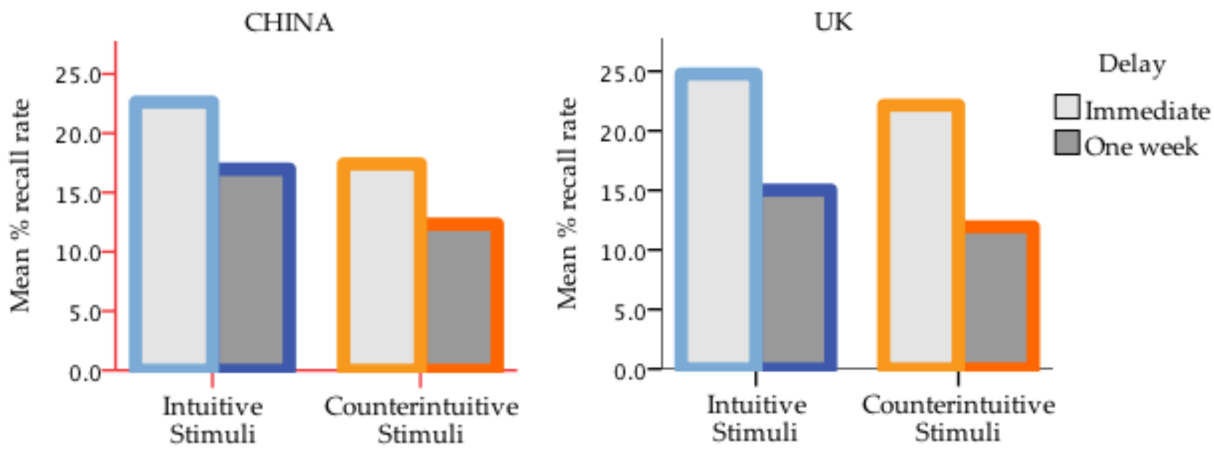


Figure 24. Bars representing mean percentage of recall in immediate and delayed recall periods for middle adulthood (≥28<50 years) in UK and China.

A significant main effect of familiarity on the recall rates of stimuli was found for both UK and China, both with large effect sizes, for participants in the middle adulthood age group. This was revealed by contrasts to be due to significantly better recall rates for familiar stimuli over unfamiliar stimuli. The ontological category to which the basic unmodified concept of the stimuli adhered was also found to be a significant main effect on recall, shown as a large effect size in the UK and medium effect size in China. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of ontological category for the UK sample, $\chi^2(5) = 14.93$, $p = .011$. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .807$ for the main effect of ontological category). Sphericity was assumed for the China sample. Post-hoc tests revealed for UK older adult participants that stimuli adherent to PERSONS were significantly better recalled than ANIMATES ($p < .001$), SOLID OBJECTS ($p < .001$), and LIVING THINGS ($p < .001$), Bonferroni corrected for multiple comparisons. There were no other significant differences revealed for the UK group (all $p > .05$). For the China middle adulthood group, a significant difference between ANIMATES and the other ontological categories of PERSONS ($p < .001$), SOLID OBJECTS ($p = .048$), and LIVING THINGS ($p = .016$), Bonferroni corrected, as stimuli adherent to this ontological category had a significantly lower recall rate at this age. There were no other significant differences between the ontological categories in China (all $p > .05$). These findings are illustrated in Figure 28.

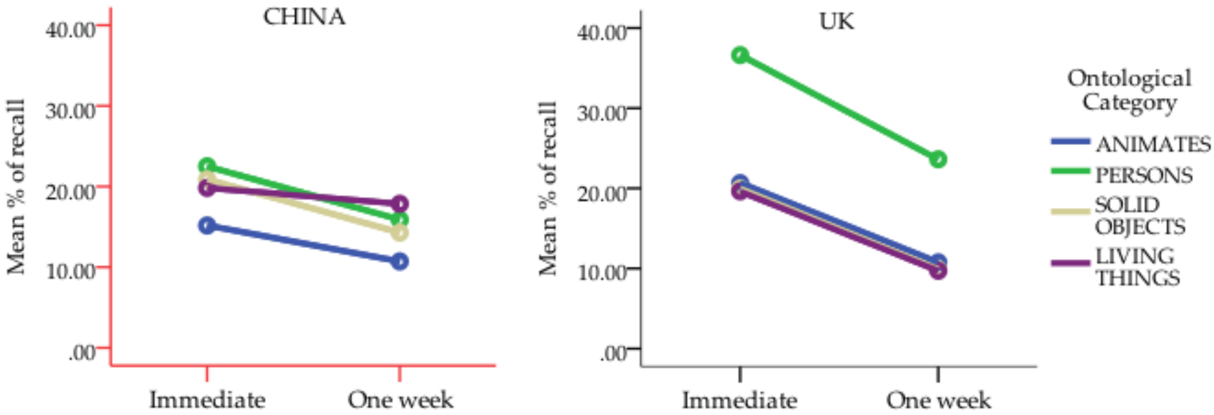


Figure 25. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for middle adulthood (≥28<50 years) in UK and China.

9.2.7 *Older adults (≥50 years)*

In the immediate recall period for the oldest age group containing older adult participants 50 years of age and above, participants in the UK recalled on average 15% of target items (4.8 of a possible 32 stimuli), and in China participants recalled an average of 11% of target items (3.53 of a possible 32 stimuli). In the delayed period of recall, UK participants recalled on average 7.1% of target items (2.28 of a possible 32 stimuli), whereas in China, participants recalled on average 7.5% of target items (2.41 of a possible 32 stimuli). Delay was found to have a significant effect on recall rates of stimuli for participants in the UK sample, $F(1, 61) = 76.58$, $p < .001$, *partial* $\eta^2 = .573$, and also in China, $F(1, 55) = 14.91$, $p = < .001$, *partial* $\eta^2 = .213$, both large effect sizes. Target items in both locations were significantly better recalled in the immediate period of recall than during the second period of recall after a one-week delay.

Table 31. *Analysis of variance for the recall of test items by older adults (≥50 years).*

Source	*df*	*F*	*partial* η^2	*p*
UK				
Counterintuitiveness	1	32.452**	.363	< .001
Counterintuitiveness within-group error	57	(627.95)		
Familiarity	1	26.607**	.318	< .001
Familiarity within-group error	57	(496.19)		
Ontological Category	3	12.235**	.177	< .001
Ontological Category within-group error	171	(687.95)		
Source	*df*	*F*	*partial* η^2	*p*
CHINA				
Counterintuitiveness	1	10.235**	.157	.002
Counterintuitiveness within-group error	55	(706.58)		
Familiarity	1	29.387**	.348	< .001
Familiarity within-group error	55	(638.8)		
Ontological Category	3	9.125**	.142	< .001
Ontological Category within-group error	165	(519)		

Note. Values enclosed in parentheses represent mean square errors. *p < 0.05. **p < 0.01.

Table 31 lists results from the mixed ANOVA for factors affecting the hypotheses and other main effects. For older adults, analyses revealed a significant main effect of the counterintuitive status of stimuli (counterintuitive versus intuitive items) on recall rate of stimuli, for both groups of UK and China participants, showing a large effect size for both groups. Again, in complete reversal of the findings from the younger age groups, in both locations intuitive stimuli were significantly better recalled than counterintuitive stimuli. For the immediate period of recall, participants in the UK recalled on average 17.7% of intuitive stimuli (M = 2.83 out of 16, SD = 1.43), but only 12.3% of counterintuitive stimuli (M = 1.97 out of 16, SD = 1.62), whereas in China, participants recalled on average 13.6% of intuitive stimuli (M = 2.17 out of 16, SD = 1.73) and only 8.5% of counterintuitive stimuli (M = 1.36 out of 16, SD = 1.27). In the delayed recall period, UK participants recalled on average 10.1% of intuitive stimuli (M = 1.62 out of 16, SD = 1.47) and 4.1% of counterintuitive stimuli (M = .66 out of 16, SD = .91), whereas in China participants recalled on average 9.1% of intuitive stimuli (M = 1.46 out of 16, SD = 1.8) and 5.9% of counterintuitive stimuli (M = .95 out of 16, SD = 1.54). The analyses revealed no interaction between counterintuitiveness and delay, in either the UK, $F(1, 57) = .688$, $p = .41$, or China, $F(1, 55) = .1.36$, $p = .249$, as there was no detectable difference in the recall rates of counterintuitive stimuli or intuitive stimuli across the two periods of recall. These findings in regard to recall rate are illustrated in Figure 29.

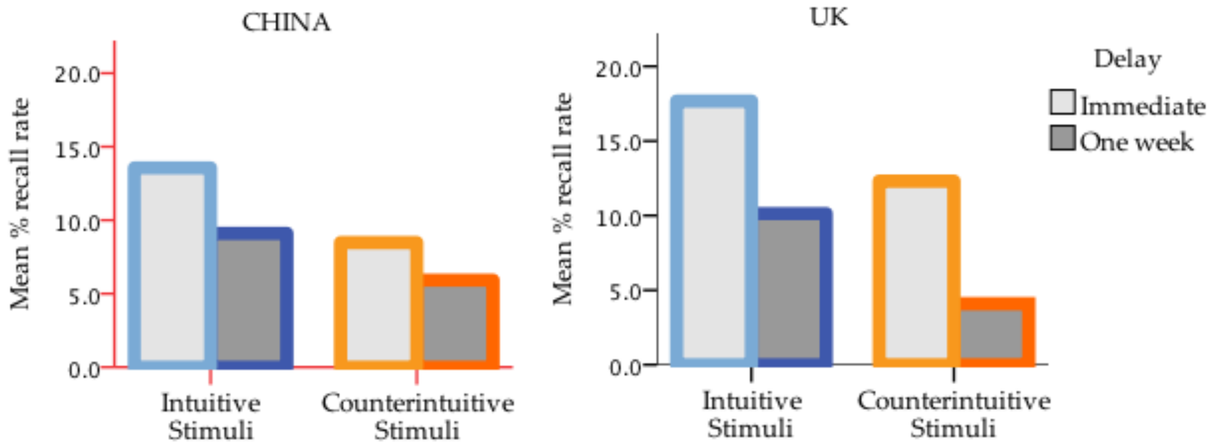


Figure 26. Bars representing mean percentage of recall in immediate and delayed recall periods for older adults (≥50 years) in UK and China.

A significant main effect of familiarity on the recall rates of stimuli was found for both UK and China, both with large effect sizes for participants in the older adults age group. This was revealed by contrasts to be due to significantly better recall rates for familiar stimuli over unfamiliar stimuli. The ontological category to which the basic unmodified concept of the stimuli adhered was also found to be a significant main effect on recall, shown as a large effect size in the UK and medium effect size in China. Sphericity was assumed for both the UK and China sample. Post-hoc tests revealed for the UK group that stimuli adherent to PERSONS were better significantly recalled than ANIMATES ($p < .001$), SOLID OBJECTS ($p < .001$), and LIVING THINGS ($p < .001$), Bonferroni corrected for multiple comparisons. There were no other significant differences revealed for the UK group (all $p > .05$). For the China older adulthood group, there was a significant difference and recall advantage of stimuli adherent to the LIVING THINGS category over the other ontological categories of ANIMATES ($p = .001$), PERSONS ($p =$

.035), and SOLID OBJECTS (p = .001), Bonferroni corrected. There were no other significant differences between the ontological categories in China (all $p > .05$). These findings are illustrated in Figure 30.

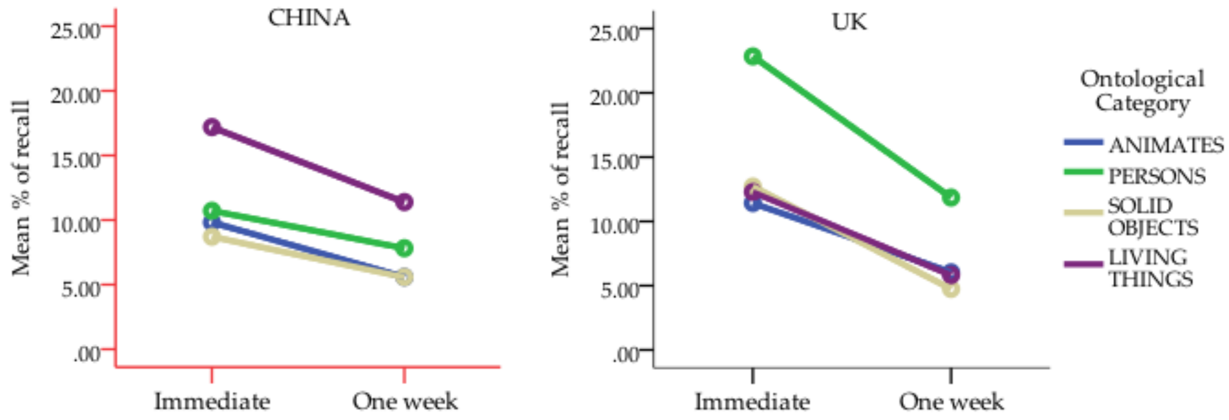


Figure 27. Mean percentage recall with respect to ontological category for immediate and delayed recall periods for older adults (≥50 years) in UK and China.

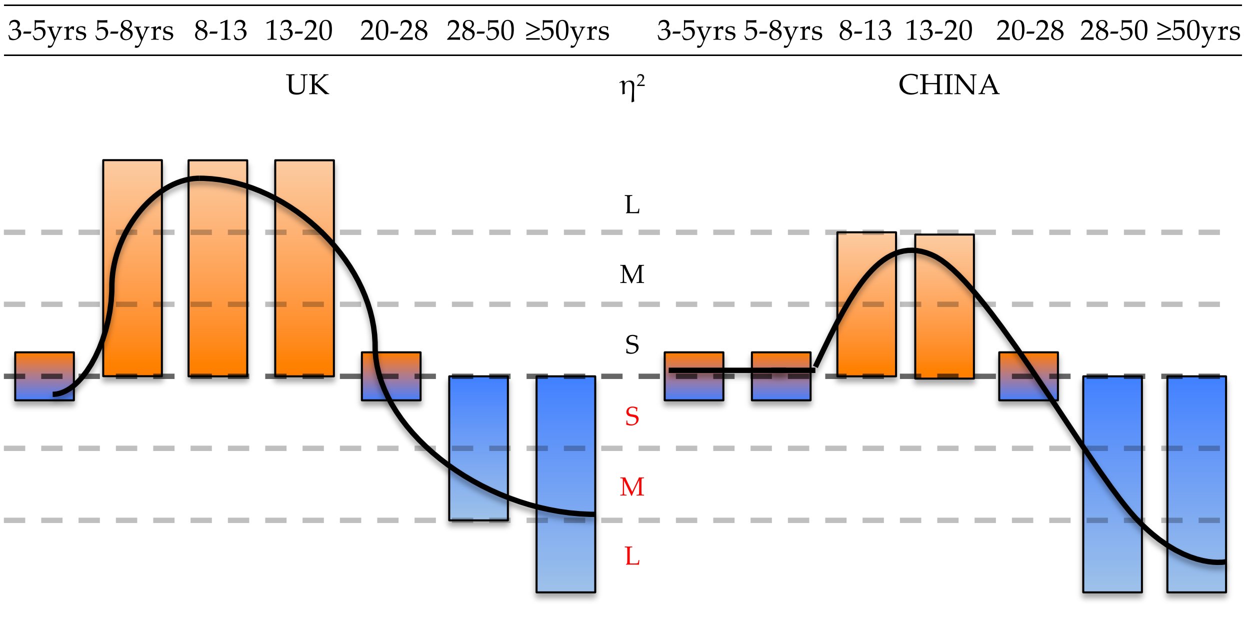
9.3 Summary

Additional Analysis #2 provided supplementary support for the *MCI age-effect hypothesis* relative to individual age groups. It provides a greater and more detailed account of the counterintuitive effect and its relation to age than has been provided by any previous investigation. The testing period in which the stimuli were recalled (immediate or one-week delayed) was found to have a significant impact on recall in participants from the middle childhood age group (≥8<13 years) and above in the China sample, and from the young childhood age group (≥5<8 years) and above in the UK sample, as significantly more stimuli were recalled in the immediate period of testing. There was no significant interaction of counterintuitiveness x delay revealed in the analyses for any of the age groups, in either the UK or China, as there was no detectable difference in the recall rates for counterintuitive stimuli versus intuitive stimuli across the two periods of recall. Adding further detail to the finding of the significant interaction of counterintuitiveness and age in Studies #1 and #3 (the memorability advantages of counterintuitive ideas versus intuitive ideas by young persons, and the reversed memorability advantage for intuitive ideas in older age), Additional Analysis #2 also revealed periods where no mnemonic preference for either intuitive or counterintuitive representations is shown. These periods were found to occur around preschool age (and also in young children ≥5<8 years old in China) due to the hypothesised undergirding intuitive ontologies still developing at this age,[74] and also around the period of young adulthood, a time of cognitive change and mixed expression of the counterintuitive effect, due to commencement of the deterioration of cognitive load capacities (e.g. Van Gerven et al. 2000, 2002) and processing speeds (e.g. Chaytor and Schmitter-Edgecombe, 2004) that reduce the ability of the aging mind to encode and commit these cognitive demanding concepts to memory, hence reducing the likelihood of the cultural transmission of counterintuitive concepts by these persons.[75] The discussion in the final chapter, Chapter 11, further examines this hypothesised relationship among the transmission of counterintuitive representations, age, and the degradation of particular systems of memory. The hypothesised U-shaped effect distribution introduced at the start of the current chapter received support in both the UK and China groups. Figure 31 displays a graphic illustration of these results representing the full length of a human lifespan for the ages at which a person is capable of contributing to cultural distributions of ideas and the ages at which mnemonic biases for either counterintuitive or intuitive concepts are found.

[74] Hence, many counterintuitive representations may be no more distinctive than counter-schematic representations and other empirical oddities (that possess no mnemonic advantage over intuitive representations).

[75] An alternative or otherwise compatible explanation of this cognitive aging process comes from the diminishing of fluid intelligence and increasing reliance on crystallised abilities (Horn and Cattell 1967; Rabbitt 1993).

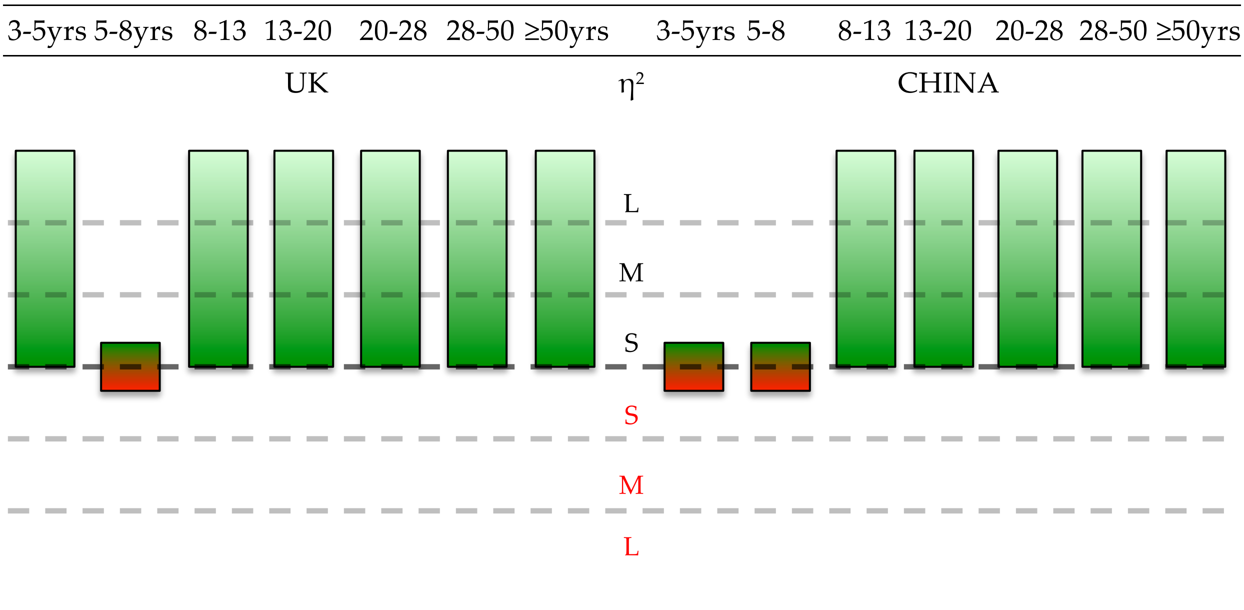
Figure 28. Comparative UK and China lifespan timelines representing partial η^2 effect sizes for significant differences found relative to age group for the recall advantage of counterintuitive stimuli over intuitive stimuli, or intuitive over counterintuitive stimuli.



Orange bars represent the finding of a significant recall advantage for counterintuitive stimuli over intuitive stimuli; blue bars represent a significant recall advantage for intuitive over counterintuitive stimuli. "L" represents a large partial η^2 effect size, "M" a medium partial η^2 effect size, and "S" a small partial η^2 effect size. The solid black curved line represents line of best fit.

The main effect of familiarity was significant across the age groups, except in preschool children (≥3<5 years) and young children (≥5<8 years) for whom no mnemonic preference for the familiarity level of stimuli was found. These results are illustrated in Figure 32. These results are roughly consistent with the conjecture expressed in Section 7.6 that children might quickly become familiar with the same common conceptual furniture that adults do faster than we might suppose. For general, nontechnical items containing basic concepts, the conceptual vocabularies of adults and children might not be too dissimilar. It appears only a short time in our cultural environments is sufficient to attain the same familiarity level with the most common physical objects, persons, animates, and artefacts inhabiting it as there is for everyone else. It should also be noted though that the youngest age groups (preschool children, young children, and middle childhood) were not as well populated with participants as the four older age groups—roughly 30 percent of the total number of subjects.[76] Greater statistical power might well have meant a significant effect of familiarity for the two younger age groups as well. But it also suggests that the lack of finding for the interaction of familiarity x age in Study #3 could have resulted from the greater weighting given these older age groups with more participants for whom the effect of familiarity was significant and of large effect size.

Figure 29. Comparative UK and China lifespan timelines representing partial η² effect sizes for significant differences found relative to age group for the recall advantage of familiar stimuli versus unfamiliar stimuli.



Green bars represent the finding of a significant recall advantage for familiar stimuli over unfamiliar stimuli; red bars represent a significant recall advantage for unfamiliar over familiar stimuli. "L" represents a large partial η² effect size, "M" a medium partial η² effect size, and "S" a small partial η² effect size.

Given that the analysis of the UK sample in Study #3 revealed no significant interaction between stimuli adhering to the different ontological categories and the age of participants doing the recalling, the results from this additional analysis are consistent with what would be expected. With the exception of preschool children for whom no significant bias was detected, stimuli adhering to the PERSONS ontological category were significantly better recalled than

[76] The three younger groups were populated by 177 participants versus a total of 587 participants in the four older-age groups.

stimuli from the other three ontological categories of ANIMATES, SOLID OBJECTS, and LIVING THINGS in the analysis of all of the remaining six age-group samples. More interesting was the finding relative to age group, given the significant interaction found for the China sample in Study #3 for ontological category x age. In comparison to the straightforward findings for the UK samples by age group, the mnemonic advantages of stimuli adhering to the PERSONS ontological category were found to be later-emerging with regard to age in the China age-group samples and gave way in older age to mnemonic biases of a different variety. Whereas the memorability advantages of PERSONS stimuli were significant as early as young childhood (≥5<8 years) in the UK group, this significant advantage of PERSONS stimuli was not manifest until adolescence in China (≥13<20 years), an advantage for PERSONS concepts that disappeared with the coming of middle adulthood (≥28<50 years) in the China sample but which in the UK sample continued through older adulthood (≥50 years) until death. Intriguingly, a significant memorability advantage for LIVING THINGS concepts was found in older adults. It could be tempting to attribute these cross-cultural differences in conceptual mnemonic bias to a cohort effect. Only further research will reveal if this is so.

10 Additional Analysis #3: Brute recall of stimuli

Barrett and Nyhof (2001) reported that part of the transmission advantage for MCI concepts in their modified serial reproduction experiment was that items that began as intuitive (albeit, bizarre) often transformed into counterintuitive versions. For instance, a hard-to-see object might be misremembered as entirely invisible. In addition, they found items could be combined with others in such a way as to yield MCI concepts that were not part of the original item list. This chapter aims to explore this transformation anew by considering the intuitive or counterintuitive status of all applicable representations recalled by participants, whether correctly recalled from the presented stimuli, or not. This additional analysis has come to be known as an analysis of the *brute recall* of representations. Brute recall should not then be understood as concerned with the measure of free recall alone—participants' correct recall of stimuli—but also with their generation of novel ideas when they erroneously recalled stimuli. If what we see in cultural transmission is a matter of massive idea generation and a brutal mixing and selecting process that produces the best representations, then the appearance of certain classes of representations via brute recall could bias subsequent transmission. The findings of brute recall are then applicable to and should be considered as secondary evidence for the *MCI hypothesis*, the *MCI age-effect hypothesis*, and the *MCI production age-effect hypothesis* (see Chapter 2 for an overview of the hypotheses). The hypotheses below are extensions of the typical formulation of Boyer's MCI hypothesis common to previous MCI studies, which asserts that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence are attention-demanding and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). Given the brute-mixing process described above, facilitated in the analysis of all representations correctly and incorrectly recalled (whether stimuli or not) by participants in Study #1, are minimally counterintuitive (MCI) ideas more likely to be produced in this process than intuitive (INT) ideas without violating the ontological category? The first outcome is the following hypothesis:

- The *MCI brute recall hypothesis* predicts that participants will record significantly more MCI representations than INT representations. Therefore, the H_o to be rejected is that there is no difference between the brute recall rates for INT and for MCI ideas.

Second, "children's worlds" have been reported to contain more works of the imagination than those of adults (Harris 2000). As well as better remembering and recall minimally counterintuitive stimuli (Studies #1 and #3; Additional Analysis #2; Gregory and Barrett 2009), do younger persons also produce MCI ideas in greater quantities than older persons? Given the opportunity to produce MCI and INT representations in a brute-mixing process resulting from correctly recalled stimuli and other incorrectly produced representations, will the age of participants affect MCI brute-recall rates?

- The *MCI brute recall age-effect hypothesis* predicts that a significant interaction of counterintuitiveness and age will be revealed, as younger persons will record significantly more MCI concepts than will older persons of the sample. Therefore, the H_o to be rejected is that no significant interaction of counterintuitiveness and age will be found, as there is no significant difference in the brute-recall rates of MCI representations for younger and older persons.

10.1 Method

To facilitate this additional analysis, all answers recorded by participants in Study #1 (whether part of or derived from the original stimuli set, or not) were coded as intuitive representations or counterintuitive representations, or marked as "X" denoting exclusion from proceedings (see details of coding methodology in Section 10.2, below). This coding was conducted by two coders using Barrett's counterintuitive coding and quantifying scheme (2008) and using the same methodology and procedures described in Chapter 8. It considered representations recalled by participants in both the immediate and one-week delayed testing periods, in both the minimal condition (Experiment #1) and the elaborated condition (Experiment #2) of stimuli presentation (see Chapter 5 and Chapter 6, respectively, for further details), and included recall data from both UK and China samples.

10.2 Coding participant generation of MCI and INT ideas

To correctly identify generation of an MCI idea and the corresponding schema-level effect category, in addition to information pertaining to transfer or breach of expectation set responsible for the core knowledge violation, two coders in each of the UK and China studies were trained in the procedures of Barrett's (2008) quantifying and coding scheme, without previous experience or knowledge of MCI theory. These coders independently processed the adjective-noun combinatorial answers provided by the participants. Items were coded as either intuitive (INT), minimally counterintuitive (MCI), or impossible to ascertain (X) due to the bizarre nature of the generated item, or excessive ambiguity in its meaning due to polysemy, metaphorical use, or ease of lending an analogous meaning to it. All X items were discarded from further proceedings. The coders compared their answers for each participant. If they did not agree on the appropriate category for a generated item, they discussed it in a prescribed manner until concurrence was reached. This method required the coders to brainstorm together as many possible meanings and language uses of the generated modified noun in question as they could immediately think of, then judge which of these would be the most likely meaning the participant ascribed to it. If the likelihood of the most likely meaning, or language use, of the item was thought to be 90 percent or more of all possible representations it was marked as "MCI" or "INT", and if the probability was considered to be less it was excluded as "X". For example, consider the modified noun "shrinking chair", which could have a number of different meanings and language usages, such as a chair that is slowly grinding away on the floor to reduce in size, or being eaten by woodworm. In addition to this, it could be an item in a fairy tale involved in an event in which furniture becomes smaller. It was for the coders to determine the probability of the most likely representation in the mind of the participant. If the coders could not reach agreement, they excluded the item. In addition to identifying whether the modified noun belonged to the intuitive or counterintuitive category, the coders also independently identified, for counterintuitive items, the type of transfer of expectation set or breach of expectation set involved in the violation of intuitive status. Discussion was required to resolve any disagreement. The data was coded in identical fashion for both the UK- and China-based experiments data using the quantifying and coding scheme of Barrett (2008).

10.3 Participants

This additional analysis considered the same participants that completed the minimal and elaborated conditions in Experiments #1 and #2 of Study #1, respectively. As the brute recall of participants' representations was irrespective to the specific conditions of the recall experiments, for this analysis all subjects were amalgamated into one sample (see Section 10.5 for further statistical justification). For details of recruitment methods for these participants and of the experiment sites, see Chapters 5 (Sections 5.1.5 and 5.2.3, respectively). Table 32 displays descriptive and frequency statistics for this amalgamated sample, also respective to the age groups by which participants were recruited according to prescribed quotas.

Table 32. *Descriptive and frequency statistics according to participant age group for subjects of additional analysis of brute recall*

Age group		Age				Sex		Language	
	N	Min	Max	*M*	*SD*	Male	Female	Foreign	Natural
≥3<5 years	45	3.17	4.92	3.95	0.4	25	20	0	45
≥5<8 years	65	5	7.92	6.71	0.94	29	36	0	65
≥8<13 years	65	8	11	9.58	0.84	36	29	0	65
≥13<20 years	150	13	19	15.85	1.95	71	79	11	139
≥20<28 years	154	20	27	23	2.08	74	80	18	136
≥28<50 years	160	28	49	35.34	6.45	75	85	22	138
≥50 years	125	50	86	59.76	9.31	62	63	1	124
Totals	764	3.17	86	26.55	1.74	392	372	52	712

10.4 *Inter-coder reliability*

In consideration of both the immediate and delayed recall periods in both the UK and China, of all the novel and incorrectly recalled ideas generated by participants (but as previously stated the analysis of brute recall below also includes totals of correctly recalled coded stimuli[77]), concurrence was reached between coders for a total of 763 minimally counterintuitive ideas and 995 intuitive ideas. However, 456 ideas were excluded when the intended meaning of the participant responsible for the representation proved indeterminable. Between coders there was disagreement over the counterintuitiveness, intuitiveness, or grounds for exclusion for a tallied total of 125 ideas (before resolution procedures described in Section 7.1 brought a final decision), which meant overall inter-coder reliability was high at 94.4%.[78]

10.5 *Results*

From initial consideration followed the conjecture that for the analysis of brute recall of stimuli that is the concern of the current chapter, the mode of presentation (written, oral or mixed) would not to be as important and necessary a factor as it had been for the two free-recall experiments (one for the minimal condition and the other for the elaborated condition) in Study #1 (Chapter 5). This reasoning proved to be justified as an initial general linear model (GLM) demonstrated that this between-subjects factor of presentation mode did not significantly affect recall ($p > 0.05$). Given that all participants had equal time to recall as many stimuli (correctly or not) as they could regardless of what condition or mode of presentation they had been assigned to, it appears that equal and approximate amounts of ideas for these brute recall totals were

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[77] A grand total of 5109 MCI ideas (3048 from the immediate period and 2061 from the delayed period) and 4808 intuitive ideas (2880 from the immediate period and 1928 from the delayed period) were considered in the analysis of brute recall.

[78] Although not directly comparable to Barrett, Reed-Burdett, and Porter (2009) due to the necessity of coding intuitive ideas and identifying exclusions in addition to the coding of minimally counterintuitive ideas, secondary evidence in support of the reliability of Barrett's (2008) coding scheme can be drawn from this result.

present and comparable across the conditions. Therefore, the following analyses consider the conflation of data from these differing conditions of presentation mode into one set.

A two-way mixed ANOVA considering counterintuitiveness and delay, with country of experiment site as a between-subjects factor, and age as a covariate, was used to analyse the data. A full factorial model of fixed-effects incorporating all remaining factors and covariates was created. This GLM was initially quite large and contained many non-significant interactions. Methodical processing of the model was made to reduce the model to contain only significant interactions and essential main effects bearing upon the hypotheses. Non-significant factors, covariates, and their interactions were excluded one at a time from the model, excluding those with the highest *p*-value first, until a finalised model containing only significant effects and factors and interactions bearing on the hypotheses remained. Table 33 illustrates the findings of this GLM.

Table 33. *Analysis of variance for brute recall of ideas*

Source	*df*	*F*	*partial* η^2	*p*
Between subjects				
Age	1	32.21**	.044	< .001
Counterintuitiveness (CI) x Age	1	85.81**	.110	< .001
CI within-group error	697	(4.12)		
Country of Location	1	1.22	.002	.269
Counterintuitiveness x Country of Location	1	7.78**	.011	.005
Delay x Country of Location	1	24.77**	.034	< .001
Delay within-group error	697	(2.56)		
Within subjects				
Counterintuitiveness	1	37.61**	.051	< .001
Delay	1	79.16**	.102	< .001
Counterintuitiveness x Delay	1	0	0	.956
CI x Delay within-group error	697	(1.24)		

Note. Values enclosed in parentheses represent mean square errors.*p < 0.05. **p < 0.01.

All effects are reported as significant at $p < .05$. The cross-cultural between-subjects factor of the country of location, regarding the country in which the experiment was conducted, was revealed to be not significant as a main effect. As a consequence of this finding, no split model for the analysis of UK and China samples took place. For the complete sample, a small effect size[79] was discovered from a significantly greater amount of minimally counterintuitive representations recorded by participants in comparison to intuitive representations. For the immediate testing period, 764 participants produced on average 3.77 (*SD* = 2.51) intuitive representations and 3.99 (*SD* = 2.15) counterintuitive representations. Seven hundred and one participants returned for the delayed period of testing. In the delayed period, participants recorded on average 2.75 (*SD* = 2.29) intuitive representations and 2.94 (*SD* = 2.07) counterintuitive representations. Figure 33 illustrates findings in regard to brute recall rates of intuitive and counterintuitive representations.

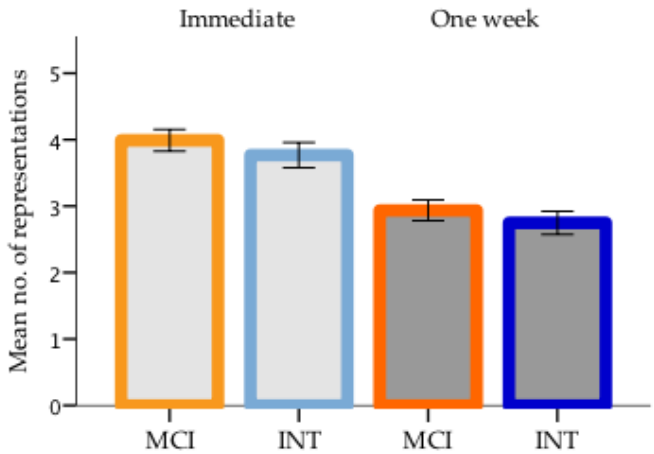


Figure 30. Bars representing mean number of representations recorded in immediate and one-week delayed testing periods [error bars +/- 2 SE].

A small effect size of a significant cross-cultural difference in the recording of minimally counterintuitive versus intuitive representations was detected from a significant interaction of counterintuitiveness and country of experiment site. However, further investigation revealed the same significant main effect of counterintuitiveness for participants in both the UK sample,

[79] Cohen (1988, 1992) offers a conversion (see Cohen 1988: 283) for partial *eta* squared effect sizes (*partial* η^2) where 0.0099 constitutes a small effect, 0.0588 a medium effect, and 0.1379 a large effect.

$F(1, 348) = 31.56$, $p < .001$, *partial* $\eta^2 = .083$, and the China sample, $F(1, 348) = 9.16$, $p = .003$, *partial* $\eta^2 = .026$, with medium and small effect sizes, respectively, Bonferroni corrected for multiple comparisons. The factor of delay was found to affect the number of representations produced for the brute recall analysis, with a medium effect size. However, there was no significant interaction of counterintuitiveness and delay revealed by the analyses, as there was no detectable difference in the mean sum of counterintuitive representations and intuitive representations produced by participants across the two testing periods. A small effect size was revealed in the significant interaction of period of testing and experiment site (delay x country of location), due to UK participants recording a greater number of representations in the immediate period. No significant interaction of experiment site x ratio of MCI to INT representations (counterintuitiveness) x delay was found, $F(1, 697) = .91$, $p = .763$. A medium effect size for the significant interaction of counterintuitiveness and age was discovered. Further investigation revealed this was due to younger participants producing a larger ratio of minimally counterintuitive ideas over intuitive ideas than did older participants in the sample, for whom this trend was reversed. Older persons recorded greater numbers of intuitive representations than counterintuitive representations.

10.6 Summary

Clear support for the *MCI brute recall hypothesis* was revealed by the analysis of brute recall. This provides secondary support for the typical formulation of the MCI hypothesis, which asserts that concepts that violate developmentally natural intuitive knowledge structures have a transmission advantage over other concepts. Overall, counterintuitive stimuli were recorded significantly more often than intuitive stimuli, across the sample. These findings are comparable to the overall significant counterintuitive effect seen in Experiment #2 of Study #1, with which it shares a more complete age range of participants (3 years and 2 months to 87 years of age). Given that this age range is larger than that of the sample in Experiment #1 of Study #1 (13 to 84 years), for which a reversal of the counterintuitive effect is seen (intuitive stimuli were overall significantly better recalled than counterintuitive stimuli), this provides grounds to suspect that the increased concentration of younger participants in the sample and the impact of age played a role in the discovery of an overall significant counterintuitive effect. Reinforcing this conjecture, support was found also for the *MCI brute recall age-effect hypothesis*, as revealed in the significant interaction of counterintuitiveness and age. This gives secondary support to both the *MCI age-effect hypothesis* and the *MCI production age-effect hypothesis* and is consistent with the age-related free-recall findings of Study #1 (Experiments #1 and #2) and Study #3, and also the significant age effect in the generation of representations shown in Study #3. Contrasts revealed the propensity for younger participants in the age range to significantly better generate and remember counterintuitive representations (i.e. there was a significant difference in *brute recall* rate) than older participants in the age range, for whom this trend is reversed, as older persons were revealed to record significantly more intuitive representations than counterintuitive representations. The substantial implications of this age effect for counterintuitive representations, for both younger and older cultural agents, will be discussed in the concluding Chapter 11.

Drawing support for the purported universality of the counterintuitive effect from a cross-cultural replication of findings is slightly more complicated. Cross-cultural differences were revealed in the number of representations recorded for the immediate and delayed periods of testing. However, even though a cross-cultural difference was found for the brute recall (a mixing of the generation and the recall of stimuli) of counterintuitive versus intuitive representations themselves, post-hoc tests revealed the counterintuitive effect was significant in both the UK and China samples. From this, tentative support is provided for the universality of the counterintuitive effect. Chapter 11, the concluding chapter, will undertake greater discussion and elaboration of all these findings in light of the complete picture of all the analyses in this thesis.

11 Conclusion

This thesis investigated Pascal Boyer's theory of counterintuitive cultural concept transmission, also known as the minimally counterintuitive (MCI) hypothesis. The typical formulation of the MCI hypothesis asserts that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence are attention-demanding and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). This theory is grounded in the experimental findings and theoretical formulations of developmental psychology and cognitive science. It is committed to a framework of ontological categories and their corresponding domains of intuitive assumptions that constitute part of the foundations of a cognition-based "meta-culture". Reported as present in religious systems, epidemiologically successful folktales, and particular historical texts, counterintuitive representations are purported to be universal to human cultures.

The thesis considered a series of free-recall experiments (Studies #1 and #3) and an item-generation task (Study #2) that aimed to test the typical formulation of Boyer's MCI hypothesis anew, and in extension, the testing of several hypotheses of interest to MCI theory. The findings of these experiments not only have the potential to refresh and give new direction to the research of MCI theory, but also could substantially contribute to cognitive anthropology, developmental psychology, and beyond. The findings of these studies have several important highlights. In Study #1, the MCI hypothesis (and other central hypotheses) was tested by means of the free recall of stimuli adhering to a 2(level) x 2(category) within-subjects design including immediate and one-week delayed periods of testing for the recall of stimuli, and incorporated the between-subjects factor of cross-cultural samples in the UK and China. Involving 940 participants, Study #1 consisted of two comparative free-recall experiments: Experiment #1 presented a minimal condition of stimuli structure (stimuli as subject-predicate statements) and Experiment #2 presented an elaborated condition of stimuli structure (stimuli incorporating additional descriptive elements). The results were analysed by hierarchical linear model (HLM), with familiarity, counterintuitiveness, and delay as two-level fixed factors, and age and schema-level effects of positive emotion, negative emotion, imagery, humour, and inferential potential as covariates. Mixed support was revealed for predictions of the MCI hypothesis in the typical formulation that has dominated previous MCI experimental studies. However, subsequent analyses revealed two other important findings for all conditions and experiment sites: a significant interaction of counterintuitiveness x familiarity and of counterintuitiveness x age. First, results revealed that culturally familiar counterintuitive representations already present in cultural distributions are better remembered and therefore more likely to continue to be transmitted than unfamiliar and novel counterintuitive representations (this novel variety of counterintuitive stimuli has dominated previous experimental research). Second, younger persons recalled proportionally more counterintuitive stimuli over intuitive stimuli, but for older persons a reversal of this trend was observed, as a significantly greater recall rate of intuitive stimuli over counterintuitive stimuli was found. A third important finding was revealed in the statement-generation task of Study #2. The task required participants to combine an adjective plus a noun to form statements to represent different five schema-level categories (positive emotion, negative emotion, imagery, humour, and interest). In analysing the items generated by participants who were unprompted and unaware of the hypothesis, an ANCOVA considering counterintuitiveness and the covariate of age revealed younger persons naturally generated significantly greater amounts of counterintuitive representations than did older persons, at both the UK and China experiment sites. Therefore, not only do younger persons have a greater propensity to transmit counterintuitive representations than older persons (Studies #1 and #3), but are also potentially likely to introduce new counterintuitive representations into cultural distributions. Study #3 (similar in design to Study #1) explored a theoretical tenet of the cognitive science of religion that has heretofore not been investigated experimentally, which combines the counterintuitive effect with that of the hypersensitive agency detection device (HADD)—a combination used to explain the proliferation of supernatural agent representations in world religions. The measure of free recall was used to investigate the superior mnemonic advantages of supernatural agents, reported to be a recurrent universal of world religions (Brown 1991), and the primary defining factor of religion (Barrett 2004a; Boyer 2001). A four-way mixed ANOVA considering counterintuitiveness, familiarity, ontological category, and delay, with age as a covariate, revealed a fourth important finding: the significant interaction of counterintuitiveness x ontological category, revealed to be due to better recall rates for counterintuitive PERSONS stimuli—also known as supernatural agent concepts—at both experimental locations.

Section 11.1 will discuss these four highlighted findings listed above, including additional findings relating to the other hypotheses investigated in the free-recall experiments in Studies #1 and #3, the item generation task in Study #2, and Additional Analyses #1, #2, and #3 (see Chapter 2 for a complete listing of hypotheses). This section will also consider competing interpretations and identify the limitations of the studies. The implications of these synthesised findings for several outstanding questions for MCI theory and other disciplines, including directions for future research, will be the topic of Section 11.2. Concluding remarks are then provided in Section 11.3.

11.1 General discussion

In addition to investigating hypotheses extending from Boyer's original description of the mnemonic advantages of counterintuitive representations (Boyer 2000, 2001), the experimental studies in this thesis considered the typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies, characterised by Boyer's assertion that concepts that violate developmentally natural intuitive knowledge structures without threatening semantic coherence are demand attention and have a transmission advantage over other concepts (Boyer and Ramble 2001: 535-64). Hypothesis #1 refers to this typical formulation of the *MCI hypothesis*. It predicted that minimally counterintuitive (MCI) stimuli would be significantly better recalled than intuitive stimuli (INT) consistent with domain-specific intuitive assumptions. Studies 1 and 3 directly tested the typical MCI hypothesis and revealed mixed support for it. Viewed in isolation, these mixed findings in Study #1 with regard to the typical formulation of the MCI hypothesis are conflicting and even confusing to behold. Experiment #1 (the minimal condition of stimuli presentation: subject-predicate statements) revealed a recall advantage for INT stimuli over MCI stimuli, in both the UK and China samples, which seemed to refute the MCI hypothesis. However, in Experiment #2 (the elaborated condition; stimuli with additional descriptive material) the effect was reversed, and support for the MCI hypothesis was revealed in the significant recall advantage of MCI stimuli over INT stimuli. Although the designs of Experiments #1 and #2 were remarkably alike, their samples differed in one crucial dimension: the disparity in the concentration of younger participants and the age ranges in the samples, as Experiment #2 was devised to include children aged 3 to 12 years, who were not included in Experiment #1. Analysis of the free-recall experiment in Study #3 also revealed contradictory and surprising findings in support of (in the case of the UK experiment) and also in rejection of (in the case of the China experiment) the typical formulation of the MCI hypothesis that has dictated previous MCI free-recall studies. In the UK experiment MCI stimuli were significantly better recalled than INT stimuli, whereas in the China experiment INT stimuli were revealed to be significantly better recalled than MCI stimuli: a complete reversal of the counterintuitive effect from one location to the other! However, in the light of findings in this thesis for hypotheses that extend the typical formulation of the MCI hypothesis, especially the MCI age-effect hypothesis (see below), these conflicting results are enlightening on their own and help to explain why several previous experimental studies of MCI theory that test the predictions of the counterintuitive effect have produced conflicting results (e.g. Gonce et al. 2006; Gregory and Barrett 2009; Norenzayan et al. 2006; Tweney et al. 2006).

In contrast to the findings of several previous free-recall experiments in MCI theory (e.g. Gonce et al. 2006; Gregory and Barrett 2009; Norenzayan et al. 2006), no overall differential decay of MCI or INT concept memory was observed over the course of one week (the period from immediate to one-week delayed recall). Regardless of whether it was INT or MCI stimuli that were significantly better recalled in the particular experiment or experiment site (in Studies #1 and #3), the magnitude of this effect did not vary as a function of time. Similarly, in Additional Analysis #2, the analyses revealed no significant interaction of counterintuitiveness x delay for any of the seven constituent age groups in either the UK or China samples. The relatively high recall rates of stimuli in the immediate period over those of the one-week delayed period of testing (especially with regard to the UK samples) could have masked the differential fitness of these categories over time, as one week was not enough to reveal the differential decay of the memorability of the different types of concepts. For example, Barrett and Nyhof (2001) used a third period of participant recall, after three months. For the free-recall experiments of this thesis a similar third period of recall following the one-week period of delay was not utilised so as to avoid a potential floor effect due to the inclusion in the samples of older persons and children whose expected stimuli recall rates were lower than those of young adults and adolescents. Further studies could track effects in the full extent of decay by using longer periods.

Hypothesis #2 was the *familiar-MCI hypothesis*. Covered in the introduction to this thesis (see Sections 1.5.1 and 1.5.2), Boyer's original formulation of the counterintuitiveness effect described and predicted the epidemiological advantages of culturally "familiar" counterintuitive representations (Boyer 2001: 58-105). Are concepts that are both counterintuitive and highly familiar more memorable than counterintuitive concepts that are culturally unfamiliar? As an extension of Boyer's (2000, 2001) original description of the mnemonic advantages of counterintuitive representations, the familiar-MCI hypothesis predicted that familiar minimally counterintuitive stimuli (fMCI) will be significantly better recalled than unfamiliar minimally counterintuitive stimuli (uMCI). This integral aspect of Boyer's theory has been largely ignored until now, as previous studies have unilaterally focused on novel and culturally unfamiliar representations that violate template-level intuitive assumptions. This absence of empirical evidence has permitted the assumption that widely distributed counterintuitive representations that figure in cultural agents' everyday lives have lost their saliency, and therefore the mnemonic advantage of the template-level violation (Bloch 2005, Upal 2010). However, support for this familiar-MCI hypothesis was revealed in analysis of the free-recall experiments in Studies #1 and #3. The results of Experiments #1 and #2 in Study #1 revealed support for the hypothesis, as fMCI stimuli were better recalled than both their uMCI and intuitive varieties. This finding was replicated across both minimal and elaborated modes of stimuli presentation, and also cross-culturally for both the UK and China samples in both experiments. A similar finding was reported in Study #3, which also replicated this result cross-culturally.

These findings supporting the familiar-MCI hypothesis provide strong grounds to refute the assumption of Bloch (2005) and Upal (2010) that an MCI representation that becomes commonly communicated and culturally familiar to a cultural group will not have the same mnemonic advantage as a uMCI cultural representation, due to a loss of saliency. All free-recall experiments in Studies #1 and #3 revealed the significant effect that familiarity (a schema-level effect) can have on a concept's recall performance. However, the significant interaction of counterintuitiveness x familiarity, and the superior recall rates of fMCI stimuli over all other stimuli types that were subsequently revealed, demonstrate that signal detection theory and the familiarity effect alone (see Section 1.5.1) are not accountable for this consistent recall advantage of fMCI stimuli over uMCI stimuli. This is a new, unique finding within the MCI literature and adds to the expanding body of experimental research reporting the interaction of schema-level effects and template-level violations (e.g. Purzycki 2010, 2011; Sloan et al. 2007). On a more speculative note, support for the familiar-MCI hypothesis also has the potential to answer a question poorly addressed in the anthropological literature: just how do these widely distributed cultural counterintuitive representations (frequently entertained by all in a cultural group), which play an integral affective role in the behaviours of persons within the culture, maintain this privileged position of epidemiological success? The supporting evidence found here for the mnemonic advantages of the schema-level effect of familiarity and signal detection theory helps to answer this question. As long as a counterintuitive representation fulfils the criteria of semantic coherence, consistency of public representation and private representation (see Section 1.5.7), and applicability to the cultural role it is to serve, results here suggest the mnemonic advantage it gains from the familiarity effect as the counterintuitive representation becomes more culturally familiar and more widely communicated (correlating with an increasing semantic activation-level—see *signal detection theory, Section 1.5.1*) provides a *ratcheting effect* towards wider distribution of the cultural representation. This dual-mnemonic effect in the synthesis of schema-level and template-level violation could help to explain how certain privileged familiar counterintuitive representations maintain a position of successful transmission within a culture (e.g. particular privileged god concepts that are repeatedly transmitted through religious practices).

Hypothesis #3, the *MCI age-effect hypothesis*, predicted that there would be a significant interaction between age and recall of MCI stimuli, as younger persons would recall proportionally more MCI stimuli than INT stimuli than older persons in the sample. This was the first experimental research in MCI theory to consider wider age ranges representative of population demographics of age. Previous studies have utilised much smaller sample sizes with highly restricted age ranges. It was also the first MCI study, perhaps surprisingly, to have children as subjects. Indeed, all but one of the previous studies have used as participants the convenient resource of university students acquiring credit. (Boyer 2001 is the exception.) These representative age ranges of this thesis are the largest sample sizes for an MCI study to date (and may have contributed to the discovery of the unique findings of this thesis, previously undetectable due to lacking statistical power). Unanimous support for the MCI age-effect hypothesis was found. A significant interaction of counterintuitiveness x age was found for both free-recall experiments (Experiments #1 and #2) in Study #1. Analyses revealed a significant interaction of counterintuitiveness x age in the free-recall experiment in Study #3, with a large effect size in the UK, and a medium effect size in China. In the analyses of all free-recall experiments, at all experiment sites, contrasts revealed this interaction to be due to the significantly greater proportional recall rate of MCI over INT stimuli for younger persons in the age range than for participants at the older adulthood end of the spectrum. In analyses for both Experiments #1 and #2, this greater recall rate for MCI over INT stimuli in younger persons was reversed for older persons, in whom further analysis in both experiments fascinatingly revealed a significant recall advantage for INT stimuli over MCI stimuli. With regard to the mixed findings for the typical formulation of the MCI hypothesis reported for Study #1, this age effect in the recall of counterintuitive representations now explains the seemingly strange and conflicting results of the significant overall recall advantage for INT stimuli over MCI stimuli as revealed in Experiment #1, and conversely, for MCI stimuli over INT stimuli in Experiment #2. These mixed findings for the MCI hypothesis in Study #1 can now be explained as being due to the expanded age range of participants in Experiment #2, by way of the inclusion of children aged 3 to 12 years (in contrast, the age of participants in Experiment #1 ranged from 13 years old to 50 years and above). These child participants aged 3 to 12 years, who were not present in the sample for Experiment #1, constituted approximately 40 percent of the sample in Experiment #2. The significant interaction of counterintuitiveness x age found in both Experiments #1 and #2 showed that children store and retrieve MCI stimuli better than older adults do, thereby explaining the recall advantage for MCI stimuli over INT stimuli in Experiment #2, but not in Experiment #1, which excluded children 3 to 12 years of age**.** The same mnemonic trend for younger and older persons in the significant interaction of age x counterintuitiveness has been observed in additional analyses of previous MCI studies (e.g. Gregory and Barrett 2009; Hornbeck and Barrett, forthcoming).

Supplementary and detailed support was also provided for the MCI age-effect hypothesis in the findings of Additional Analysis #2, which appeared in Chapter 9. Although this chapter functioned to provide additional descriptive statistics for the age groups constituting the samples for Study #3, it provided the opportunity to test a hypothesised inverted U-shaped effect distribution for the curvilinear relationship between lifespan maturation and the recall of MCI stimuli versus INT stimuli. Support was found for this hypothesised curvilinear age effect. The same inverted U-shaped effect-size distribution was present in the analysis of both the UK and China samples, although for participants in the middle childhood (≥8<13 years old) and adolescent (≥13<20 years old) groups in China the initial "bump" for the recall advantage of MCI over INT stimuli was less pronounced. In addition to revealing the age groups in which INT stimuli were better recalled than MCI stimuli (for persons in middle adulthood, aged 28 to 49 years, and older adults, aged 50 years and above, in both the UK and China), the results also revealed periods where no mnemonic preference for either intuitive or counterintuitive representations is shown. These occur in both the UK and China samples around the time of preschool age (and also in young children of 5 to 7 years in China), presumably due to the undergirding intuitive ontologies still developing at this age, and also in both the UK and China around the period of young adulthood (20 to 27 years of age), possibly a time of cognitive change and mixed expression of the counterintuitive effect (see below). Figure 29, in Section 9.3, provides a graphic illustration of this curvilinear effect-size distribution representing the full length of a human lifespan, comprising the age groups where mnemonic biases for either counterintuitive or intuitive concepts are found. Additional Analysis #2 provided a richer and more detailed account of the counterintuitive effect and the impact of age than has been provided by any prior investigation.

The findings of this thesis suggest areas for future research with regard to the relationship between age and transmission of counterintuitive concepts. In addition to the mnemonic advantage of MCI stimuli for younger persons, the consistent finding of a memorability advantage of INT stimuli for older persons needs to be explained. Several competing theories that might account for this age effect merit consideration. Could it be perhaps that the minds of younger persons are more often exposed to counterintuitive representations in their cultural environments and therefore they are more able to recall them than are adults, who do not have frequent encounters with counterintuitive representations? We might see this suggestion reflected in our own modern-technological societies, in the preference for fantasy, science fiction, and folktales in childhood and for the avant-garde public representations in youth. It could be that children and adolescents readily entertain much richer counterintuitive worlds of representations than do persons in the older age groups on the spectrum. Indeed, children's worlds have been reported as having more works of the imagination than older persons (Harris, 2000), such as the attribution of imaginary friends, more common to children (Wigger, Paxton and Ryan 2013). A recent study focusing exclusively on the free-recall performance of young children has again revealed a mnemonic bias for minimally counterintuitive representations over commonplace representations consistent with our domain-specific intuitive assumptions (Banerjee, Haque and Spelke 2013). It is also a possibility that a cohort effect can account for this counterintuitive age effect. Are modern youngsters more exposed to fantasy and counterintuitive worlds than were older persons in the sample in their youth? It could be that the recall performance of children who lack such exposure would resemble that of the older participants in the free-recall experiments in this thesis. Although these explanations appear attractive, both ideas seem unlikely in light of the thorough pretest methodology for the free-recall experiments in this thesis, and given the results of Pretest #1. The participants in this pretest were instructed to consider the stimuli and score them on a rating scale, with points representing the number of times they had entertained such ideas. The data resulting from Pretest #1 therefore indicated how familiar participants were with such concepts, thus providing a mean value for likelihood of occurrence for each of the stimuli within the particular cultural group. The ages of participants involved in this task of Pretest #1 ranged from 6 to 70 years old and therefore reasonably represented the age demographics of the populations under consideration. Subsequent analysis of the data from Pretest #1 revealed no significant impact of age on the mean familiarity scores for any of the stimuli categories (fMCI, uMCI, fINT, and uINT) at both the UK and China experiment sites. Therefore, evidence shows that the stimuli presented in the free-recall experiments of Studies #1 and #3 had a comparable familiarity activation level for both younger persons (including children and adolescents) and older persons in the age-ranges for both the UK and China samples. Hence, although these alternative explanations would be otherwise valid interpretations, this finding drawn from Pretest #1 demonstrates that the minds of both young and old persons had been equally exposed to the counterintuitive ideas in the stimuli set. Similarly, the possibility of a cohort effect as being responsible for the counterintuitive age-effect was diminished as the modern youngsters in the sample had received similar exposure to the fantastical ideas in the stimuli set as the older persons had. It would therefore appear that other alterative explanations, such as that the stimuli in the studies of this thesis were too childish to be sufficiently attention-grabbing for the adult participants, are also nullified, due to this equality of familiarity activation levels of the stimuli for participants falling over a wide age range—also comparable in age range to the participants recruited for the free-recall experiments. Given this equality in association levels among stimuli for persons of different ages, a new account hereby proposes that these differences in the impact of age on the recall of counterintuitive concepts can be explained by the degradation in functionality of a memory system with advancing age. However, as a preliminary sketch, subsequent greater theoretical and empirical attention is required for further clarification.

Exploration of cognitive load theory and the impact of age on working-memory capacity and processing speed offers promise to account for this double-edged age effect for both younger and older persons with regard to their recall of counterintuitive representations. Good evidence exists that demonstrates how counterintuitive concepts make greater demands on working memory resources than do concepts consistent with domain-specific intuitive assumptions, given an equal number of conceptual modifiers (Barrett and Nyhof 2001; Johnson, Kelly, and Bishop 2009; Norenzayan et al. 2006; Upal et al. 2007). It appears that only younger minds, as yet undiminished by age, have the facility to transmit concepts that make high demands on working memory capacity. Therefore, consistent with cognitive load theory, our ability to encode counterintuitive concepts decreases due to the age-related degradation in working memory as manifested in reduced capacity for processing information (Hultsch, Hertzog, Dixon, and Small 1998; Salthouse and Babcock 1991; Van Gerven et al. 2000, 2002; Wingfield, Stine, Lahar, and Aberdeen 1988) and due to overall processing-speed decreases (Chaytor and Schmitter-Edgecombe 2004; Cerella 1990; Fisk and Warr 1996; Salthouse 1993, 1996). This age-related deterioration thereby limits the amount and potentially the type of information that older persons are capable of encoding in constructs and store (see Section 1.5.4). This working-memory-based explanation for these striking age differences fits in with a widely recognised perspective of the mind that views cognitive ageing as a process of both growth and degradation. As minds age, accumulating knowledge and experience along the way, there is growth in the *crystallised abilities* (Horn and Cattell 1967, Rabbitt 1993) pertaining to schema-level information acquired for consistent behaviour in accordance with cultural norms and theories about the furniture of the world and the causal relationships between these objects. Furthermore, the *fluid abilities* of the mind, encompassing the capacity and the processing abilities of working memory, diminish as the mind ages. There is promise for this discovered age-effect in the recall of counterintuitive versus intuitive representations to be adequately theorised, especially with regard to the potential contribution of cognitive load theory. Future theoretical research and mapping of mechanisms are sure to generate original and novel hypotheses that will expand our understanding of the relationship between the counterintuitive effect, age, and the deeper psychological workings of the mind.

Hypothesis #4 was the *schema-level effect hypothesis*. In addition to the activation levels of familiarity associated with a concept, do other schema-level effects influence memorability, and therefore increase the likelihood of cultural transmission? Does the *study* of these schema-level effects contribute insight for understanding the epidemiology of cultural representations? The MCI studies of Purzycki (2010; 2011) and Sloan et al. (2007) revealed the interaction between schema-level effects (humour and imagery, respectively) and template-level violation had a superior recall advantage. Further experimental studies show several schema-level effects that affect the memorability of concepts (See Section 1.5.3 for greater details). These identified schema-level effects were: imagery, or mental imagery (e.g. Naine et al. 2013); humour (e.g. Schmidt 2002); and associated valence of emotion (e.g. Kensinger and Corkin 2003; Naine et al. 2013), especially of negative emotional stimuli (e.g. Baumeister et al. 2001; Rozin and Royzman 2001), including a revision of the proposition of inferential potential under the proxy of "interest" (Gregory and Barrett 2009)—a schema-level mnemonic effect whose discovery should be attributed to Boyer (2000, 2001). The schema-level effect hypothesis predicted that stimuli with a higher survey score for any of the schema-level effect categories of positive emotion (POS), negative emotion (NEG), imagery (IMA), humour (HUM), or interest (IP) would affect the recall success of a stimulus. Analysis of data from the two free-recall experiments in Study #1 provided some support for the schema-level effect hypothesis. Contrary to previous research (e.g. Kensinger and Corkin 2003; Paivio 1990; Schmidt 1994), none of the schema-level effects of negative emotion, positive emotion, imagery, humour, or inferential potential was revealed to significantly predict recall in the minimal condition (Experiment #1). However, for the elaborated condition of stimuli presentation (Experiment #2), stimuli with higher survey scores exemplifying their associated negative emotion, humour, and inferential potential all enjoyed a mnemonic advantage, as these schema-level effects were revealed to significantly predict recall rate. Therefore, support for the schema-level effect hypothesis was limited. Contrary to findings of previous MCI studies (Purzycki 2010, 2011; Sloan et al. 2007), neither Experiment #1 nor #2 revealed that the interaction of schema-level effect and counterintuitiveness significantly affected the recall of stimuli. As stated in the background information of this thesis, the experimental design tested only the mnemonic impact of these five schema-level effects. They were not incorporated into the 2(level) x 2(category) experimental design, as was the case for the schema-level effect of familiarity and the template-level violation of counterintuitiveness. As scores representing how well each stimulus exemplified each of the schema-level effects varied on a continuum according to the survey scores of participants, it is possible that there was insufficient variation to provide adequate means of testing. However, when aiming to produce a model of cultural transmission, to discard these ever-present schema-level effects might still have a confounding effect due to the otherwise good experimental evidence for their impact on recall. This is especially poignant given the demonstration of the great degrees of variation between stimuli according to how well they exemplified each of these schema-level effects in the results of Pretest #1. They should be considered, regardless of how difficult they prove to control for.

Hypothesis #5 was the *MCI production age-effect hypothesis.* "Children's worlds" have been reported to contain more works of the imagination than those of adults (Harris 2000). In extension of the finding of Study #1 and Study #3 that younger persons recall a significantly larger proportion of MCI stimuli versus INT stimuli than do older adults, in provision of an appropriate creative environment, do younger persons also have the capacity to generate MCI representations in significantly greater quantity than older persons? Participants were asked to combine an adjective with a noun to form statements to represent each of the five categories of schema-level properties (POS, NEG, IMA, HUM, and IP). They were also blind to the definition of "counterintuitiveness" and any potential for generating both MCI and INT representations in completing the task. The MCI production age-effect hypothesis predicted that a significant interaction of counterintuitiveness and age would be revealed, as younger persons would freely generate more MCI representations than would older persons in the sample. Analysing MCI and INT representations generated by subjects provides a fresh area of exploration to develop an understanding of the epidemiology of cultural representations. This experimental study was the first to address an outstanding concern of research in the transmission of counterintuitive concepts, as cultural transmission is constrained not only by recall, but also by the emergence of representations. Studies until now have investigated the mnemonic biases for counterintuitive ideas already established as cultural ideas, or for novel ideas given to participants, but none so far has attempted to explain the origin of cultural representations in the minds from which they spring (here, from the minds of the British and Chinese participants in Study #2). This experiment provided just that: insight towards explaining how such counterintuitive representations enter cultural distributions in the first place, which members of societies are most likely to produce them, and the mnemonic dynamics of self-authored representations. Analysis of the generation of representations by participants revealed support for the MCI production age-effect hypothesis, as a significant interaction of counterintuitiveness x age was found. Younger persons given the opportunity to combine an adjective with a noun to represent their ideas and feelings freely generated more MCI concepts in this task than did older persons in the sample. Given children's often odd-seeming conceptual productions, (e.g. through attributing mental states and intentional acts to dolls/toys) and the strange varieties of ideas they seem to prefer to attend to (e.g. actions of imaginary friends, folktales involving talking animals), the finding that younger persons in the population spectrum produce significantly more counterintuitive representations than older adults may not seem farfetched. It would be very surprising to observe an adult within the older population spectrum habitually engaging in such activities (apart from individuals experiencing an unfortunate onset of dementia, perhaps). This first-of-its-kind MCI-theory generation task was fitting, as the outcomes of the counterintuitive effect have been hypothesised to be more than just differential memory. More specifically, attention, in addition to memorability, has been predicted to interact with the production of counterintuitive ideas (Boyer 1994, 2000, 2001). Preliminary experimental evidence already exists to show that adults, when creating stories, prefer minimally counterintuitive ideas over intuitive ideas and maximally counterintuitive ideas (Tweney et al. 2006). Further work in MCI theory should include tasks that measure attention biases and inferences among participants that result from exposure to counterintuitive concepts. The investigation of conceptual biases in the creation of narratives, with special regard to age, would complement the evidence presented in this thesis and help to explain biases for particular literary themes in childhood such as stories and folktales of a magical-religious nature (e.g. Grimm and Grimm 1869/2003).

A free-recall experiment followed this initial generation task in Study #2. The findings of the second part of this analysis (see Section 6.6.2) promises some very interesting implications. It aimed to provide a supplementary test of the MCI hypothesis and the MCI age-effect hypothesis. In this second task of Study #2, each participant was asked to recall the stimuli he or she had generated for the first task. There were two periods of recall: the first after a 3-minute distractor task, and a second after a one-week period of delay. It was found that the participants did not recall the MCI representations significantly better than the intuitive stimuli, both of which they had previously generated themselves. Given the mixed findings and lack of support in Study #1 (as well as in Study #3 and Additional Analysis #3) for the typical formulation of the MCI hypothesis that has dictated previous experimental MCI studies, it is perhaps not surprising that no support was found for the MCI hypothesis when the full age ranges of the samples (in both UK and China) were considered. What is surprising, given the support found for the MCI age-effect hypothesis in both experiments in Study #1 (as well as in Study #3 and Additional Analysis #3), is that no interaction of counterintuitiveness x age was discovered. Although younger persons produced a significantly greater number of MCI representations over INT representations in the generation task, these same younger persons did not recall proportionally more MCI stimuli than INT stimuli, for stimuli the participants themselves generated. This failure to find a significant interaction of counterintuitiveness x age for the recall aspect of Study #2 might appear surprising, given that further investigation revealed a significant advantage for MCI stimuli over INT stimuli in younger persons in the free-recall studies, Studies #1 and #3. That said, the important difference here might be that the stimuli in Studies #1 and #3 were determined by the experimental design and the pretest methodology; the stimuli were not generated by the participant himself, which was the case for the stimuli utilised in Study #2. Therefore, no support could be attributed to either the MCI hypothesis or the MCI age-effect hypothesis from the results of Study #2. However, Section 6.7 provides strong potential explanations, grounded in possible limitations of the study design, for this lack of significant findings. There was likely insufficient statistical power for valid investigation of the counterintuitiveness x age interaction, given the much smaller samples in Study #2 (N = 40, UK; N = 50, China) than in Experiment #2 of Study #1 (N = 198, UK; N = 201, China) and Study #3 (N = 382, UK; N = 382, China), both of which included child participants and investigated a similar age-range, and both of whose analyses revealed a significant counterintuitiveness x age interaction. (The sample in Study #2 also included proportionally fewer children than the samples in these other studies.) The fact that a significant majority of participant-generated counterintuitive stimuli were classed in the humour schema-level effect category is striking and could suggest a reason for the lack of findings for the MCI age effect. In this free-recall aspect of Study #2, stimuli adhering to the schema-level effect of humour had the lowest mean-recall rates of all five schema-level categories and were significantly more poorly recalled than stimuli in either the positive emotion or the imagery schema-level effect categories. Interestingly, both the schema-level categories of positive emotion and imagery possessed significantly fewer, and relatively few, counterintuitive stimuli in comparison to the humour category. These findings contrasted starkly with the findings of the elaborated condition free-recall experiment in Study #1, Experiment #2, where for the presented stimuli (not participant-generated), the HLM revealed mnemonic advantages for stimuli exemplifying the schema-level effect of humour, negative emotion, and inferential potential (though the recall advantages for these last two were not significant in Study #2). This finding could open a door to interesting new hypotheses about the cultural environment required for counterintuitive representations to possess the mnemonic advantage. Jokes are commonly well-distributed and successful cultural representations. We can reasonably assume that jokes with counterintuitive conceptual properties are successful. We might ask, Does the transmission of a counterintuitive representation by way of a humorous idea depend on special additional factors to be better encoded in long-term memory? Not always counterintuitive in kind, the humorous utterances we often make in the company of others can be easy to generate, and good for a quick giggle amongst peers. Furthermore, these simple jests have an important social function, as shared laughter stimulates endorphin release, which in turn facilitates group bonding (see Dunbar 2004; Mehu and Dunbar 2008). But, in this functional role a simple jest might be insufficient to make the transmitted humorous idea memorable, especially to the person that produced and uttered it. These simple jests might just become lost entities in human social interaction, easily forgotten and rarely committed to long-term memory. Consider the simple, passing silly comments you make in the course of the day in typical interaction with others, if you can remember them in the first place. We know we often behave and communicate in a way to be humorous amongst peers. Jokes are humorous ideas delivered in a particular manner (or bundles of humorous ideas together in a narrative, for example). A good joke—one worth remembering and communicating again—may depend on hidden factors. As comedian Frank Carson used to put it: “It’s the way I tell ’em!” To say that some “jokes” aren’t memorable might seem unlikely, given the plethora of jokes people regularly tell and retell. But it might be that humorous ideas that one produces are not as memorable to oneself, the author, as they are to others (in this study, the participants required to recall the humorous jest or idea), as these jokes do not have the same effect as hearing them from another person. Jokes told to oneself lack the surprise and other elements that another person can deliver, especially if "told well". In defence of counterintuitive jokes, the free-recall experiment of Purzycki (2010) revealed a mnemonic advantage for humorous counterintuitive stimuli over standard counterintuitive stimuli and intuitive varieties. But again, Purzycki's findings did not consider the recall of counterintuitive jokes by the same person who recently made them up (as was the case for participants in this free-recall experiment in Study #2. So again, a simple lack of appropriate statistical power might account for the missing counterintuitive effect in Study #2.

It is possible that MCI research has so far failed to identify other specific environments or particular individuals required to successfully transmit counterintuitive representations. The optimal conditions for transmitting the counterintuitive elements of a speech act may not necessarily exist within a humorous context, but rather require solemnity or seriousness, or perhaps even the prestige bias lent by a person of high social standing (see Chudek et al. 2012, Henrich and McElreath 2003, McElreath and Henrich 2007). Perhaps the less-than-light-hearted manner of delivery of many religious materials is not at all accidental, but rather necessary for successful transmission. We might even consider these possibilities to explain why counterintuitive ideas of one's own novel authorship seem not to promote memorability. Two factors could be absent for novel counterintuitive representations generated by oneself: a mnemonic bias that might stem from the transmission of a representation by an authoritative author and/or a shortage of items for cognitive association at the time of coding and retrieval that would otherwise be provided in the context of a counterintuitive representation delivered by an external actor. Indeed, previous MCI studies may have failed to recognise and control for the impact of prestige bias on the recall of stimuli—including the prestige bias arising from the person of the experimenter. Positioned as an authority distributing instructions to participants, and authorised as a representative of a prestigious institution, the experimenter likely has no problem instigating a prestige bias for the transmission of representations within an experiment. This transmission bias could vary from study to study due to the way experimenters presented themselves to the participants, and due to the varying airs of officialness surrounding them. The very content of the counterintuitive stimulus (e.g. a snail that is reading, a cucumber that is listening, a man that is invisible), carefully vetted and controlled for over the duration of a study, may be less important to its perceived memorability than the confident stance or the vocal intonation of the research assistant. For a counterintuitive idea to be successfully distributed, must it be perceived to come from an "immaculate conception," midwifed by an authority figure integral to the event, to lend a corresponding prestige bias? Examples of such figures of privileged position, essential to the mnemonic advantage, could be charismatic teachers or healers. The testimony of persons of authority would then be predicted to be of greater mnemonic impact than individuals perceived to have lower social position. No MCI theory study to date has controlled or tested for such an effect. It is reasonable then to suppose that while participants in MCI theory studies search for meaning while engaged in these tasks, they perhaps also perceive (on some cognitive level, whether or not conscious access to the cognitive structure is granted in the thought process that they have received some kind of "special" knowledge from an expert or authority figure representing an established, prestigious educational institution, and demands attention in the mind of the participant. Controlled memory experiments are in general both extremely strange and salient events to those who take part in them.

Hypothesis #6 was the *supernatural agency hypothesis.* Supernatural agents are reported to be a recurrent universal of world religions (Brown 1991), and the primary defining factor of religion (Atran 2002; Barrett 2004a; Boyer 1994, 2000, 2001; Pyysiäinen, Lindeman and Honkela 2003). Study #3 was the second study to use a free-recall experiment in both the UK and China. It investigated the interaction of the counterintuitive effect and the *hypersensitivity agency detection device* (HADD) which, due to its oversensitivity to the unseen presence of agents, has been asserted to explain the universal proliferation supernatural agent concepts. This study was the first of its kind to investigate the hypothesised transmission advantages for supernatural agents. It was also the first experimental study to find support for this central tenet of the cognitive science of religion. This supernatural agency hypothesis predicted a significant interaction of counterintuitiveness and ontological category, as MCI concepts that fall under the PERSONS ontological category would be better recalled than MCI and INT concepts of other ontological category kinds. Support was found for this hypothesis in both the UK and China. A significant interaction of counterintuitiveness x ontological category was found, revealed to be due to an overall better recall rate of counterintuitive mentalistic-agent concepts than the other seven combinatorial concept varieties (INT/MCI x PERSONS/ANIMATES/SOLID OBJECTS/LIVING THINGS). This was an extremely exciting and unique finding. The replicated significant finding at these cross-cultural locations had an equivalent small effect size. Interestingly, there was no interaction in the recall of stimuli for counterintuitive mentalistic-agent concepts and age, as might be foreseen given the reliable finding of the interaction of counterintuitiveness and age in Studies #1, #2, and #3. The mnemonic advantage for supernatural agent concepts appeared to be constant for persons of all ages. Although no significant interaction of familiarity x counterintuitiveness x ontological category was found in the analysis of the free-recall data, future experimental designs might consider designs based on this interaction. To reveal that culturally familiar supernatural mentalistic agents had a superior mnemonic and therefore inferred transmission advantage would really be exciting—think psychological foundations for supernatural agents of the major world religions! To this end, a stimuli set comprised of items of a more directly religious nature might be more appropriate than the stimuli set used here.

Hypothesis #7 was the *HADD hypothesis.* The design of the free-recall experiment of Study #3 also facilitated testing of the anticipated outputs of the hypersensitive agency detection device (HADD), which is a component of the supernatural agency hypothesis.

Guthrie (1993), Boyer (2001) and Barrett (2000, 2004a) have hypothesised that a psychological mechanism hypersensitive to agency detection would be adaptive since having a strong perceptual bias to interpret ambiguous events as caused by an agent makes it far less likely that our ancestors would have ended up as the victims of predators. It would have been far less costly for our ancestors to detect too many agents in their environments than too few. The HADD hypothesis predicted that animate stimuli would be significantly better recalled than inanimate stimuli. Hence, a group containing stimuli falling under the PERSONS and ANIMATES ontological categories ("animates") would have a significantly better mean recall rate than a second group containing stimuli falling under the SOLID OBJECTS and LIVING THINGS ontological categories ("inanimates"). An additional analysis revealed further support for this component of the supernatural agency hypothesis, as stimuli assigned to the animates group had a significantly better mean recall rate than stimuli assigned to the inanimates group. A larger effect size was detected for the UK than for the China samples: large and small effect sizes, respectively. There has been little experimental investigation to determine the existence of HADD (only Barrett and Johnson 2013, and Nairne et al. 2013) and virtually no available experimental evidence for the role of HADD in acquiring and maintaining religious concepts. This study is the first of this kind to provide experimental evidence for HADD's role in transmitting religious-type ideas. However, in isolation, HADD is not particularly relevant to the scientific exploration of religion, but has much wider relevance to psychology and cognitive science. That said, what has explanatory power for religious phenomena is HADD's interaction with the counterintuitive effect.

The main effect of ontological category (PERSONS, ANIMATES, SOLID OBJECTS, and LIVING THINGS) built into the experimental design of the free-recall experiment in Study #3 permitted a deeper evaluation of the constituent ontological components of HADD. It appears that the operations of HADD could depend on factors more complicated than a strong perceptual bias to interpret ambiguous events as caused by animates rather than inanimates. At both the UK and China experimental sites, stimuli adhering to the PERSONS ontological category (e.g. a man that is invisible, or a queen that is rich) were significantly better recalled than stimuli belonging to the other three ontological categories of ANIMATES, SOLID OBJECTS, and LIVING THINGS. Indeed, this is consistent with the textual analysis of popular world folktales by Barrett, Burdett, and Porter (2009), who discovered that although more of the counterintuitive concepts discovered in these transcripts were counterintuitive agents, most of these counterintuitive agent concepts were also counterintuitive PERSONS concepts. The analysis of the China recall data revealed another, perhaps more intriguing finding. Stimuli belonging to the LIVING THINGS ontological category (e.g. a pumpkin that is poisonous) were also better recalled than stimuli from both the ANIMATES and SOLID OBJECTS ontological categories. This was not found in the analysis of the UK sample. This is truly a unique finding. The same analysis also revealed a significant interaction of ontological category x age. It is perhaps now not surprising to discover that this too was found only for the China sample. Whereas PERSONS concepts were consistently better recalled by participants throughout the age range of the UK sample, contrasts revealed that for the China sample PERSONS concepts were better recalled by younger persons, but interestingly older persons more commonly recalled LIVING THINGS concepts. This interaction of ontological category and age required further exploration. It was thought possible that a linear model used in Study #3 to analyse this data was not sufficiently sophisticated to detect the finer aspects of the interaction of ontological category with age. For instance, there might have been age effects present only in the much younger groups that the linear analysis was not sensitive to. Different domains of intuitive knowledge come online at different times during early childhood; therefore, differential mnemonic biases for certain ontological category kinds might be present for these ages. Hence, Additional Analysis #2 further investigated the relationship between the recall of ontological category concepts and age in much greater details, analysing recall data from the seven age groups separately constituting the samples, and comparing. The results of this additional analysis unveiled a layer of detail previously unseen. Given the lack of significant interaction between stimuli adherent to the different ontological categories and the age of participants doing the recalling that was revealed in the analysis of the UK sample in Study #3, the results from this additional analysis are consistent with what would be expected. Excepting UK preschool children, for whom no significant bias was detected, stimuli adherent to the PERSONS ontological category were significantly better recalled than stimuli of the other three ontological categories of ANIMATES, SOLID OBJECTS, and LIVING THINGS in the analysis of the remaining six age-group samples. In comparison to the straightforward findings for the whole UK sample partitioned by age group, the mnemonic advantages of stimuli adherent to the PERSONS ontological category were found to emerge later in the range of age groups that composed the China sample, and gave way in older age to mnemonic biases of a different variety. Whereas PERSONS stimuli had a significant memorability advantage as early as young childhood (≥5<8 years) in the UK range of age groups, this significant recall advantage for PERSONS stimuli did not emerge until the adolescent (≥13<20 years) age group among the range of age groups in China. This significant recall advantage for PERSONS concepts disappeared by the age group for middle adulthood (≥28<50 years) within the China sample, but in the UK sample continued through the age group representing older adulthood (≥50 years). Most intriguingly, a significant memorability advantage for LIVING THINGS concepts was found for older adults. It might be tempting to attribute to a cohort effect these cross-cultural differences in conceptual mnemonic biases between ontological domains. As experimental research on intuitive ontologies in China has been described as offering a "dearth" of evidence (De Cruz and De Smedt 2007), this may be an exceptional finding, specific to the Chinese population. LIVING THINGS concepts include food kinds; for example, some of the stimuli used in the free-recall experiments of Studies #1 and #3, such as "a cabbage that is rotting" and "a potato that is muddy". Given the scarcity of food in a country that has seen rapid economic change in recent years, failed agricultural experiments, and cultural revolutions endemic to the early lives of many older persons in the China sample, we might ask, Could a cohort effect account for this unique finding of a mnemonic bias for LIVING THINGS concepts (including food kinds? The same level of food scarcity was less common in the lives of older participants in the UK experiment (the Second World War would have affected only very few of the oldest UK participants). The literature concerning intuitive ontologies and memory says nothing of the possibility of such an effect. With respect to a potential hypothesis for this cohort effect as being the product of food scarcity, only future research comparing cultural locations where prior food scarcity has been followed by rapid economic growth accompanied by plentiful food would help to unveil a reason for the significant recall advantage for LIVING THINGS among members of the older age groups in the China sample. A counterargument against this cohort effect might, however, reveal other examples within the stimuli set, such as "a cow that is standing" that also potentially represent a food resource—when slaughtered—but instead falls under the ANIMATES ontological category. The inanimate beef product that results from the butchering process of an animate, living cow would fall within the SOLID OBJECTS category. Therefore, although food concepts might most commonly populate the LIVING THINGS category, they also may fall under SOLID OBJECTS.[80] This cohort effect due to food scarcity might also result from an unbalanced design with regard to stimuli specific to the recall experiments in Studies #1 and #3, which contained more food concepts in the LIVING THINGS category than is representative of the furniture of the world. Experimental research into food concepts and ontological category membership would be enlightening. This research might indicate that FOOD should be an ontological category in its own right—perhaps one that supersedes other ontological categories.

[80]Possibly confounding things further, food concepts might also fall under the ANIMATES ontological category for peoples that see their food as walking around and don't differentiate between "meat" and "living animal" in the stricter fashion common to many persons in Western societies who never kill their food themselves. However, again the relevant psychological literature as yet says nothing about food and ontological category membership.

Hypothesis #8 was the *transmission mode equality hypothesis.* Specific to the design of the first free-recall experiment in Study #1 (Experiment #1), it predicted that no significant differences in recall rates would be revealed between stimuli presented to participants by the oral mode of stimuli presentation and stimuli presented to other participants in the written mode. Prior to the arrival of written symbols, the cultural transmission of stories and folktales has been dominated by the oral mode of transmission, whether by means of epic, ballad, or counting-out rhyme (Rubin 1995). Various studies have looked at the changing relationships between oral and written communication when societies from different historical periods move from a primarily oral culture with limited written materials to a "document-minded" one (Thomas 1989: 36). These document-minded cultures have been described as having a different "literate mentality" (Clanchy 1979). It is claimed that oral and written language affect human memory differently, as written texts are often primarily used as mnemonic aids rather than as works of reference (e.g. Hildyard and Olson 1982, Person 1993). Consistent with predictions of the transmission mode equality hypothesis, no significant difference in the transmission mode (written and oral) of recall stimuli was discovered in Experiment #1 in Study #1. This lack of findings does not support any claim that a cognition-based transmission advantage exists for folktales and religious materials in the written formats that prevail in modern-technological societies. These findings are comparable to those of Brimer and Mueller (1979), who found no significant differences between recall rates of sequences of written and oral items. However, as the oral transmission of narratives and counterintuitive concepts has played such an important role in human cultural heritages, subsequent studies should not rule out its inclusion in ecologically valid designs, especially when comparing cultures that are not equally document-minded (such as the UK and China).

Hypothesis #9 was the *item-centric hypothesis.* It has been asserted that simple grammatical structures, lacking the context provided by a narrative, cannot successfully communicate MCI concepts and provide memorability advantages for them over concepts consistent with domain-specific intuitive assumptions (Gonce et al. 2006; Upal et al. 2007, 2010). The item-centric hypothesis predicted that there would be no significant interaction of counterintuitiveness x presentation mode, as no differences would be revealed between the mean recall rates of INT stimuli and of MCI stimuli between participants using the minimal condition (a simple subject-predicate statement) and the elaborated condition (with additional descriptive materials to form narrative context) of stimuli presentation. Additional Analysis #1 facilitated this comparison. Robust support was found for the item-centric hypothesis in the analysis of the free-recall responses of participants, as no significant interaction between counterintuitiveness x presentation mode was found. This lack of finding helps to resolve the debate in MCI theory between the concept-centric view of the counterintuitive unit of transmission (Barrett and Nyhof 2001, Boyer and Ramble 2001, Gregory and Barrett 2009) and the context-based position that presupposes that the successful transmission of counterintuitive ideas requires the context given by a narrative (Gonce et al. 2006; Upal et al. 2007, 2010). It could, however, be fairly argued that a limitation of this analysis was that the elaborated condition for presenting stimuli did not truly represent "narratives" in the sense of possessing all aspects constituent of a story. However, as outlined in Section 1.5.8, we might argue that this item-centric versus context-dependent mnemonic debate is more of a non-debate based on a false premise, as no one would seriously deny the role contextual materials have in shaping meaning. This additional analysis should be seen more as a demonstration that when thorough pretesting methodology is used to ensure semantic coherence and when the reference to the object the stimulus designates is consistent for all stimuli, no theoretical reason remains to suggest that additional contextual material will make counterintuitive ideas more memorable or transmissible. The pretest methodology for the free-recall experiments of the thesis as described in Chapter 4 ensured that the identical stimuli used in both the minimal and elaborated conditions of presentation modes possessed equal levels of semantic coherence and strictness of reference. Therefore, stimuli consistently delivered the same private representation to participants and did not differ in their private representation despite differences in presentation modes. The invasiveness of analogous reasoning in inadvertently shaping meanings and leading to polysemy has been a confounding factor in the stimuli sets of previous MCI studies that have failed to recognise this effect (e.g. the "rigorous matching" of the lists of Norenzayan et al. 2006, that contained polysemic stimuli such as "thirsty door**").** To minimise confounding effects, forthcoming studies must develop a common scheme to operationalize the role that the contextual information around a public representation has in shaping the resulting private representation. Such a scheme should focus on the intent of the actor who produces the utterance/public representation as well as define the varieties of contextual information available to the recipient of the communication act, both before and after the event in which the public representation is entertained (which Tweney et al. 2006, otherwise referred to as "predictability" and "postdictability"). The scheme should encompass the contextual information available for acquiring meaning from public representations communicated within written materials, nonverbal symbolism, utterances, and other sensory communication, and importantly consider any understanding of intent that the recipient might acquire from the original producer of the communication act.

Supplementary support for the MCI hypothesis, the MCI age-effect hypothesis, and the MCI production age-effect hypothesis can also be drawn from the results of Additional Analysis #3 concerning the *brute recall* of concepts. Barrett and Nyhof (2001) reported that part of the transmission advantage for MCI concepts in their modified serial reproduction experiment was that items that began as intuitive often transformed into counterintuitive versions. For instance, a hard-to-see object might be misremembered as entirely invisible. In addition, they found items could be combined with others so as to yield MCI concepts that were not part of the original item list. If what we see in cultural transmission is a matter of massive idea generation and a brutal mixing and selecting process that produces the best representations, then the appearance of certain classes of representations via brute recall could distort subsequent transmission (e.g. representations that result from the widely appreciated effect of "Chinese whispers"). Analysis of this brute-mixing process and transformation was facilitated by considering all recorded representations of participants who completed Study #1, whether or not the recorded representations were in the target stimuli set (it considered both correct and incorrect answers). This analysis then considered a mixing of data comparable to both the recall of concepts (e.g. Studies #1 and #3) and the generation of unique stimuli (e.g. Study #2). The *MCI brute recall hypothesis* predicted that participants would record significantly more MCI representations than INT representations. The analysis of brute recall revealed clear support for the MCI brute recall hypothesis. This provides secondary support for the typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies, which asserts only that concepts that violate developmentally natural intuitive knowledge structures have a transmission advantage over other concepts. Participants recorded MCI representations significantly more often than INT representations. A second hypothesis, the *MCI brute recall age-effect hypothesis*, predicted that a significant interaction of counterintuitiveness and age would be revealed, as younger persons in the age range of the sample would record significantly more MCI representations than would older persons in the sample. Support was also found for this second hypothesis. Following the finding of the significant interaction of counterintuitiveness x age, contrasts revealed the propensity for younger participants to generate as well as remember significantly more MCI representations than INT representations than did older adults, for whom this trend is reversed, as older persons were revealed to record significantly more INT representations than MCI representations. This gave supplementary support to the MCI age-effect hypothesis and the MCI production age-effect hypothesis and was consistent with the age-related free-recall findings of Study #1 (Experiments #1 and #2) and Study #3, and also the significant age-effect in the generation of representations in Study #3. The findings promise to aid understanding of not only the cognitive biases for particular types of ideas in the distributions of cultural representations, but also the roles of agents of younger ages in cultural groups who are largely responsible for creating and producing cultural representations. This helps to outline the bigger picture to explain mechanisms for the cultural stability of these representations for cultural agents of all ages. As proposed in Section 11.2, consistent with the cultural epidemiology framework,[81] understanding more about the impact of age on cultural transmission and modelling agents' roles in introducing counterintuitive representations (younger persons) to and expelling them (older persons) from cultural distributions of representations has the potential to answer outstanding questions in cognitive anthropology.

Overall, the experimental findings in this thesis support the claim of the universality of the counterintuitive effect. However, minor cross-cultural differences in the recall rates of MCI stimuli were found. In this investigation of the MCI hypothesis, the findings were comparable for the UK and China samples for both free-recall experiments in Study #1, although the final HLM model parameter estimates revealed a significant effect of counterintuitiveness in the UK sample that was not present in China. Cross-cultural findings for the counterintuitive effect were also similar in the analysis of brute recall rates in Additional Analysis #3. However, in the free-recall experiment in Study #3, which considered a conflation of the minimal and elaborated conditions, a recall advantage for MCI stimuli over INT stimuli in the UK was, interestingly, reversed in China, where participants recalled INT stimuli better than MCI stimuli. More important, perhaps, when judging this claim of universality and other findings relevant to future developments in MCI theory, is that the predictions of the MCI age-effect hypothesis and the familiar-MCI hypothesis found identical support in both the UK and China in both Experiments #1 and #2 in Study #1 and in Study #3. Identical findings were also found to support the MCI production age-effect hypothesis for the UK and China samples in Study #2. These findings lead us to ask, Could the subtle underlying cross-cultural differences seen in Study #3 (and in Additional Analysis #2, in the "older adults" group) with regard to the mnemonic bias for LIVING THINGS found in the China sample, but not in the UK sample, account for this minor cross-cultural difference in the counterintuitive effect? These preliminary findings could indicate further differences in how intuitive ontologies develop in children in the

[81] Terms used in regard to the cultural epidemiology framework are easily confused with those used for memory systems and processes. The cultural epidemiology framework is a level of explanation that supervenes on top of that of memory systems and processes. To conflate these levels of explanation would be to misunderstand these independent fields of research.

UK and China. As previously noted, no research is available to verify whether a cohort effect exists for the development of intuitive ontologies. However, none of the few experimental research projects conducted so far in China on the development of intuitive ontologies indicates substantial differences between development in Westerners and in the Chinese population (e.g. Lane et al. 2013; Legare, Zhu, and Wellman 2013; Wellman, Cross, and Watson 2001). Factors in the experimental design could also account for the differences in recall rates between the UK and China participants in Study #3, such as the Chinese children's relatively labored comprehension of the written stimuli compared to the UK children's ease, as in general written Chinese has a slower learning trajectory than the Roman alphabet has for UK children of equal age (DeFrancis 1984, 1989). Comparison of the recall rates for stimuli between the age groups of children in Additional Analysis #2 confirms that this supposition is possible. Although Chinese children seem to recall stimuli more slowly than UK children, this deficit disappears by adulthood, as overall recall rates of stimuli are somewhat more comparable between adult participants in the UK and China. Given the entrenched positions in the debate about the purported differences between the "analytic" cognition of Westerners and the "holistic" thinking of East Asians, these findings could be a noteworthy contribution to this debate.

11.2 Implications for outstanding questions

In light of these findings, this section attempts to address some questions that represent longstanding dilemmas for MCI theory, as well as other questions that have come to prominence during the undertaking of this thesis. Ideas and suggestions for new areas of research are developed throughout this section.

The counterintuitive effect: Both adaptive and a by-product of the way the mind works?

We might understand the nature of the relationship between age and counterintuitiveness in light of the selection pressures impressing upon our ancestors. There are strong grounds to believe that attending to violations of intuitive assumptions of our intuitive ontologies—especially earlier in life—would impose fitness benefits. Modern science often delivers strange discoveries that contradict what we believe intuitively to be true. Venus-flytraps violate our intuitive assumptions about the non-predatory and inanimate nature of plants, but they truly belong to the furniture of the world. We talk of the "sun rising" and the "sun going down", but most of us know that the earth revolves around the sun: what we *know* contradicts our intuitive evaluation of visual data. We typically trust our intuitions to deliver us true predictions about the world around us, but very often it seems these fast and frugal psychological mechanisms turn out to be wrong. The ability to rapidly utilise these rapid non-reflective intuitive mechanisms for behaviours, as opposed to actions going through the slow route of reflective domain-general mechanisms, represents a fitness advantage for its possessor. In a scenario more common to the ancestral environment, if you do not act quickly enough in dangerous situations, but instead must slowly, consciously process all eventualities and desires of third parties, you would probably be quickly eaten by hungry mega-fauna! It follows that, in childhood, the ability to track these environmental contingencies, and all possible outcomes, derives from the default presumptions of these intuitive mechanisms: without this non-reflective foundational knowledge underlying our reflective beliefs about the world, environmental contingencies would be unknowable to us. A well-developed mind of this variety, able to track environmental uncertainties rapidly and efficiently, would have acquired a selection bias over slower, less encompassing minds. However, it is perhaps still most useful to view the mnemonic bias for counterintuitive representations and the cultural productions in children and adolescents as by-products of the way the mind works. Units of non-reflective intuitive knowledge when acted upon and entertained also manifest as reflective beliefs about how the world is. These reflective beliefs of our non-reflective knowledge, or violations of it, are subject to the mind's epistemic reasoning in the same way that reflective beliefs are. However, due to this dual-level processing of the mind, a violation of intuitive knowledge retains its mnemonic advantage as long as the mind is still young and capable enough to process its greater cognitive load in comparison to concepts consistent with our intuitive assumptions. By later adulthood, we may already have had adequate exposure to knowledge violations of these intuitive ontologies to spur natural cognitive development. Therefore, to attend to such conceptual exceptions later in life represents an unnecessary conceptual cost. Given the potential fitness benefits of tracking violations of our intuitive assumptions during childhood, the counterintuitiveness effect's consequent contribution to the proliferation of religious-type cultural representations; and the impact of age on the differential production and transmission rates of counterintuitive representations, the counterintuitive effect is best understood as both adaptive and a by-product of the way the mind works.

Given the reported mnemonic advantages of counterintuitive representations over intuitive representations, why are counterintuitive representations a minority of cultural representations?

Communication acts, written symbols, artefacts, and other cultural materials are more commonly populated with wooden chairs and hot food than with counterintuitive representations such as talking mice and disembodied persons, although the latter are better remembered. This outstanding question for MCI theory and cultural epidemiology has already received theoretical attention (e.g. Atran and Norenzayan 2004; Barrett 2004b; Tweney et al. 2006; see Section 1.5.9 for further details). The technical terms used with regard to the cultural epidemiology framework should not be confused with those of memory systems and processes.[82] The cultural epidemiology framework is a level of explanation that supervenes on that of memory systems and processes, and to conflate these levels of explanation would be to

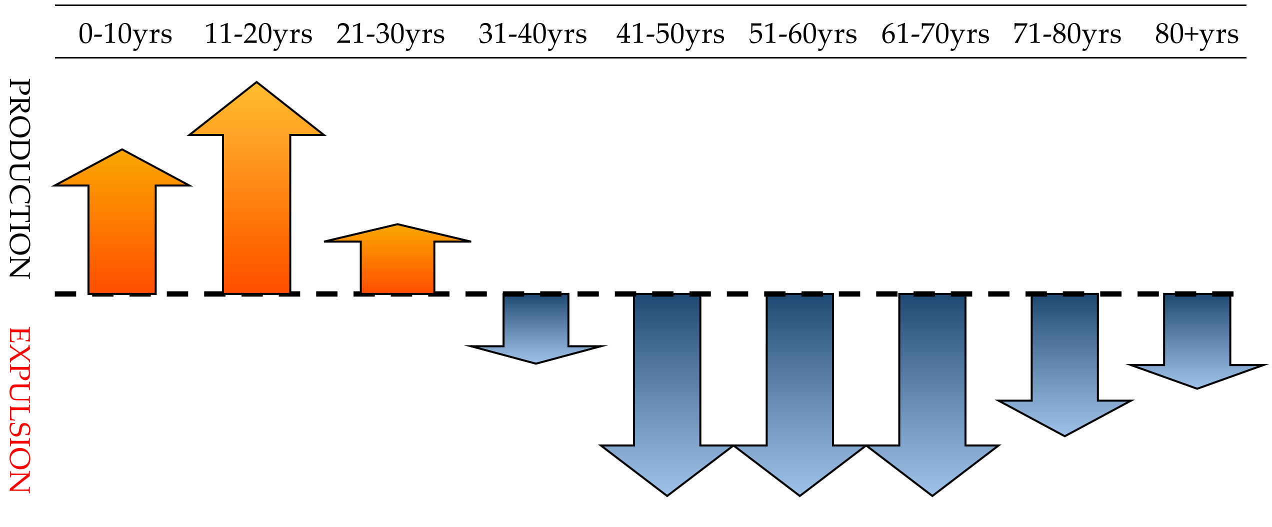
[82] For example, the term "expel" here refers to forcing the departure of ideas from a pool of representations specific to a cultural group. This supervening level of explanation that does not just concern the memory constructs of individuals within the cultural group but also the representations contained within material culture such as artefacts, symbols, and written word. Hence, it is distinct from a term used for the lack of rehearsal (due to weak cues and relative conditions between encoding and retrieval) leading to the decay of constructs from store in individual persons.

misunderstand these independent fields of research. The most prominent explanation for the minority of counterintuitive representations in cultural distributions has been that counterintuitive ideas may naturally degrade over time into intuitive ideas (see Barrett and Nyhof 2001). As Justin Barrett puts it: “Intuitive concepts will always remain in the vast majority as long as (1) the things that people typically experience (like rocks and daisies) fit intuitive assumptions (which they seem to do); (2) intuitive assumptions serve as defaults for unknown properties, thereby producing intuitive concepts; and (3) conceptual load problems of reasoning with multiple counterintuitive concepts in any given contexts lead to those concepts degrading” (2004b: 732). However, this relatively simple conjecture has acquired little empirical support. Until the discovery of the age-related findings in this thesis, the search for an answer to this outstanding question that considers the effect of age on the transmission of counterintuitive representations has not been impossible. Although the findings relating to MCI age-effects in this thesis do not entirely answer the question, they help to provide a more complete answer than has previously been possible. The propensity for younger participants to generate as well as to remember significantly more counterintuitive representations than do older adults, for whom this trend is reversed, has the potential to substantially help us to appreciate not just the cognitive biases for certain ideas in the epidemiology of cultural representations, but also mechanisms underlying the cultural stability of counterintuitive representations. A better answer may arise from our understanding of this asymmetrical impact of age on cultural transmission and of the roles agents of different age-groups play: some to contribute new counterintuitive representations, and others to expel counterintuitive representations from cultural distributions. Given this asymmetric trend, two mechanisms play a role in keeping the number of counterintuitive representations to a stable minority within a cultural distribution: (1) younger persons generate and remember more counterintuitive ideas, which introduces counterintuitive ideas *into* cultural distributions during their own youth; whereas (2) older adults, due to deteriorating cognitive capacities, cannot attend to, remember, or generate counterintuitive representations with such frequency, leading to the depletion of counterintuitive ideas in the form of encoded constructs of memory, written materials, artefacts, and other cultural materials *from* cultural distributions. With regard to memory, older adults' inability to transmit new counterintuitive ideas has the effect of weak cues for previously encoded counterintuitive ideas and lack of associated items that would aid in retrieval. In general, once the encoded construct is stored in long-term memory, if the concept is not rehearsed through entertainment and communication (facilitated by conditions at retrieval), it will decay from store[83] (Surprenant and Neath 2009: 58). Therefore, counterintuitive concepts older persons encoded and stored while they were young will gradually decay (and therefore also retreat from cultural distribution of ideas). Older adults' increasing inability to attend to cultural materials, such as the written word and artefacts containing counterintuitive ideas, will also gradually remove these cultural representations from the overall distribution of ideas within the culture. Conversely, young persons avidly communicate and generate counterintuitive representations and are indirectly responsible for producing counterintuitive ideas in cultural materials (e.g. toys, storybooks, and illustrations) and maintaining and motivating various communication acts (e.g. folktales, ballads, and counting-out rhymes). It therefore follows that younger persons introduce counterintuitive ideas into a cultural distribution of ideas and are responsible for producing them, whereas older adults are responsible for expelling counterintuitive ideas from that cultural distribution of ideas. However, time spent in these roles is asymmetrical: Older persons have a larger temporal window during which to expel counterintuitive representations from among the ideas distributed within cultural groups, whereas children and adolescents have smaller windows during which to produce, spread, and maintain these ideas within cultural groups. Hence, this greater amount of time expelling and shorter amount of time producing counterintuitive ideas

[83] However, this generalisation can be made, but depends on the conditions at encoding and at retrieval. With respect, examples such as Cohen's (1985) second law of memory, which states that the longer an item remains in memory the lower the likelihood it will be remembered, are too simplistic and incorrect.

in the lifespans of persons helps to explain how they remain a minority of cultural representations. Figure 34 illustrates an estimate of this curvilinear and asymmetrical relationship between age and the production and expulsion of distributed counterintuitive ideas. Results from the experiments of Studies #1, #2, and #3 of this thesis that revealed support for both the MCI age-effect hypothesis and the MCI production age-effect hypothesis have motivated this conjecture.

Figure 31. Lifespan timeline representing the asymmetrical relationship between the ages during which counterintuitive representations are produced and expelled from the cultural distribution.



Orange arrows represent the introduction of counterintuitive ideas into the cultural distribution and the ages at which this occurs; blue arrows represent the expulsion of counterintuitive ideas from the cultural distribution and the ages at which this occurs. Larger arrows signify ages associated with the greatest production or expulsion of counterintuitive ideas.

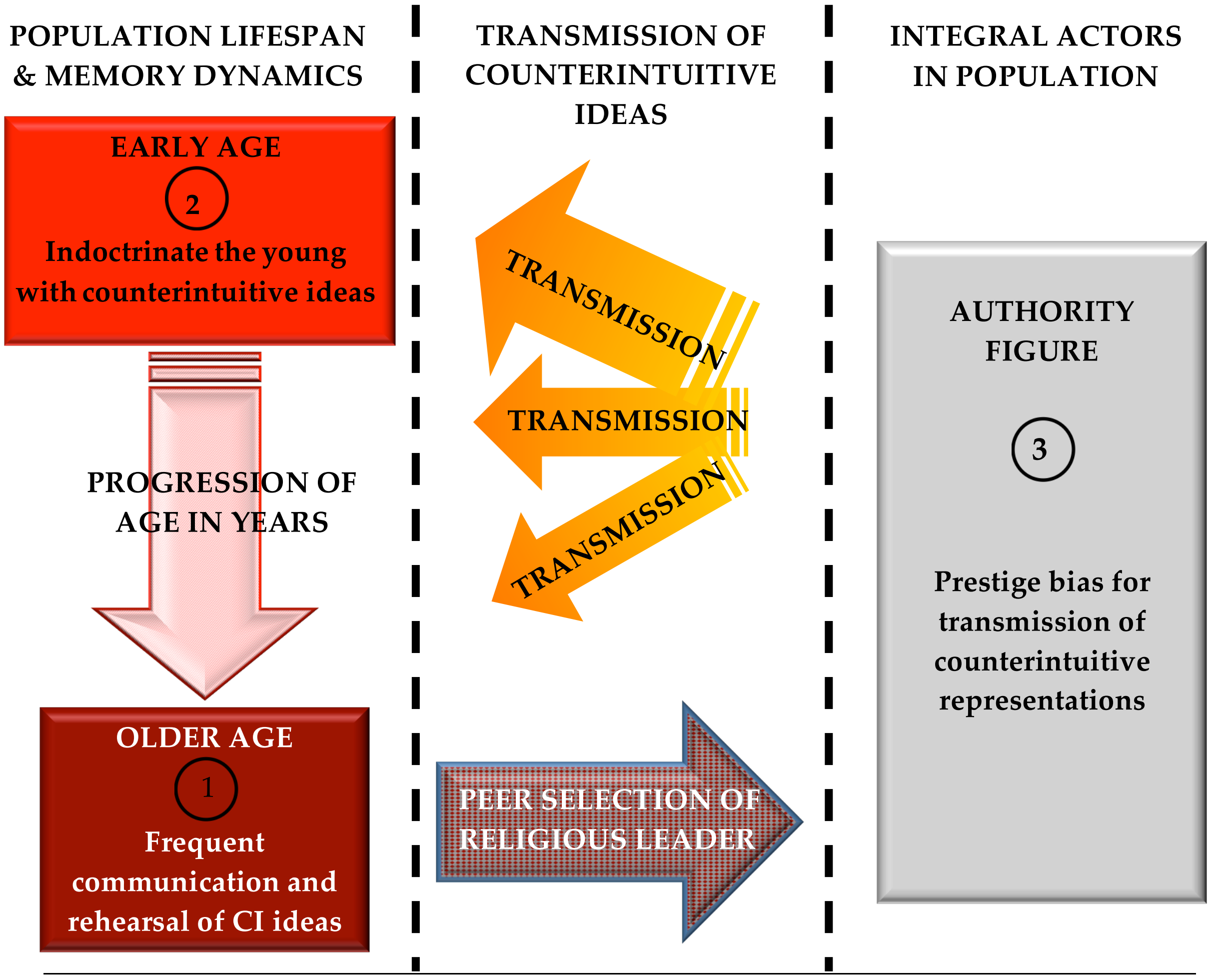
This proposed explanation is admittedly just part of a more complete answer. However, this theoretical model can generate some interesting predictions in regard to the differential population dynamics of age. Are cultural groups with lower life expectancy, and therefore a greater concentration of younger persons, more susceptible to a proliferation of counterintuitive cultural representations than are cultural groups such as "developed" societies with higher life expectancy? The proliferation of witchcraft- and juju-based beliefs and behaviours in sub-Saharan West African societies with lower life expectancy come to mind, whereas higher levels of atheism[84] and perceived lower levels of superstitious belief due to the dominance of analytic thought are present in various "Western" societies with proportionally more older persons.

Given that older adults are so inept at remembering and generating counterintuitive representations, what mechanisms could account for the maintenance of religion and religious ideas?

Perhaps the most important implications of this thesis's findings arise from the impact of age on the transmission of counterintuitive representations. Support was found for the *MCI age-effect hypothesis*, which predicted that younger persons (children and adolescents) better recall MCI concepts than INT concepts, and that a reversal of this effect would be seen for older adults, who would better recall INT concepts than MCI concepts. Support was also found for the *MCI production age-effect hypothesis* as younger persons also had the propensity to generate significantly more MCI representations than their older counterparts. Unlike younger persons, older persons appear very bad not just at encoding and storing counterintuitive concepts, but also at generating new counterintuitive representations. Hence, the question we must ask is, How are religion and religious ideas maintained, given that older persons are so inept with counterintuitive representations? Older people the world over surely do communicate certain counterintuitive representations, the hallmark of religiosity (Barrett 2004a; Boyer 2000, 2001), with habitual frequency. Old hands fondling well-worn rosary beads, belief in the activities of unseen supernatural agents, and worship of an omniscient Abrahamic god spring to mind. Three mechanisms are proposed here that facilitate the maintenance of religious ideas. They are based on the assumption that religious indoctrination is a top-down process in which older persons teach to the young. This proposal should be considered a preliminary sketch. Figure maps the connections among these three mechanisms:

[84] Of course, atheists do not lack the propensity to entertain counterintuitive representations: think of the strange and counterintuitive propositions of science (e.g. the lack of spatiotemporal continuity in subatomic particles).

Figure 32. The circular connection of three mechanisms responsible for maintaining religion and religious (counterintuitive) representations.



Orange arrows signify the transmission and direction of transmission of counterintuitive representations. Factors are labelled "1," "2," and "3" according to the order in which they appear in the accompanying text.

The first of the three mechanisms is simple: in general, once the encoded construct is stored in long-term memory, if the concept is rehearsed through frequent entertainment and communication (facilitated by conditions at retrieval) it will remain stored and will not decay from memory[85] (Surprenant and Neath 2009: 58). This permits older persons to retain key religious concepts in store, while those concepts that are not rehearsed decay so as to become forgotten (e.g. the decay of concepts integral to imaginative play as a young child). The second proposed mechanism, to indoctrinate persons with religious representations (counterintuitive

[85] However, this generalisation can be made, but it depends on conditions at encoding and upon retrieval.

representations), requires the transmission of religious materials to young persons. In general, it appears that there is no point in transmitting new religious counterintuitive representations to older persons due to the difficulties of encoding and committing to store.[86] The findings of this thesis supporting the MCI age-effect hypothesis demonstrate this requirement. As illustrated by the interaction of age and the counterintuitive effect in free recall of stimuli, younger persons remember counterintuitive concepts better than intuitive concepts, whereas older persons recall intuitive concepts better than counterintuitive concepts. This thesis has argued that the degradation of working-memory functionality and the higher demands that counterintuitive concepts place on working memory (in comparison to intuitive concepts) result in this effect. The third mechanism in this proposal, completing this circular relationship, factors in the prestige bias conferred by an authority figure on the transmission of counterintuitive ideas (Chudek et al. 2012; Henrich and McElreath 2003; McElreath and Henrich 2007). The continuous recycling of religious ideas requires the attention bias bestowed by an authority figure[87] to sufficient rehearse counterintuitive religious concepts in older persons with degraded working memory so these ideas do not decay in store. Counterintuitive concepts in older adults need rehearsal. If decay from store occurs later in life, new counterintuitive concepts are difficult to encode and store in older persons. The prestige bias of testimony coming from respected individuals within the older age range of the population is crucial to maintaining the successful transmission of these religious ideas.[88] The inclusion of an authority figure with a prestige bias on transmission completes the connective loop among these three factors. The authority figure would not only transmit ideas to the young but also help to ensure that older persons continue

[86] Of course, there are always exceptions to the rule. However, this might require extraordinary reinforcing conditions at the time of encoding and retrieval.

[87] This sketch does not address what motivations the authority figure has in adopting this role, but they are presumably related to a personal decision about the best available strategy in life—one that is subject to selection by the preached-to—that ultimately results in the enhanced reproductive fitness of the authority figure.

[88] This enforced rehearsal of the prestige bias of the authority figure has the supplementary effect for older persons in that these religious concepts retain high association levels, in that social cues occur often, leading to further reinforcement of transmission and rehearsal.

to entertain and communicate the counterintuitive concepts embedded in religious materials and in the rituals they have practiced since early life. Although the impact of this prestige bias on the transmission of ideas has drawn substantial theoretical attention (e.g. dual inheritance theory; see Richerson and Boyd 2006), there has so far been far limited experimental research to test the hypothesis (see Chudek et al. 2012).

How is it that some maximally counterintuitive (MXCI) concepts are epidemiologically successful?

In a final vein of speculation, future research might consider the mnemonic interaction of counterintuitiveness and familiarity and its potential relationship with epidemiologically successful counterintuitive representations that have more than one template-level violation, here known as *maximally counterintuitive (MXCI) concepts*. (An example of an MXCI concept might be an invisible woman who can hear your thoughts, and who has died and been reborn.) Free-recall tests in MCI studies have revealed that MXCI representations are significantly less well recalled than MCI representations (which have only one template-level violation), and are even outperformed by banal intuitive ideas (e.g. a brown beverage that tastes like vinegar and has a high viscosity) with the same number of modifiers (Norenzayan et al. 2006; Johnson, Kelly and Bishop 2010). However, these studies have considered only MXCI ideas with unfamiliar components. Yet many successful culturally entrenched MXCI representations exist whose epidemiological successes have not been adequately explained at present. We need only to think of an omnipotent, ubiquitous, immutable, ineffable, etc., Abrahamic god (see Barrett 2008 for further details). This is an area completely devoid of experimental design and empirical research. It is here proposed that the mnemonic interaction of the schema-level effect of familiarity and the template-level violation of counterintuitiveness could provide what should be regarded as a *ratcheting effect* towards more proliferative cultural distribution (see discussion of Hypothesis #2 in Section 11.1). If a widely distributed "familiar" MCI idea with a high activation level between concept and modifier, for example INVISIBLE MAN, were to be fitted with a second counterintuitive property, given sufficient semantic coherence and credibility in its new cultural context—I'm thinking of the credibility of potential films starring a FLYING INVISIBLE MAN—would it outperform, in memory tests, intuitive ideas with two modifiers as well as MXCI ideas with two unfamiliar counterintuitive modifiers? This prediction of a ratcheting effect for generating MXCI ideas formed during the process of adding a CI modifying property to an MCI idea—one that is already an established, familiar representation within a given culture—would fit in with the predictions of signal detection theory (e.g. Green and Swets 1966; Ingram et al. 2011).

11.3 Concluding remarks

The findings of the experiments in this thesis demonstrate the need for substantial revisions to the typical formulation of the MCI hypothesis that has dominated prior experimental MCI studies, which asserts only that concepts that violate developmentally natural intuitive knowledge structures have a transmission advantage over other concepts. Furthermore, results here open up exciting new dimensions for exploring individuals' contribution of counterintuitive ideas to cultural distributions of ideas, the interaction of the counterintuitive effect with other cognitive mechanisms in people's minds, and the changing cognitive capabilities for the communication of minimally counterintuitive concepts that humans possess as they progress through their lifespan. Strong evidence was provided for the interaction of template-level violation and schema-level effects. The generation tasks and free-recall experiments of these studies investigated aspects never previous explored in this area of research and revealed several unique findings. Strong support was found for Boyer's original description of the counterintuitive hypothesis that predicted the superior transmission advantages of culturally familiar counterintuitive ideas. This discredits armchair assumptions by Bloch (2005) and Upal (2010) that counterintuitive representations that have become familiar, to the extent that they are epidemiologically commonplace and entwined in the everyday behavioural motivations of a cultural group, have lost their "cognitive significance". The first-time utilisation of samples representative of population age demographics aided in the discovery that younger persons have superior cognitive capacity than older adults for remembering and generating counterintuitive ideas. These same cognitive capabilities for template-level violations in young children showed that these transmission biases become effective early in human development, near the beginning of formal religious training. This interaction between age and the counterintuitive effect points towards future research into the roles different age groups play in contributing cultural representations to or taking them away from distributions of ideas—and toward the possibility of a Chomskian *window of opportunity* for the successful transmission of religious-type representations. The practice of recruiting university students common to all prior MCI research should be abandoned if we are to better understand the cognitive mechanisms behind the counterintuitive effect and its interactions with other cognitive mechanisms. Until now MCI studies have been designed to attain only a shallow understanding of our memory processes. In the preliminary sketch provided, cognitive load theory fits well with the finding of the impact of age on MCI recall. However, for the wider psychological research community to appreciate the degradation of cognitive load with age, more must be understood about the intrinsic mnemonic effect of template-level violation. Furthermore, understanding about this mnemonic effect should be integrated into the typical formulation of memory systems that dominates memory research (e.g. Tulving 1985; Surprenant and Neath 2009). Providing another first for MCI research and the cognitive science of religion, this thesis has found evidence for the superior mnemonic advantage of supernatural agent concepts. Reported as the single most recurrent factor in world religions, and consequently identified as the defining trait of religion, supernatural agent concepts are a central tenet of the cognitive science of religion, yet there has been no experimental investigation of their mnemonic advantage, let alone evidence to support it, until now.

Although fascinating minor differences between the two experimental populations were revealed, all of most important findings replicated for both UK and China populations. The findings in this thesis not only largely support the claim of the universality of intuitive ontologies, but also contribute to the enduring debate over the supposed differences between the analytic cognition of Westerners and the holistic thinking of persons in East Asia, because evidence here illustrates much greater similarities than differences between the minds of Chinese and British persons. These results, and their implications, contribute to a budding literature of the cognitive science of religion that reveals religious beliefs and concepts to be the natural by-products of cognitive mechanisms that come online during early childhood in normal developmental environments and that originally evolved for purposes other than religion-specific ones. It is hoped that subsequent revisions, additions, and elaborations to our understanding of the counterintuitive effect will usher in a wave of dynamic new research and attract further attention from other disciplines.

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Appendixes

Appendix 1 UK Pretest #1 Answer Sheet

BEFORE YOUR START THE TASK PLEASE MAKE SURE YOU FILL IN YOUR DETAILS HERE.

Info about yourself – please complete.

Age	
Nationality	
Male/Female	
Date	
Time	

MANY THANKS!!!!!!

The following pages contain a listing of **48 sentences** for each of which you are required to provide a score.

THE QUESTION:

How many times during your lifetime do you judge that you have mentally encountered each idea?

Varieties of **'mental encounter'** could include representation from the following means:

(i) encountering a representation of the idea direct from **real life experience**;

(ii) watching/reading/hearing/entertaining representation of idea through **books, films, cartoons, animation, magazines, music, news**, etc, etc…. in the form of general/particular characters, animates, objects, things, etc;

(iii) it could be an **character/object** of **fiction or non-fiction**;

(iv) an item of **oral communication**—an item within plain old **conversations—** orally communicated **stories or folktales**;

(v) seeing it represented as a **photo-image** or piece or **art**, etc.;

(vi) as a item of thought/creation of your own mind and **imagination**.

(vii) etc, etc…..

… in other words, by any means possible that has placed the idea in your mind.

- PLEASE CONSIDER THE TOTAL POSSIBILE REPRESENTATIONS OF EACH ITEM VERY CAREFULLY.

IMPORTANT:- HOW CLEARLY YOU CAN IMAGINE THE IDEA, OR NOT, **IS IRRELEVANT**. WHAT IS OF NECESSITY IS THE **AMOUNT OF TIMES YOU HAVE PREVIOUSLY ENCOUNTERED A REPRESENTATION OF IT, OR NOT**.

Record your answers on the scale provided under each item (do please look ahead). FOR EACH ITEM, PLEASE PLACE A CIRCLE AROUND A NUMBER ON THE SCALE – TO YOUR BEST ESTIMATE.

IN THE PROCESS OF COMPLETING THE TASK: A NUMERICAL GUIDE

The scale on which your scores are placed are bound at the extremes by 'never' (1 = minimum) and 'every moment' (9 = maximum) between which is a number scale.

The table below serves as a ***guide*** for attributing a numerical amount to the perceived numbers of times you have mentally encounter one of the listed idea. The aim of the table is to provide you with a better perspective relative to known periods of time. PLEASE OBSERVE YOUR CLOSEST AGE IN THE LEFT COLUMN AND USE IT TO BETTER YOUR QUANTIFIED JUDGEMENTS.

Age (years)	*Age(months)*	*Age (weeks)*	*Age (days)*	*Age (hours)*
10	120	520	3640	87360
20	240	1040	7280	174720
30	360	1560	10920	262080
40	480	2080	14560	349440
50	600	2600	18200	436800
60	720	3120	21840	524160
70	1440	3640	35480	611520

IMPORTANT:-

- DO NOT HESITATE TO LATER CHANGE A SCORE GIVEN AN ITEM AFTER FURTHER REFLECTION.
- PLEASE ENSURE YOU PROVIDE A SCORE FOR ALL ITEMS.

WHEN YOU HAVE REACHED THE END OF THE LISTING, PLEASE GO BACK THROUGH YOUR ANSWERS ON THE SHEET AND ADJUST SCORES AS NECESSARY.

TAKE AS MUCH TIME AS YOU FEEL NECESSARY TO COMPLETE THE TASK.

Instructions for a **SECOND TASK** are to be found on the final page of this handout. Please complete task 1 first. Both tasks require completion.

MANY THANKS.

THE TASK STARTS HERE

A cow that is lying-down

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A snail that is reading

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A person that is indestructible

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A tree that is thinking

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A mouse that is talking

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A squirrel that is swimming

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A wolf that is acting

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A queen that is rich

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A clown that is kneeling

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A potato that is muddy

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A man that is invisible

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A hen that is pregnant

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A skeleton that is fighting

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A cabbage that is rotting

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A being that is everywhere

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A cucumber that is listening

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A gardener that is bodiless

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A moon that is hollow

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A whale that is blinking

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A monk that is skipping

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A stone that is smooth

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A carrot that is ticklish

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A mountain that is soft

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A boy that is dirty

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A caterpillar that is eating

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A pumpkin that is poisonous

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A snowflake that is hungry

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A dog that is laughing

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A banana that is curved

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A comet that is sad

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A cactus that is greasy

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A chef that is immortal

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A flower that is angry

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A student that is intangible

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A balloon that is hovering

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A venus-flytrap that is grabbing

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A berry that is brittle

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

An island that is four-sided

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A corpse that is walking

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A raindrop that is splashing

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A rabbit that is egg-laying

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

An icicle that is dripping

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A frog that is jumping

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A bush that is fireproof

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A postman that is hiding

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A goat that is deaf

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A doctor that is busy

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

A bucket that is happy

every moment	100,000 times, or more	10,000 times	1,000 times	100 times	50 times	several times	once or twice	never
9	8	7	6	5	4	3	2	1

END

*****IMPORTANT*** NOW PLEASE GO BACK THROUGH YOUR ANSWERS AND ADJUST THEM AS NECESSARY (SEE INSTRUCTION PAGE).**

TASK 2

Return to the start of your completed Answer Sheet.

In the space by the side of each sentence, rewrite the sentence in an alternative worded version according to your primary understanding of it – rewrite it in your own words. PLEASE USE DIFFERENT WORDS TO THE ORIGINAL SENTENCE (but, you can use ‘a’, ‘that’ and ‘is’, if you wish)

For example: **‘a cat that is silent’** could be rewritten [according to your own understanding] as **‘a feline-mammal that is not making any noise’**

Please do this for all 48 items.

Appendix 2. UK Answer Sheet 2b: Questionnaire of schema-level effects for stimuli

Task Answer Sheet 2

Week 2

CALIB2B/JG/1109

Please fill in your details here

Age	
Nationality	
Male/Female	
Date	
Time	

MANY THANKS!!!!!!

Please do not turn over the page until instructed to do so.

TASK INSTRUCTIONS PAGE

One week ago you created items according to a subject category and question. You created 4 combinations (one adjective + one noun – in that order) for each category. To recap, the SUBJECT CATEGORIES were:

POSITIVE EMOTION	**A measure of positive emotion/good feeling you associate with an idea: e.g. pleasantness, like, etc.**
NEGATIVE EMOTION	**A measure of the negative emotion/bad feeling you associate with an idea: e.g. anger, dislike, etc…**
IMAGERY	**A measure of the ease of which an idea can be pictured in your mind.**
HUMOUR	**A measure of how funny/humorous an idea is. It might relate to past experience memories, or just seem particularly amusing to you.**
INTEREST	**A measure of how interesting/thought provoking an idea is. To be 'interesting' the idea should lead into several more thoughts and theories.**

Task instructions
The following pages contain a series of 32 short sentences containing a noun and an adjective. Using the rating scale provided next to each subject category title, please rate each sentence item according to the subject category affect (you are already familiar with these categories. They are the same subject categories by which you created last week's combinations – as above)

Rating scale:
9 = strong affect/strong sense or feeling; 1 = no affect/no sense or feeling

- **Please circle a number to mark you answer on the rating scale.**

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

PLEASE TURN BACK TO THIS TASK INSTRUCTIONS PAGE AT ANY TIME.

Please turn the page and begin when you are ready.

THE TASK STARTS HERE

PLEASE TURN BACK TO THE 'TASK INSTRUCTIONS PAGE' AT ANY TIME.

'A cow that is lying-down'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A snail that is reading'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A tree that is thinking'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

‘A mouse that is talking’

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

‘A squirrel that is swimming’

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

‘A wolf that is acting’

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A queen that is rich'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A man that is invisible'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A skeleton that is fighting'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A cabbage that is rotting'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A being that is everywhere'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A cucumber that is listening'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A gardener that is bodiless'

	Strong affect 9	8	7	6	5	4	3	2	No affect 1
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A moon that is hollow'

	Strong affect 9	8	7	6	5	4	3	2	No affect 1
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A monk that is skipping'

	Strong affect 9	8	7	6	5	4	3	2	No affect 1
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A stone that is smooth'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A carrot that is ticklish'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A boy that is dirty'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A caterpillar that is eating'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A pumpkin that is poisonous'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A snowflake that is hungry'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A comet that is sad'

	Strong affect								No affect
	9	8	7	6	5	4	3	2	1
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A cactus that is greasy'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A chef that is immortal'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A balloon that is hovering'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A venus-flytrap that is grabbing'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'An island that is four-sided'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A rabbit that is egg-laying'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'An icicle that is dripping'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

'A postman that is hiding'

	Strong affect								No affect
POSITIVE EMOTION	9	8	7	6	5	4	3	2	1
NEGATIVE EMOTION	9	8	7	6	5	4	3	2	1
IMAGERY	9	8	7	6	5	4	3	2	1
HUMOUR	9	8	7	6	5	4	3	2	1
INTEREST	9	8	7	6	5	4	3	2	1

Important Notes:-

- Consider each sentence carefully. **Think of all the things/ideas/memories the words represent.**
- Ensure you provide a rating score for all categories.
- Do not hesitate to later change a rating-score after further reflection.
- **There is no time limit to this task. Take as much time as you feel necessary.**

'A goat that is deaf'

	Strong affect 9	8	7	6	5	4	3	2	No affect 1
POSITIVE EMOTION									
NEGATIVE EMOTION									
IMAGERY									
HUMOUR									
INTEREST									

'A potato that is muddy'

	Strong affect 9	8	7	6	5	4	3	2	No affect 1
POSITIVE EMOTION									
NEGATIVE EMOTION									
IMAGERY									
HUMOUR									
INTEREST									

END

Appendix 3. UK Stimuli set for elaborated condition

Experiment stimuli set in the elaborated condition of presentation, comprised of necessary minimally counterintuitive items (fMCI and uMCI) and intuitive items (fINT and uINT), in a balanced design. Corresponding ontological category are listed as determined by the subject noun in obedience with the categorical definitions of Keil (1979) and counterintuitive coding as per the formulation of Barrett (2008).

Elaborated Item	*Ontological Cat.*	*CI coding*
There is a small furry animal that is chatting away. It is a mouse that is talking.	ANIMACY	^{M}MOUSE
There is a big hairy beast that is pretending to be someone else. It is a wolf that is acting.	ANIMACY	^{M}WOLF
There is a fully-grown male person that is impossible to see. He is a man that is invisible.	PERSONS	MAN$_{p}$
There is a mature female life-form that is all places at once. He is a being that is everywhere.	PERSONS	BEING$_{u}$
There is a fleshless white bony-structure that is engaged in combat. It is a skeleton that is fighting.	SOLID OBJECTS	^{A}SKELETON
There is a round air-filled item that is hanging in mid-air. It is a balloon that is hovering.	SOLID OBJECTS	BALLOON$_{p}$
There is a short carnivorous plant that is capturing something. It is a venus-flytrap that is grabbing.	LIVING THINGS	^{A}VENUS-FLYTRAP
There is a tall bushy woody-perennial that is mindful like a human. It is a tree that is thinking.	LIVING THINGS	^{M}TREE
uMCI	*Ontological Cat.*	*CI coding*
There is a warm-blooded fluffy critter that is giving birth to babies contained in a hard shell. It is a rabbit that is egg-laying.	ANIMACY	RABBIT$_{b}$
There is a tiny hard-backed creature that is looking intently at a book. It is a snail that is reading.	ANIMACY	^{M}SNAIL
There is an outdoors labouring man that is without physical form. He is a gardener that is bodiless.	PERSONS	GARDENER^{P}
There is an employed white-clothed woman that is going to live forever. She is a chef that is immortal.	PERSONS	CHEF$_{b}$
There is a solid space-travelling entity that is feeling unhappy. It is a comet that is sad.	SOLID OBJECTS	^{M}COMET
There is a delicate icy substance that is desiring to eat. It is a snowflake that is hungry.	SOLID OBJECTS	^{B}SNOWFLAKE
There a long green vegetable that is hearing things around it. It is a cucumber that is listening.	LIVING THINGS	^{M}CUCUMBER
There is an orange crunchy root that is excited when stroked	LIVING	CARROT$_{b}$

lightly with fingers. It is a carrot that is ticklish.	THINGS

fINT	*Ontological Cat.*
There is a large hairy bovine that is resting on the ground. It is a cow that is lying-down.	ANIMACY
There is a long hairy insect that is munching on food. It is a caterpillar that is eating.	ANIMACY
There is a male juvenile kid that is covered in filth. He is a boy that is dirty.	PERSONS
There is a powerful womanly monarch that is very wealthy. She is a queen that is rich.	PERSONS
There is a thin frozen object that is losing water. It is an icicle that is dripping.	SOLID OBJECTS
There is a hard solid thing that is even all over when felt. It is a stone that is smooth.	SOLID OBJECTS
There is a round leafy living-thing that is decomposing. It is a cabbage that is rotting.	LIVING THINGS
There is a common dull-coloured tuber that is covered in dirt. It is a potato that is muddy.	LIVING THINGS

uINT	*Ontological Cat.*
There is a stubborn horned mammal that is unable to hear things. It is a goat that is deaf.	ANIMACY
There is a little tree-living rodent that is travelling through water. It is a squirrel that is swimming.	ANIMACY
There is a uniformed working employee that is trying not to be seen. He is a postman that is hiding.	PERSONS
There is an adult cloaked human that is swinging a rope while jumping. He is a monk that is skipping.	PERSONS
There is an isolated sea-bound landmass that is square shaped. It is an island that is four-sided.	SOLID OBJECTS
There is a spherical orbiting satellite that is empty inside. It is a moon that is hollow.	SOLID OBJECTS
There is a hardy spiky organism that is covered in a slippery substance. It is a cactus that is greasy.	LIVING THINGS
There is a colourful bulky fruit that is harmful if eaten. It is a pumpkin that is poisonous.	LIVING THINGS

Appendix 4. China stimuli set for elaborated condition

Experiment stimuli set comprised of necessary minimally counterintuitive items (fMCI and uMCI) and intuitive items (fINT and uINT), in a balanced design. Corresponding ontological category are listed as determined by the subject noun in obedience with the categorical definitions of Keil (1979) and counterintuitive coding (CI) as per formulation of Barrett (2008).

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fMCI item

English

There is a small furry animal that is chatting away. It is a mouse that is talking.

yǒuyīzhīmáoróngróngdexiǎodòngwù tāzhèngzàixiánliáo nàshìyīzhīlǎoshǔ tāzài
有一只毛茸茸的小动物，它正在闲聊。那是一只老鼠，它在

jiǎnghuàle
讲话了。

There is a big hairy beast that is pretending to be what it isn't. It is a wolf that is disguising.

yǒuyīzhīpángdàdeyǒumáodeyěshòu tāzhèngzàijiǎzhuāngchéngqítādòngwù nàshìyīzhī
有一只庞大的有毛的野兽，它正在假装成其它动物。那是一只

láng tāzàiqiáozhuāngle
狼，它在乔装了。

There is an adult male person that is unperceivable by sight. He is a man that is invisible.

yǒuyīgènánxìngchéngniánrén tāshìbùnéngbèikànjiànde nàshìyīgènánrén tāshì
有一个男性成年人，他是不能被看见的。那是一个男人，他是

yǐnxíngde
隐形的。

There is a living intelligent entity that is all places at once. He is a being that is everywhere.

yǒuyīgèchōngmǎnzhìhuìdeyǒushēngmìngdeshítǐ tākěyǐlìkèdàorènhédìfāng nàshìyī
有一个充满智慧的有生命的实体，他可以立刻到任何地方。那是一

gèshēngwù tāshìwúchùbùzàide
个生物，它是无处不在的。

There is a fleshless bone-composed structure that is engaged in combat. It is a skeleton that is fighting.

yǒuyīgèyóugǔtouzǔchéngdeméiyǒuròutǐdejiégòu tāzhèngzàizhàndòu nàshìyīgè
有一个由骨头组成的没有肉体的结构，它正在战斗。那是一个

kūlóu tāzàidǎjiàle
骷髅，它在打架了。

There is a round air-filled object that is hanging in mid-air. It is a balloon that is hovering.

yǒuyīgèchōngmǎnkōngqìdeqiúxíngdewùtǐ tāzhèngxuánzàibànkōngzhōng nàshìyīgè
有一个充满空气的球形的物体，它正悬在半空中。那是一个

qìqiú tāzàiáoyóule
气球，它在遨游了。

There is an attractive scented open-bud that is showing an expression of happiness. It is a flower that is smiling.

yǒuyīduǒyǒuyòurénxiāngwèidekāifàngledehuābāo tāzhǎnxiànchūkuàilèdebiǎoqíng
有一朵有诱人香味的开放了的花苞，它展现出快乐的表情。

nàshìyīduǒhuā tāzàixiàole
那是一朵花，它在笑了。

There is a woody leafy plant that is fruiting items of currency. It is a tree that is money-laden.

yǒuyīgèduōyèdemùběnzhíwù tāshàngmianjiémǎnlehuòbìguǒshí nàshìyīkēshù tāshì
有一个多叶的木本植物，它上面结满了货币果实。那是一棵树，它是

guàmǎnleqiánde
挂满了钱的。

uMCI item
English

There is a warm fluffy mammal that is giving birth to offspring within a hard shell. It is a rabbit that is egg-laying.

yǒuyīzhīwēnnuǎnderuǎnruǎndebǔrǔdòngwù tāzhèngzàichǎnluǎn nàshìyīzhītùzǐ tā zàixiàdànle
有一只温暖的软软的哺乳动物，它正在产卵。那是一只兔子，它在下蛋了。

There is a tiny hard-backed creature that is looking intently at a book. It is a snail that is reading.

yǒuyīzhībèibùjiānyìngdexiǎoshēngwù tāzhèngzàizhuānzhùdìkànshū nàshìyīzhī wōniú tāzàidúshūle
有一只背部坚硬的小生物，它正在专注地看书。那是一只蜗牛，它在读书了。

There is an outside working lady that is without physical form. She is a gardener that is bodiless.

yǒuyīgèzàishìwàigōngzuòdenǚshì tāméiyǒuwùzhìdewàixíng nàshìyīgèyuándīng tā shìwúxíngde
有一个在室外工作的女士，她没有物质的外形。那是一个园丁，他是无形的。

There is a white-clothed womanly employee that is going to live forever. She is an chef that is immortal.

yǒuyīgèchuānbáiyīfudenǚxìngyuángōng tājiāngyǒngyuǎnhuózhe nàshìyīgèchúshī tāshìyǒngshēngde
有一个穿白衣服的女性员工，她将永远活着。那是一个厨师，她是永生的。

There is a space-travelling solid object that is feeling unhappy. It is a comet that is sad.

yǒuyīgèzàiyǔzhòuzhōngchuānsuōdegùtǐwùzhì tāgǎndàobùgāoxìng nàshìyīkē huìxīng tāshìbēishāngde
有一个在宇宙中穿梭的固体物质，它感到不高兴。那是一颗彗星，它是悲伤的。

There is a delicate frozen crystal-object that is wanting to eat. It is a snowflake that is hungry.

yǒuyīgèxiānxìdeníngjiédejīngtǐ tāzhèngxiǎngchīdōngxī nàshìyīduǒxuěhuā tāshì è de
有一个纤细的凝结的晶体，它正想吃东西。那是一朵雪花，它是饿的。

There a long green vegetable that is hearing things around it. It is a cucumber that is listening.

yǒuyīgèchángchángdelǜsèdeshūcài tāzhèngzàigǎnshòuzhōuwéideshēngyīn nàshìyī gēnhuánggguā tāzàitīngle
有一个长长的绿色的蔬菜，它正在感受周围的声音。那是一根黄瓜，它在听了。

There is an orange crunchy root that is sensitive to the touch. It is a carrot that is ticklish.

yǒuyīgèjúhuángsèdeyìsuìdegēnbù tāduìchùmōhěnmǐngǎn nàshìyīgēnhúluóbo tāshì pàyǎngde
有一个橘黄色的易碎的根部，它对触摸很敏感。那是一根胡萝卜，它是怕痒的。

fINT item
English

There is a slim hairy insect that is munching on food. It is a caterpillar that is eating.

yǒuyīzhīshòushòudeduōmáodekūnchóng tāzhèngzàijǔjuéshíwù nàshìyīzhī máomáochóng tāzàichīle
有一只瘦瘦的多毛的昆虫，它正在咀嚼食物。那是一只毛毛虫，它在吃了。

There is a long-legged slimy amphibian that is leaving the ground quickly. It is a frog that is jumping

yǒuyīgèchángtuǐdeniánhuádeliǎngqīdòngwù tāzhèngzàikuàisùdìlíkāidìmiàn nàshì
有一个长腿的黏滑的两栖动物，它正在快速地离开地面。那是

yīzhīqīngwā tāzàitiàole
一只青蛙，它在跳了。

There is a short juvenile kid that is covered in grime. He is a boy that is dirty.

yǒuyīgèǎiǎideniánshàodeháizi tāshēnshàngfùgàizheyīcéngwūgòu nàshìyīgè
有一个矮矮的年少的孩子，他身上覆盖着一层污垢。那是一个

nánhái tāshìzāngde
男孩，他是脏的。

There is a powerful womanly monarch that is very wealthy. She is a queen that is rich.

yǒuyīgèquánlìhěndàdenǚxìngdìwáng tāshìfēichángyǒuqiánde nàshìyīgènǚwáng tā
有一个权利很大的女性帝王，她是非常有钱的。那是一个女王，她

shìfùyǒude
是富有的。

There is a frozen thin bar that is losing liquid. It is a icicle that is dripping.

yǒuyīgèníngjiédexìxìdebàng tāzhèngzàibúduàndìsǔnshīshuǐfèn nàshìyīgēn
有一个凝结的细细的棒，它正在不断地损失水分。那是一根

bīngzhù tāzàidīshuǐle
冰柱，它在滴水了。

There is a hard dense block that is even to the touch. It is a stone that is smooth.

yǒuyīgèyìngyìngdejiānshídekuàizhuàngwù tāmōqǐláishìpíngde nàshìyíkuài
有一个硬硬的坚实的块状物，它摸起来是平的。那是一块

shítou tāshìguānghuáde
石头，它是光滑的。

There is a plump ground living-thing that is decomposing. It is a cabbage that is rotting.

yǒuyīgèyuángǔngǔndechángzàidìshàngdedōngxī tāzhèngzàibúduàndìbiànhuài nàshì
有一个圆滚滚的长在地上的东西，它正在不断地变坏。那是

yīkēbáicài tāzàifǔlànle
一棵白菜，它在腐烂了。

There is a yellow sweet food-item that is bent in the middle. It is a banana that is curved.

yǒuyīgèhuángsèdeyǒutiánwèideshíwù tādexíngzhuàngshìxiàngzhōngjiānwānqūde nà
有一个黄色的有甜味的食物，它的形状是向中间弯曲的。那

shìyīgēnxiāngjiāo tāshìwānde
是一根香蕉，它是弯的。

---

uINT item

English

There is a stubborn horned farm-animal that is unable to hear sound. It is a goat that is deaf.

yǒuyīzhīchángzhejiānyìngjījiǎodeshēngchù tātīngbújiànshēngyīn nàshìyīzhī
有一只长着坚硬犄角的牲畜，它听不见声音。那是一只

shānyáng tāshìlóngde
山羊，它是聋的。

There is a little tree-living rodent that is moving through water. It is a squirrel that is swimming.

yǒuyīzhīxiǎoxiǎodeshēnghuózàishùshàngdenièchǐmùdòngwù tāzhèngzàishuǐlǐyí
有一只小小的生活在树上的啮齿目动物，它正在水里移

dòng nàshìyīzhīsōngshǔ tāzàiyóuyǒngle
动。那是一只松鼠，它在游泳了。

There is a uniformed working employee that is trying not to be seen by others. He is a postman that is hiding.

yǒuyīgèchuānzhuózhìfúgōngzuòdegùyuán tāzhèngzàichángshìbùbèibiérénkàndào nà
有一个穿着制服工作的雇员，他正在尝试不被别人看到。那

shìyīgèyóudìyuán tāzàiduǒcángle
是一个邮递员，他在躲藏了。

There is an adult robed human that is swinging a rope while jumping. He is a monk that is skipping.

yǒuyīgèchuānzhuójiāshādechéngniánrén tāzàitiàoyuèshíyáobǎishéngzǐ nàshìyīgè
有一个穿着袈裟的成年人，他在跳跃时摇摆绳子。那是一个

héshang tāzàitiàoshéngle
和尚，他在跳绳了。

There is a giant orbiting sphere that is empty inside. It is a planet that is hollow.

yǒuyīgèjùdàdeànguǐdàoyùnxíngdeqiútǐ tādelǐmiànshénmedōuméiyǒu nàshìyīgè
有一个巨大的按轨道运行的球体，它的里面什么都没有。那是一个

xíngxīng tāshìzhōngkōngde
行星，它是中空的。

There is a massive rocky protrusion that is spongy throughout. It is a mountain that is soft.

yǒuyīgèyóuxǔduōdeyánshízǔchéngdetūqǐwù tāzhěnggèdōuxiànghǎimiánshìde nàshìyī
有一个由许多的岩石组成的突起物，它整个都像海绵似的。那是一

zuòshān tāshìróuruǎnde
座山，它是柔软的。

There is a hardy spiky organism that is covered in a oily substance. It is a cactus that is greasy.

yǒuyīgènàihàndeyǒujiāncìdeyǒujītǐ tābèifùgàileyīcéngyóuzhī nàshìyīkē
有一个耐旱的有尖刺的有机体，它被覆盖了一层油脂。那是一颗

xiānrénzhǎng tāshìyóunìde
仙人掌，它是油腻的。

There is a colourful bulky fruit that is harmful if eaten. It is a pumpkin that is poisonous.

yǒuyīgèyánsèxiānyàndecūdàdeshuǐguǒ tāshìyīzhǒngyǒuhàideshíwù nàshìyīgè
有一个颜色鲜艳的粗大的水果，它是一种有害的食物。那是一个

nánguā tāshìyǒudúde
南瓜，它是有毒的。

Appendix 5. Testing procedure for free-recall experiments

TESTING PROCEDURE SHEET

EXPERIMENTS 3, 4 & 5
JULY - SEPTEMBER 2010

Materials and resources required for the study:

2 x research assistants
2 x laptops with large screen
2 x stopwatches
2 x program software and files
2 x tables
2-4 x chairs
1 x distraction-task game
1 x *Participant Registration Sheet* to anonymously record details of participants
4 x clipboards
4 x A4 envelopes to place the completed participant sheets into
Adequate amounts of sheet paper and pens
1/2 x testing spaces
1 x waiting/registration space

Set-up of test area

Set-up of the experiment area can be done by anyone involved.

- Utmost care should be taken to make sure testing spaces are not interfering/sharing stimuli with other testing spaces: e.g. stimuli screen not in view of each other/ not in view when participant is approaching the testing space.

Testing space - Participants are to be individually tested, or tested in pairs, in an experimental environment comprised of a quiet space with a laptop running the stimuli software programme. The large-screen laptop screen should be placed on a table, approximately 1 metre in front of a chair on which the participant should sit while viewing. Ambient stimuli will be reduced to a minimum within the testing area (e.g. noise and stimuli through open windows; walls plain with no posters, pictures, sign etc.)

Waiting/Registration area – This should be separate from the testing space. A similar amount of reduction of ambient stimuli is required by way of picture and sign removal, in addition to a small amount of seating for waiting participants.

Recruitment Methods

There are essentially 2 methods of recruitment/methods of receiving a participant into the experiment.

1) *On-site recruitment.*

- Make the prospective participant your approach aware that they is a 50RMB reward offered to be received when the participant return s for the second week of testing.

2) *Advance timetabled recruitment*:
- Snowballing; advance booking; advertisements
- Demands careful time management and attention.

Testing Procedure – Week 1

Please take great care to follow the instruction carefully. Your failure to do so could bias the results.

REGISTRATION:

- Ensure the participant fills in their details on the *Participant Registration Sheet*
- **Make sure to remember their participant number stated on the line they fill their details in on.**

IMPORTANT

- Do not engage in conversation with participants during the experiment. Answer their questions concisely. Make it clear you cannot talk to them at this point.
- Ensure to keep your stopwatch on you at all times.
- Always remember to record the participant's number on the completed Answer Sheet after they have finished before placing it in the folder.
- Always carry a pen with you.

Instructions for the two research assistants taking the participant through the testing procedure:

Please read carefully and familiarise yourself with the procedure before the testing period. This sheet can be used as a **prompt card** if so wished.

1) When a participant has arrived and has been marked off by the assistant taking care of the register, say to the participant "COULD YOU PLEASE FOLLOW ME", and lead the participant to the testing space. Request that they take a seat.
   - Make sure there are no distractions or potential distractions around the testing space before you begin – e.g. noisy people sitting/standing nearby.
2) At this point the screen will have the word "Start" displayed on it, as it is in its starting position. At this point you can advise the participant of the following: "YOU'RE ABOUT TO TAKE PART IN A SIMPLE MEMORY TASK. THE FOLLOWING VIDEO CLIP WILL CONTAIN A SERIES OF SHORT SENTENCES. EACH SENTENCE WILL REMAIN ON THE SCREEN FOR NINE SECONDS. YOU WILL SEE A TOTAL OF 32 SENTENCES. PLEASE TAKE CARE TO CONSIDER EACH SENTENCE CAREFULLY"
3) The video clip is started by touching any key on the laptop keyboard. Ask the participant "ARE YOU READY?", when affirmative, advise the participant: "OKAY. STARTING NOW"
4) Immediately retreat to a position directly to the side of the participant approximately 2 metres away on the chair provided.
5) When "End" is displayed on the screen (after approx. 5 minutes), the video clip has finished. Leave the laptop where is it. Lift the distractor-task game from the floor and place it ready on the table
6) **Distractor Task**: Inform the participant "PLEASE TAKE A SEAT. WE SHALL NOW HAVE A SHORT GAME".
   - Before starting the game make sure you have the stopwatch to hand. **Measure 3 minutes playing time.**
7) Begin playing the game. Request that the participant takes the first turn.
8) When 3 minutes is completed, advise the participant: "THANKS FOR THE GAME. TIME IS UP".
9) Now pass the participant a clipboard with a blank piece of paper and a pen found from a nearby source. Ask the participant: "COULD YOU NOW PLEASE WRITE DOWN ANY OF THE

SENTENCES YOU CAN REMEMBER FROM THE SCREEN. YOU HAVE THREE MINUTES TO WRITE DOWN AS MANY AS POSSIBLE". Using the stopwatch again measure 4 minutes. When the time is up SAY: "PLEASE STOP", and pick up the completed participant sheet.

10) Take the completed task paper, **RECORD THE PARTICIPANT'S NUMBER** on the top right-hand corner of the sheet and place it in the 'IMMEDIATE RECALL DATA' folder nearby.
11) Ask the participant: "CAN YOU PLEASE FOLLOW ME", and lead the participant back to the registration area.
12) Provide the participant with an APPOINTMENT CARD with your contact detail on in. Record the time at which they are to return next week.
13) Thank the participant for their assistance. Remind them that they will be rewarded with 50RMB upon their return for a 'SOMEWHAT DIFFERENT TASK'
14) IMPORTANT – Now return to the testing space and reset the software in advance of the next participant choosing a different random order file.
    - Never reset the software in view of a participant as the will have a brief glimpse of the upcoming stimuli.

Repeat the procedure with the next participant.

Testing Procedure – Week 2

Please take great care to follow the instruction carefully. Your failure to do so could bias the results.

REGISTRATION:

When the participant returns for their appointment ENSURE that they place a tick on the Participant Registration Sheet, and that you have memorised their number.

IMPORTANT

- If there is more than one participant make sure they use the clipboards provide to ensure their answers remain concealed.
- Carry a stopwatch and pen at all times.
- Do not indulge in conversation with participants during the experiment.

Instructions for the two research assistants taking the participant through the testing procedure:

Please read carefully and familiarise yourself with the procedure before the testing period. This sheet can be used as a **prompt card** if so wished.

1) Ensure that the participant has place a tick next to their phone number on the Participant Registration Sheet and that you know their participant number.
2) When a participant has arrived and has been marked off by the assistant taking care of the register, say to the participant "COULD YOU PLEASE FOLLOW ME", and lead the participant to the testing area. Request that they take a seat.
    - Make sure there are no distractions or potential distractions around the testing space before you begin – e.g. noisy people sitting/standing nearby.

3) Now pass the participant(s) a clipboard holding a blank piece of paper and a pen from nearby. Ask the participant: "COULD YOU NOW PLEASE WRITE DOWN ANY OF THE SENTENCES YOU CAN REMEMBER FROM LAST WEEK'S TASK. YOU HAVE 4 MINUTES TO WRITE DOWN AS MANY AS POSSIBLE."
4) Using the stopwatch, measure **4 minutes.** When the time is up SAY: "PLEASE STOP".
5) Take the completed task paper, **RECORD THE PARTICIPANT'S NUMBER** on the top right-hand corner of the sheet and place it in the 'DELAYED RECALL DATA' folder nearby.
6) Ask the participant: "CAN YOU PLEASE FOLLOW ME", and lead the participant back to the waiting area.
7) Request that the Sign the 'CASH RECEIVED SHEET' and give them their 50RMB compensation.
8) Thank the participant for their assistance.

Wait for the next participant to arrive then repeat.

Appendix 6. Coding procedure sheet

Point-Scoring Guidance Sheet

This sheet provides a points scoring system for two Scoring Assistants from which to code the written recalled items of persons tested.

Materials:
The A4 folder provided contains the participants test sheets.
A 'Coding Sheet' is provided for each individual that participated in testing.

In explanation the system of scoring, please observe the structure of the subject-predicate sentence:

[indefinite article] – [noun, *subject*] – [pronoun (that) + verb (to be)] – [adjective, *predicate*]

e.g. 'A cup that is thinking'

Participants are to be scored upon the basis of recall of the subject **noun** and the predicate **adjective** only. No other part of the sentence is relevant to point accumulation, including grammatical structure. A maximum of one point will be scored for recall of both the subject noun and the predicate adjective together in the same grammatical structure.

For example, a maximum of 1 points will be scored for:
e.g. 'A **cup** that is **thinking'**
or '**Thinking cup**'

BUT, a maximum 1 point should also be scored if either the noun or the adjective is of different grammatical root/form, a synonym, plural, subject to poor handwriting or poorly spelled (but obviously recognisable) – **it is the meaning of the recall that is important**, not its observable form. For example the following all score a maximum 1 point:

e.g'**Cups** that are **thoughtful**'
or 'A **cup** that is **reasoning**'
or 'A **cup** that has **thoughts**',
or '**Cups** that **think**',
or '**Thincing cup**'.

One point scoring sheet should be completed and retained each individual that participated in testing.
• Appropriate spaces have been provided to code for both the participants first (PERIOD 1) and second weeks (PERIOD 2) of testing.

• As points are scored one tick should be placed inside the box next to the test item it has relation to.

• Both scoring assistants should score for each participant on independent scoring sheets, followed by a check for concurrence between both scoring assistants. Any items upon which agreement is not reached should be discussed based upon the contents of this procedure sheet until concurrence is attained. Only one scoring sheet should be retained; the other discarded.

IMPORTANT:

• No same noun or adjective should be scored more than once (no box should have more than one tick inside it).

GUIDELINE NOTES - TROUBLESHOOTING

• TRANSFORMATION - If an adjective has been transformed into a noun but still retains its original meaning it should also be considered correct – e.g The dead [noun] that is a corpse [noun].

• SYNONYMS should be adjudged according to their presence in a respectable thesaurus such as Oxford or Chambers publications.

• GRAMMATICAL ROOTS – Any recalled item sharing the same grammatical root should be considered correct and ticked of accordingly - e.g. near = nearby, dimension = dimensional, thinked = thinking.

Reference list

Test Items – Complete Listing

fMCI items

A mouse that is talking
A wolf that is acting
A man that is invisible
A being that is everywhere
A skeleton that is fighting
A balloon that is hovering
A venus-flytrap that is grabbing
A tree that is thinking

uMCI items

A rabbit that is egg-laying
A snail that is reading
A gardener that is bodiless
A chef that is immortal
A comet that is sad
A snowflake that is hungry
A cucumber that is listening
A carrot that is ticklish

fINT items

A caterpillar that is eating
A cow that is lying down
A boy that is dirty
A queen that is rich
An icicle that is dripping
A stone that is smooth
A cabbage that is rotting
A potato that is muddy

uINT items

A goat that is deaf
A squirrel that is swimming
A postman that is hiding
A monk that is skipping
An island that is four-sided
A moon that is hollow
A cactus that is greasy
A pumpkin that is poisonous

Appendix 7. **Additional Experiment #1: UK Question Sheet**

Answers in the combined form of one adjective plus one noun (in that order, to form a modified noun), are to be selected by yourself from the following lists.

This is the POSITIVE EMOTION category.
Please write 'POSITIVE EMOTION' in the first available 'SUBJECT CATEGORY' box on your Answer Sheet. Please record your answers in the spaces numbered 1-4 underneath.

Question: Which combinations (one adjective + one noun – in that order) fill you with positive emotion/good feelings? It could be that your chosen combination is representative of the subject of a pleasant past memory, such as an event of personal significance. It could be an entity you simply have a strong liking for, or just one that is stimulating in itself in a particularly pleasant manner when you think of it. Importantly, whatever your choice, it should fill you with a feeling of strong positive emotion.

Please write-down 4 modified-noun combinations (one adjective + one noun – in that order) on the sheet provided. Do not hesitate to correct/change/delete your choices until you feel you have the 4 answers that are your best possible choices. Please take time to carefully consider all nouns and all adjectives. **You have 4 minutes in which to complete this task**. YOU WILL BE NOTIFIED WHEN YOU HAVE 30 SECONDS REMAINING.

ADJECTIVE LIST		NOUN LIST
spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough, devious, dying, screaming, murderous thoughtless, ugly, untalented, angry, scary, horrible, high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long, loyal, healthy, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping.	+	son, daughter, mother, father, man, woman, boy, girl, baby, child, dog, cat, frog, spider, bear, lion, goat, snake, shark, whale, mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing, tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo.

Answers in the combined form of one adjective plus one noun (in that order, to form a modified noun), are to be selected by yourself from the following lists.

This is the NEGATIVE EMOTION category.
Please write 'NEGATIVE EMOTION' in the first available 'SUBJECT CATEGORY' box on your Answer Sheet. Please record your answers in the spaces numbered 1-4 underneath.

Question: Which combinations (one adjective + one noun – in that order) would you consider to be associated with negative emotion in yourself? It could be that your chosen combination stimulates a negative emotional feeling in you because it is representative of an unpleasant subject of past memories, or other event of personal significance to you. Or, it could just relate to an entity which you have a strong dislike to, find particularly repulsive, or associate with feelings of anger, etc.

Please write-down 4 modified-noun combinations (one adjective + one noun – in that order) on the sheet provided. Do not hesitate to correct/change/delete your choices until you feel you have the 4 answers that are your best possible choices. Please take time to carefully consider all nouns and all adjectives. **You have 4 minutes in which to complete this task**. YOU WILL BE NOTIFIED WHEN YOU HAVE 30 SECONDS REMAINING.

ADJECTIVE LIST		NOUN LIST
spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough, devious, dying, screaming, murderous thoughtless, ugly, untalented, angry, scary, horrible, high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long, loyal, healthy, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping.	+	son, daughter, mother, father, man, woman, boy, girl, baby, child, dog, cat, frog, spider, bear, lion, goat, snake, shark, whale, mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing, tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo.

Answers in the combined form of one adjective plus one noun (in that order, to form a modified noun), are to be selected by yourself from the following lists.

This is the IMAGERY category.
Please write 'IMAGERY' in the first available 'SUBJECT CATEGORY' box on your Answer Sheet. Please record your answers in the spaces numbered 1-4 underneath.

Question: Which combinations (one adjective + one noun – in that order) would you consider to be especially easy to picture in your mind, without the need of actually viewing the object itself? Your choice should not necessarily represent any entity of any special emotional significance to you, but could represent some entity from your past/memory which makes visualization particularly easy for you.

Please write-down 4 modified-noun combinations (one adjective + one noun – in that order) on the sheet provided. Do not hesitate to correct/change/delete your choices until you feel you have the 4 answers that are your best possible choices. Please take time to carefully consider all nouns and all adjectives. **You have 4 minutes in which to complete this task**. YOU WILL BE NOTIFIED WHEN YOU HAVE 30 SECONDS REMAINING.

ADJECTIVE LIST		NOUN LIST
spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough, devious, dying, screaming, murderous thoughtless, ugly, untalented, angry, scary, horrible, high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long, loyal, healthy, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping.	+	son, daughter, mother, father, man, woman, boy, girl, baby, child, dog, cat, frog, spider, bear, lion, goat, snake, shark, whale, mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing, tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo.

Answers in the combined form of one adjective plus one noun (in that order, to form a modified noun), are to be selected by yourself from the following lists.

This is the HUMOUR category.
Please write 'HUMOUR' in the first available 'SUBJECT CATEGORY' box on your Answer Sheet. Please record your answers in the spaces numbered 1-4 underneath.

Question: Which combinations (one adjective + one noun – in that order) would you consider to be especially humorous to you? Your choice could be one of special significance to you which draws from past experience memories, or it could just be one that seems particularly amusing to yourself when in combination.

Please write-down 4 modified-noun combinations (one adjective + one noun – in that order) on the sheet provided. Do not hesitate to correct/change/delete your choices until you feel you have the 4 answers that are your best possible choices. Please take time to carefully consider all nouns and all adjectives. **You have 4 minutes in which to complete this task**. YOU WILL BE NOTIFIED WHEN YOU HAVE 30 SECONDS REMAINING.

ADJECTIVE LIST

spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough, devious, dying, screaming, murderous thoughtless, ugly, untalented, angry, scary, horrible, high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long, loyal, healthy, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping.

+

NOUN LIST

son, daughter, mother, father, man, woman, boy, girl, baby, child, dog, cat, frog, spider, bear, lion, goat, snake, shark, whale, mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing, tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo.

Answers in the combined form of one adjective plus one noun (in that order, to form a modified noun), are to be selected by yourself from the following lists.

This is the INTEREST category.
Please write 'INTEREST' in the first available 'SUBJECT CATEGORY' box on your Answer Sheet. Please record your answers in the spaces numbered 1-4 underneath.

Question: Which combinations (one adjective + one noun – in that order) would you consider to be especially thought provoking, or an especially interesting combination which leads into several more thoughts and theories? Your choice should not necessarily represent any entity of any special emotional significance to you, or only be capable of bringing strong imagery to mind, but perhaps a combination you feel interesting of its own accord.

Please write-down 4 modified-noun combinations (one adjective + one noun – in that order) on the sheet provided. Do not hesitate to correct/change/delete your choices until you feel you have the 4 answers that are your best possible choices. Please take time to carefully consider all nouns and all adjectives. **You have 4 minutes in which to complete this task**. YOU WILL BE NOTIFIED WHEN YOU HAVE 30 SECONDS REMAINING.

ADJECTIVE LIST		NOUN LIST
spiky, smooth, sharp, blunt, dry, wet, clean, dirty, round, straight, rough, devious, dying, screaming, murderous thoughtless, ugly, untalented, angry, scary, horrible, high, low, tall, short, deep, thin, huge, tiny, wide, narrow, long, loyal, healthy, laughing, loving, conscientious, beautiful, successful, happy, fantastic, comfortable, creeping, charging, playing, attacking, walking, sitting, growing, shrinking, lifeless, sleeping.	+	son, daughter, mother, father, man, woman, boy, girl, baby, child, dog, cat, frog, spider, bear, lion, goat, snake, shark, whale, mountain, valley, bridge, building, knife, cave, stone, city, chair, clothing, tree, plant, tomato, apple, potato, vine, mushroom, flower, banana, bamboo.

Appendix 8 Additional Experiment #1: UK Answer Sheet 1a

Task Instruction and Answer Sheet

Week 1

CALIB1A/JG/0909

Please fill in your details here, before you begin the task.

Age	
Nationality	
Male/Female	
Date	
Time	

MANY THANKS!!!!!!

PLEASE READ THE FOLLOWING CAREFULLY BEFORE YOU BEGIN:

(This information can also be referred to in the process of completing the tasks)

- Each task requires a total of **4 answers – no more, no less**.
- You shall have a total of **4 minutes to complete each task**.
- Please record your answers to each task in the following form:

1. [ADJECTIVE] [NOUN]
2. [ADJECTIVE] [NOUN]
3. [ADJECTIVE] [NOUN]
4. [ADJECTIVE] [NOUN]

… all your possible choices of 'ADJECTIVES' and 'NOUNS' will be clearly labelled.

IMPORTANT:- Please ensure that no answer is repeated within a task, or between all of the tasks (but, use individual nouns and adjectives as many times as req'd)

DON'T WORRY! All shall become clear when you see the first task page. Remember, this is only a task - it is not a test from which you can be measured or judged in any way! There are no right or wrong answers…

PLEASE CONSIDER YOUR ANSWERS VERY CAREFULLY

Please do not turn over any page until instructed to do so.

Please record your answers here…

Task 1 - SUBJECT CATEGORY [ ]

1.

2.

3.

4.

Task 2 - SUBJECT CATEGORY [ ]

1.

2.

3.

4.

Task 3 - SUBJECT CATEGORY [ ]

1.

2.

3.

4.

Task 4 - SUBJECT CATEGORY [ ]

1.

2.

3.

4.

Task 5 - SUBJECT CATEGORY [ ]

1.

2.

3.

4.

Section 2

*You have 3 **minutes** to complete all the following tasks. Please record your answers on this sheet.*

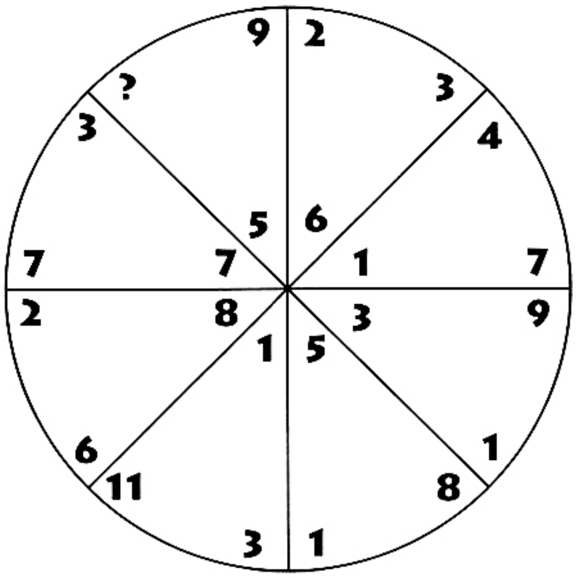
Task 1

By using every number between 1 and 16 please complete this number square so that every line, up and down left to right and diagonal adds up to 34?

13			16
	10	11	
	6		
1			4

Task 2

Replace the question mark with the correct number. (Clue: look at the relationship between the numbers in each segment.)



Task 3

Which number completes this chain?

2	10	3	15	8	40	33	?

Appendix 9. Additional Experiment #1: UK Answer Sheet 1b

Task Answer Sheet 2

Week 1

CALIB1B/JG/0909

Please fill in your details here

Age	
Nationality	
Male/Female	
Date	
Time	

MANY THANKS!!!!!!

Please record your answers below: